Wireless World

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Exhibitions—National and International

DURING the past month the activities of the staff of this journal have been, if not entirely absorbed, to a considerable extent prescribed by the spate of radio and electronic exhibitions which have followed each other (and in some cases overlapped) in the principal cities of Europe. In this issue we are able to give first-hand impressions of the shows in London, Farnborough, Berlin, Amsterdam and Copenhagen, and next month there will be reports from members of the staff who, at the time of writing, are in Milan and Paris.

We take the trouble to see all these things for ourselves and, as far as lies in our power, to convey our impressions of them to our readers, because we think it important that our own radio and electronics industry should be seen in proper perspective against a wider background, if not of the world as a whole at least of Europe where developments will affect our future outlook, whether or not we eventually join the Common Market.

Controversy always has and always will surround the necessity or advisability of holding national exhibitions at all: they are very expensive; space must be booked months if not years in advance of the knowledge of what, if anything, new there will be to show; information on new products can and often must be disclosed between show times to dealers who will not be slow to exploit the possibility of putting on their own shows for the benefit of customers. But in spite of all these arguments and when all is said and done there is really no substitute for the sense of occasion which is evoked by a big exhibition—and, although they would be the last to admit it, this applies to the exhibitors themselves as well as to the general public. The time and place set a limit to procrastination and therein lies an element of danger. We must not force the march of events to the point where immature developments are shown prematurely to the public. If things go wrong in a demonstration at an exhibition one cannot get the visitors back next week to show them it really works properly.

Looking to the future it is certain that exhibitions will go on, as they always have, in spite of grumbles by exhibitors about disruption of what they regard as more important work. Such changes as can be foreseen are likely to be in the frequency with which large exhibitions are held and the extent to which they become international rather than national in character.

Ideally, one should hold an exhibition whenever there is something new to show, and in the roaring '20s and '30s a year seemed too long to wait, so rapid was the rate of technical development. The milestones seem more widely spaced these days, but who would dispute that we should hold an exhibition here and now if a breakthrough were discovered in display devices which enabled present colour performance to be achieved at a cost no higher than that of a dual line standard receiver? Meanwhile, a compromise must be sought and our vote would go to the biennial show. The five-yearly show in Denmark seems rather frugal, and annual shows are now apt to give the impression of "the mixture as before"—particularly when, as sometimes happens, one finds the stands of the same firms in the same places year after year. The German radio show, which many would say is the best in Europe at the present time, both from the point of view of visitors and exhibitors, has since the war always been held in alternate years. Nearer home we now have the Instruments, Electronics and Automation Exhibition alternating with the Components Show and developments in these fields are certainly no fewer or less varied than those in domestic receiver practice.

The proposals of the German radio industry in 1959 to make their domestic receiver show openly international, on a reciprocal basis with other countries, turned out to be premature (we in this country scrutinize all exhibits carefully to ensure that they are predominantly of British origin), but in the future distinctions between national and international labels are going to be increasingly difficult to draw. With the regrouping of industry in all countries into large units and with subsidiaries of these groups setting up factories in each others' countries the only strictly national element is the cost of labour in the final product—and possibly the styling to meet the tastes of the local market. Basic technical developments and the driving forces behind their exploitation are already becoming increasingly international in character.

Parametric Amplification

OPERATION BEYOND NORMAL CUT-OFF FREQUENCY

AN interesting mode of operation for high-frequency transistors has been developed which gives input characteristics similar to a parametric amplifier and allows useful conversion gains to be obtained beyond the normal cut-off frequency of the transistor.

Normally available high-frequency transistors offer a maximum oscillation frequency of around 1000Mc/s. In this new mode of operation it was possible to use a high-frequency transistor with a normal cut-off frequency of 600Mc/s at 1000Mc/s input frequency in a third harmonic mode mixing circuit. This gave 50dB conversion gain with a noise figure of 7dB for an intermediate frequency of 10.7Mc/s.

The high-frequency behaviour of a transistor is mainly expressed by its cut-off frequency and determined by its emitter capacity, which is formed by the barrier layer capacity C_{es} and the diffusion capacity C_{ed}. Theory shows that the current-dependent or diffusion capacity depends in the following manner on the thickness of the base:

$$C_{ed} = 39\,(W^2/2D)\,I_e \quad \ldots \quad (1)$$

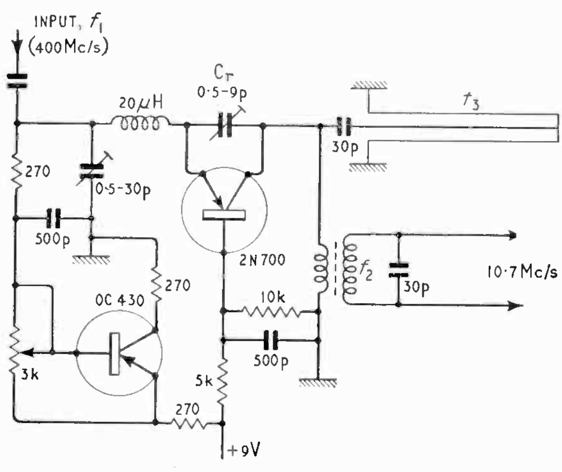
where W = width of the base, D = diffusion constant of the holes in a p-n-p transistor, and I_e = emitter current.

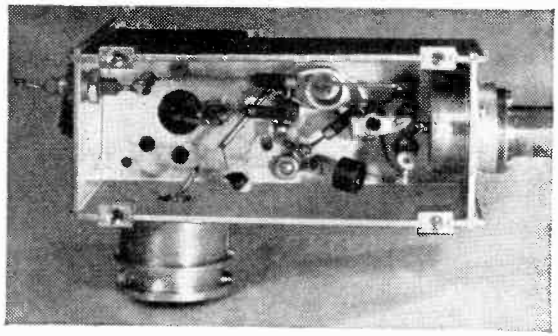
The input cut-off frequency is given by:—

$$f_o = 1/2\pi r_{bb}\,C_e \quad \ldots \quad (2)$$

where r_{bb} = intrinsic base resistance and C_e = total emitter capacity. The diffusion capacity in the grounded-base circuit appears like an inductance which can be made to cancel the barrier-layer capacity (on the convention that the direction of voltage and current is counted as positive). If by this process C_e can be made equal to zero, f_o will reach infinity. In the following part we will call this condition of operation "current-tuned".

The circuit which is to be discussed is shown in the diagram. The 2N700 high-frequency transistor





Underneath view of transistor parametric amplifier

is used as a negative-feedback oscillator in which the oscillation frequency f_3 (smaller than f_{max}, the frequency at which the gain falls to unity) is determined mainly by the coaxial line. Capacitor C_r controls the amount of feedback and thereby the conversion gain. From the theory of feedback amplifiers, the output impedance will be transferred by this capacity C_r to the input as a negative resistance with an inductive component. This capacity forms with the input circuit a capacitive divider and matching network and must be adjustable. For high emitter current and "current-tuned" conditions the input is real and has the value

$$r_e = (KT_o/q)\,(\alpha/I_e) + r_{bb} \quad \ldots \quad (3)$$

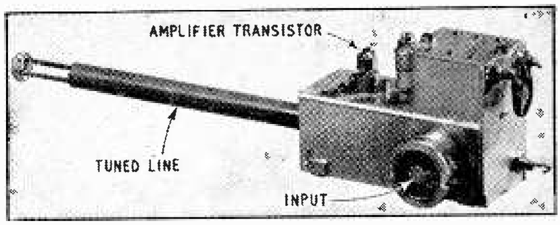
where K = Bolztmann's Constant, T_o = absolute temperature, q = charge of an electron and α = current gain. This is correct even beyond the normal cut-off frequency and will only be limited by the transit time of the minority carriers across the effective base width. To achieve this condition properly it has been found most convenient to use a ZG-Diagraph, since this readily enables the input impedance to be set to the correct resistive value, and it is also necessary to use an electronically regulated source which allows the voltage across the emitter and base to be set, and yet which keeps the emitter current constant when once set.

One can thus consider the input of the transistor as a varactor with a relatively high resistor (r_e) in series. Since we are dealing with an oscillating feedback circuit, the series resistor is negative and the input circuit appears to have a high Q at both the input and oscillating frequencies (f_1 and f_3) provided that these only differ by a small amount, e.g., by the magnitude of the intermediate frequency f_2. This also applies to harmonics of f_3. For example, taking f_2 as 10Mc/s one can use the third harmonic of a 300Mc/s oscillating frequency to get conversion gain for a 910Mc/s input signal.

The noise is mainly determined by the value of r_{bb} and is extremely low even up to 2000Mc/s, for at such frequencies and at high currents the mag-

with Transistors

By ULRICH L. ROHDE



nitude of the first part of equation (3) becomes zero.

Amplification is produced because, for a properly adjusted transistor, the input circuit appears to have a high Q and is, just like any parametric amplifier, periodically tuned within the needed bandwidth as the transistor impedance is varied from the capacitive to the inductive side by the oscillating frequency (which varies C_{od} by modulating the emitter current). Since the intermediate frequency also appears at the input, the transistor can be used to amplify f_2 also.

TABLE

Frequency (Mc/s)	Transistor	Amplification (dB)	Noise-figure (dB)
88-100	OC 615	85	3
88-100	AF 114	88	3.2
*200	OC 615	83	3
*400	OC615	46	5
*600	OC 615	25	8
600	AF 102	46	6
600	AFY 11	70	5
600	AF 122	47	7
600	AF 106	50	6
1000	AF 106	50	8
1000	2 N 1141	60	7
1000	V 122†	55	7
2000	V 122†	35	9
2000	2 N 700	30	11

*Fundamental frequency at 100Mc/s, harmonic mixing.
†Silicon npn transistor, similar to AFY 10 or 2N706.

The table gives practical examples for different frequencies and transistors. (In each case the bandwidth was 500kc/s and the intermediate frequency 10.7Mc/s.)

In conclusion I should like to thank Dr. Rüchardt of the development department of Siemens' semiconductor factory and Dr. Engbert of the semiconductor division of Telefunken for their valuable contributions to the success of this work. The firms Valvo and Intermetall have helped me by providing high-frequency transistors so that this investigation could be carried out on the broadest basis.

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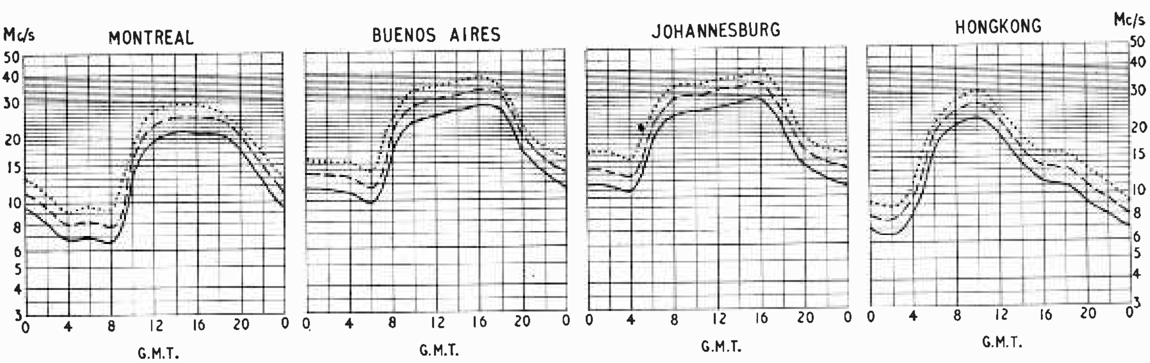
SHORT-WAVE CONDITIONS

Prediction for October



•••••••••• 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

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 gives the highest frequencies that will sustain a partial service throughout the same period.

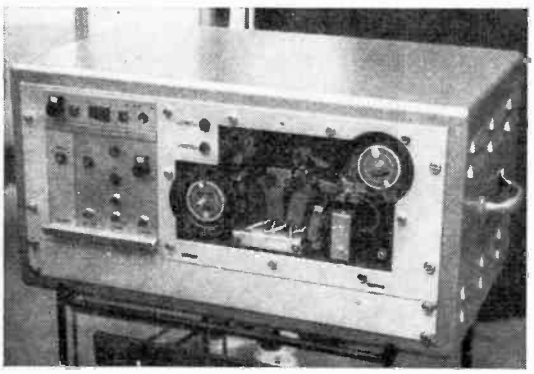
Amsterdam Firato

THIS year the Amsterdam radio show—named Firato, after the organizing body, the *Fabrikanten, Importeurs en Agenten op Radiogebied*—moved to more commodious premises in the fine new R.A.I. exhibition building in the Europaplein on the outskirts of the city. Whereas most of the European radio exhibitions are strictly national in character, the Firato is international and one sees the products of American, Japanese, as well as European firms exhibited, mostly by their Dutch agents, but often by the firms themselves, e.g., Solartron and Venner from England, and Graetz, Schaub-Lorenz, Siemens and Telefunken from Germany. Imhofs supported their agents (J. Th. van Reysen) by taking their travelling showroom van into the exhibition. A notable absentee this year was Grundig who elected to put on a separate event in the showrooms of their Amsterdam agents.

As befits the dominant radio and electronics firm in the Netherlands, Philips occupied the largest stand in the exhibition. This was sectionalized and well laid out, and a 92-page guide to the exhibits had been specially prepared for the occasion. Some recent Philips developments have been reported elsewhere in this issue in connection with the Berlin radio exhibition, but many others were shown in Amsterdam—for example, the Type ZPH, 8MR700 series of mobile telephones with 5-, 10-watt outputs and frequency ranges of 68-80 or 146-174 Mc/s. Through the initiative of the Netherlands PTT, mobile radio is becoming of rapidly increasing importance in Holland. Already it is possible to communicate with telephone subscribers anywhere in Holland through 38 fixed stations, and a new system of coded signalling ("Simofoon") is under development by the PTT which will enable simple messages to be sent by combinations of three coloured lights on the car dashboard. In this way the available spectrum will provide a large number of much narrower channels than are required for speech.

Intercomm. systems developed by Philips include a neat simplified two-wire system ("Snelcontact") for house or office, and more elaborate systems for schools and hospitals, the latter with voice communication between patient and duty nurse which saves time and energy.

In addition to the "vertical construction" tape recorder illustrated in the German show report (p. 534



Philips EL 3599 message repeater for 19-inch rack mounting, with front cover removed.

Philips EL 3582 dictating machine, showing (inset) independent tape supply and take-up casettes.

of this issue) Philips have developed a new professional recorder (EL 3566) and a new four-track portable stereo recorder (EL3531) with stacked moving-coil microphone. For synchronizing automatic slide projectors with tape recordings a transistorized accessory (EL 3769/00) is now available to provide switching pulses from the second track. A new message repeater (EL 3599) for airports, etc., uses standard ¼-in tape and has a maximum duration of 30 minutes (at 1⅞ in/sec) with a very high speed of rewind. Selection of the required message is remotely controlled, a translucent section of tape in conjunction with a lamp and photoelectric relay being used to find the start of the message. A number of these units, which are 7in high, can be assembled in standard 19-in racks. In the latest Philips dictating machine (EL 3582) interchangeable drop-in tape spools give 40 minutes duration on dual-track ¼-in tape. Tape threading is completely mechanized; a thin perforated metal leader tab is picked up, passed through the recording head gate and connected to the take-up spool simply by squeezing together the two keys seen in the photograph above the linear time (footage) scale.

In electronics Philips are actively pursuing the application of computer techniques to the comparatively simple tasks of automation in the home and in self-service stores and were demonstrating prototype circuitry for desk calculators and other labour-saving devices. Many new valves and components were shown, including a miniature (38×31mm) decade counter tube (Z504S), a miniature cadmium sulphide cell (ORP14) for automatic cameras, quartz crystals now in rectangular evacuated glass containers instead of the familiar metal cases, and a miniaturized version (ZZ1000) of the well-known cold cathode voltage reference tube 85A2. As the result of extended research (and extrapolation) a life of 600,000 hours is predicted for cold cathode switching tubes now receiving renewed attention by Philips.

In the domestic field a redesigned "Memomatic" channel selector with concentric fine tuning was noted on Philips television receivers, and also a neat and unobtrusive linear channel indicator in a horizontal slot in the picture surround. The transistor battery ("cordless") sound broadcast receiver B6X19T incorporates a combined tuning indicator and battery voltage check in the form of a miniature pointer meter let into the loudspeaker grille.

The flair for styling and craftsmanship which has always been evident in the Erres range of television and sound broadcast receivers marketed by R. S. Stokis en Zonen was again reflected in the décor of their stand. Last year it was *haute couture* and this year sets were displayed against a background of the art of violin making.

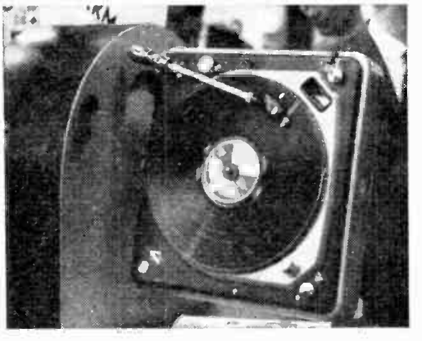
The chassis of Erres receivers are made by the firm of van der Heem who are also well-known for their professional communications equipment and electronic instruments. Of particular interest on their stand this year was a compact portable television signal generator (Type 3521) measuring 11in×8in×2in and weighing only 4lb. It uses transistors throughout with self-contained batteries and produces a check pattern with a superimposed circle. The output is 30mV in bands I and II and 5mV in bands IV and V, and models are available for 625- or 819-line standards.

The firm of Jobo N.V., who specialize in gramophone turntables and record players, gave a striking demonstration of their type 2600 professional turnable in conjunction with the "All Balance" pickup arm. The unit as a whole was mounted on a rig which slowly tilted it from near vertical to near vertical through about 170°, with no groove jumping or other audible effect on the reproduction.

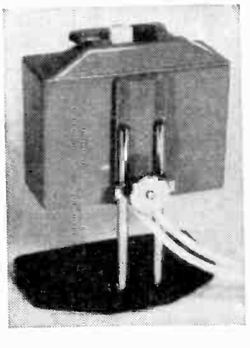
The Japanese firm of Sony showed a wide range of transistor sets and tape recorders through their Dutch agents Fa. A. Bansteder and Toshiba Tokyo Shibura Electric through their agents N. V. Emjeka showed a neat transistor echo sounder ("Fish-Tenda") costing in Holland the equivalent of £36. Toshiba are also marketing comprehensive ranges of tantalum sintered-anode and ceramic capacitors.

The "Tele-com STTR-801" transmitter-receiver distributed by Fa. P. Jennen is a remarkably compact transistor pocket instrument measuring 6¾in×2⅝in×1⅝in. It works in the 27 Mc/s band and both transmitter and receiver are crystal-controlled. Power output is 100mW into a telescopic λ/4 aerial and the supply comes from eight Penlite cells.

Although there is a prescribed upper limit in phons for the sound level which individual exhibitors may emit, the Firato, like other Continental shows, has a high cumulative background. It is not all noise and we heard some very fine recitals by amateur organists on the stands of the many Dutch firms exhibiting electronic organs.

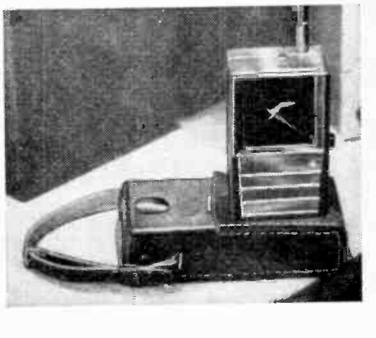


Jobo 2600 transcription turntable and "All-Balance" pickup arm.



Slide projector control unit for use with tape recorders (Philips EL 3769/00).

Portable transistor television signal generator (van der Heem).



"Tele-Com" crystal-controlled pocket transmitter-receiver for 27 Mc/s.

UNATTENDED BATTERY OPERATION

OPTIMUM CONDITIONS FOR FLOAT-CHARGING NICKEL-CADMIUM CELLS

By H. C. SPENCER

THE rapidly increasing use of unattended equipment of all sorts is due in no small measure to the development of apparatus employing transistors and therefore operating from quite small power intakes. These low power requirements are now being met either by using primary cells of one sort or another, power-feeding along a signal-carrying line where this is possible, or storage cells operated on either a charge/discharge basis or float-charge from a primary power source.

We are rapidly reaching the state, if in fact we have not already done so, when servicing visits to unattended equipment are made primarily for battery maintenance. Because of the remoteness or inaccessibility of many of these installations, sending an engineer to the site can be a very costly business. A considerable saving in running costs should therefore be possible by using a technique of battery operation whereby the frequency of the need for these visits is much reduced.

Looking at the storage battery itself, its most recurring need for attention is to replace lost electrolyte, as charging may be carried out quite automatically without actually visiting the installation. One solution to this problem would be to use the hermetically-sealed secondary cells which are now in production. An alternative possibility is to use nickel-cadmium cells of conventional and cheaper construction under controlled conditions, and this method has been found to give the required performance. One of the characteristics of the nickel-cadium cell is that if its potential can be kept below that at which dis-association by gassing of the electrolyte takes place, then loss of electrolyte can only be due to evaporation. By designing a vent incorporating a release valve, very little loss will take place, as much of the trapped vapour will condense back during night-time cool periods.

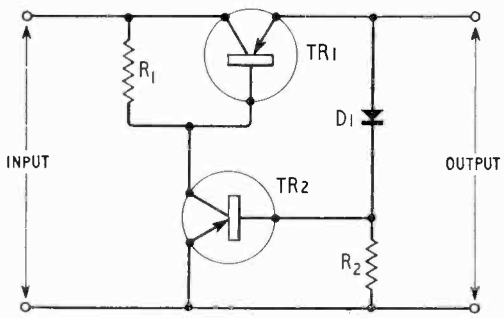


Fig. 1. Circuit diagram of charging regulator.

A simple static circuit to ensure that the storage battery potential cannot rise above a predetermined level is shown in Fig. 1. The predetermined level is set by choosing a suitable Zener diode, or combination of diodes D1. Fig. 2 shows the performance of this very simple arrangement as designed to keep an 8-cell battery charged in this way.

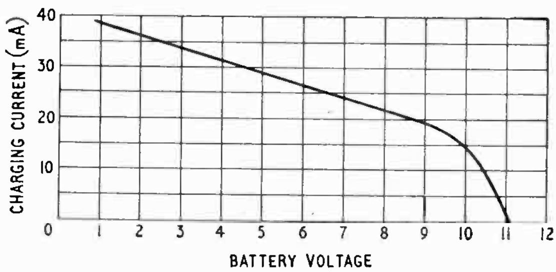


Fig. 2. Operating curve of charging regulator with simulated solar battery source, 18V, 390Ω.

The value of R_1 is chosen so that not only is the voltage drop across the control transistor TR1 as small as possible during the normal charging operation, but also to allow a high enough gain to be obtained in the amplifier transistor TR2 so that a sharply defined "knee" appears in the characteristic at the point of the Zener voltage of D1.

One very attractive power supply makes use of "NIFE" type PV cells. This type of cell is available in nominal capacities up to 45Ah, and has a big reserve of electrolyte above the level of the top of the plates. Provided the cell potential is not allowed to exceed 1.39V, some five years' use in a warm climate may be expected before the necessity for topping up will arise. A small price will be paid for this in performance in that only about 80% of the ultimate battery capacity can be utilized, but this is offset to a large extent by realizing a 90%-95% battery efficiency.

This circuit is being used to control a storage battery which is charged from solar cells, where some form of control towards the end of the summer is essential since then the level of charge in the battery is at its highest in preparation for the dark winter days. It can, however, also be used with advantage with a primary-cell/storage-cell combination. In this latter arrangement a number of primary cells charge a battery of secondary cells in order to supply an intermittent heavy current load. Without some form of regulator, the number of primary cells must be determined by the maximum allowable charge which will be made by fresh cells delivering their highest voltage. These cells will run down until their current can be delivered. Discarding them at this stage means losing the current from the remainder of the "fuel" chemical, which is often an appreciable fraction of the primary cell total output. The regulator therefore allows the use of a number of cells such that they may be used down to their virtual end-point of 0.9V or whatever it is, without an initial over-change period with its consequent waste. The cost of energy from primary cells certainly warrants taking every step to ensure full and efficient use of it.

Where sealed cells are used, for whatever reason, a somewhat similar state exists in that a dangerously high internal pressure is liable to be built up. As this pressure is due to a high gassing rate, the preventive measure is to impose a limit on the cell voltage. Because this type of cell is generally employed where space is at a premium, the compromise between minimum gassing and maximum capacity is struck nearer to maximum capacity and a slightly higher voltage is usually specified in this case, 1.46V being a typical value.

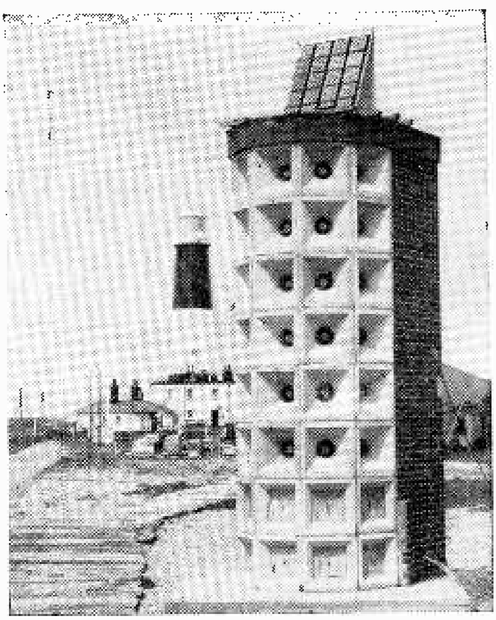
Although this method may at first glance appear to be a variation of the well known "constant potential" method of charging, there are in fact two considerable differences. First, the charging rate is reduced and stopped by the control circuit instead of by the hydrogen over-potential which builds up on the negative plates towards the end of a charge in the constant-potential system. Secondly, the charge current is limited more by the nature of the source of supply than anything else. No provision need be made for the heavy initial charging currents which flow when a true constant-potential system is used. It is therefore suggested that a system of the type such as the one described could be termed a "limited-potential" system.

Experiments initiated over the past few years show that the system appears to be quite practicable. A watch has been kept on electrolyte level, and measurements have been made on cells to determine actual as well as ultimate capacity. Contrary to experience gained with other systems—which tended to suggest that over a long period the reduction in capacity would be serious, this has not been the case. In an experiment which was made to check this, no reduction was measured after 21 months operation in this way.

Acknowledgments are due to British Telecommunications Research Ltd., for permission to publish these notes, and to NIFE Batteries, Ltd., for arranging informative discussions with their engineers.

SOLAR-CELL LIGHT BUOYS

TRINITY HOUSE research engineers are investigating the use of silicon photo-voltaic cells, or to give them their common name, solar cells, in marine buoy lighting. The justification for the research is the fact that the gas cylinders used at present require replacement about once a year—sometimes in highly adverse weather conditions—whereas solar cells are, as far as is at present known, everlasting.



An experimental bank of 400 Ferranti M.S.11 solar cells mounted on top of the electroacoustic fog signal at Dungeness

An experimental installation has been made, containing 400 cells wired in series parallel, the energy being used to charge ten NIFE storage batteries. The equipment is intended for use in shore navigation lights. It is also intended to build a model buoy to determine the optimum positioning of the solar cells when subjected to typical motions caused by wind and rough water.

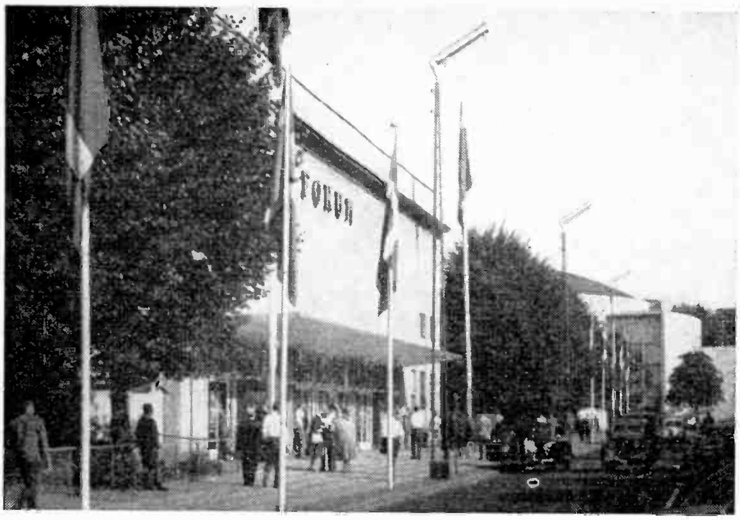
The NIFE storage cell in the buoy, of 45Ah capacity, will, in addition to providing power for the lamp or flash-tube, operate a transistor coder to give the required flashing sequence. An additional photo-cell will switch off the coder and lamp during the day, and a diode in each parallel arm of the bank of solar cells will prevent the storage cell discharging through the solar cells at night.

Among the problems outstanding are the effects of prolonged lack of sunlight, although direct sunlight is not necessary, and, as sea-birds will find the buoy a convenient perch, the well-known "Nelson's Column effect."

Steel Sampled by Spark Spectrography

A Hilger and Watts machine, the "Polyvac 12" can provide a printed record of the amounts of the constituents of a sample of steel by simultaneous spectrographic analysis of the light given out when a spark is passed between the sample and another electrode.

The light is split into a spectrum by fluorite prisms (some of the lines desired are in the ultra violet region—hence the use of fluorite and the evacuation of the apparatus to avoid absorption by the oxygen of the air), the desired lines being isolated by narrow slits and fed into 12 E.M.I. photomultipliers by a system of mirrors. The photomultiplier outputs are stored on capacitors and, at the end of the exposure time the charge is registered by a meter, pen recorder or typewriter. Analysis of "simple" steels can be achieved in 75sec whilst a determination of eleven constituent elements takes only three minutes.



Copenhagen Radio Show

DENMARK'S radio and television exhibition (*Radio og Fjernsyn i Forum*) is held once every five years in the Forum, a hall within walking distance of the centre of Copenhagen large enough to accommodate the 60 exhibitors who this year supported the exhibition under the patronage of H.M. King Frederick IX.

The indigenous radio and electronics industry of Denmark may be small by European standards, but it is very well balanced and its products are of excellent quality. Its radio and television set manufacturers compete successfully with powerful importers, and there is an active component industry as well as a sprinkling of firms specializing in professional electronic and measuring equipment and, of course, electroacoustics, sound reproduction and "hi-fi" in which Denmark has made her own niche.

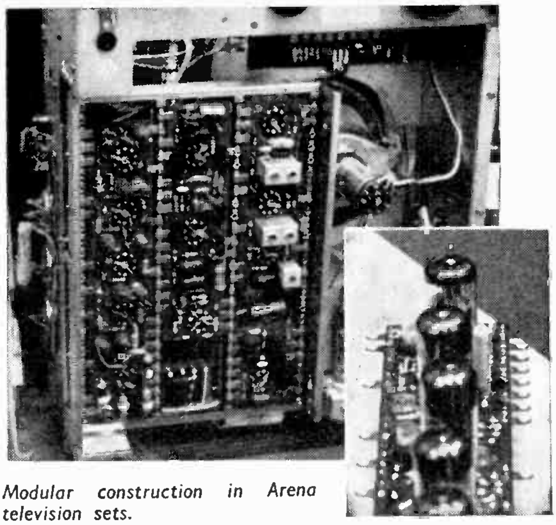
This year the number of television licence holders in Denmark is likely to pass the 700,000 mark (in 1952 there were 150). In addition to the programmes radiated by *Danmark's Radio* in bands I and III, many viewers are able to receive some of the German second programme stations at u.h.f. so that in most receivers there is provision for future development in this direction. Copenhagen has its own television centre and there was an excellent model showing future plans for its extension.

Public demand is for large screens and, as in most other European countries, the 23-in size is dominant. Portable TV sets are 19-in—even the all-transistor model shown in prototype form by Linnet & Laursen. This uses the Sylvania type 19 BAP4 display tube and 31 transistors. Power consumption is 3.2A from a 12-V accumulator. The bulky size of this "portable" seemed incongruous after the neat Pye and Ferguson transistor sets which were introduced last year in England, and we asked the designer why he had elected to use a 19-in tube. "Because a smaller picture size—even in a portable—would have no sale in Denmark. Even if it means leaving the baby behind on a picnic, the TV picture must be at least 19-in!" We got the impression that this view is held not only in Denmark but in most other Continental countries.

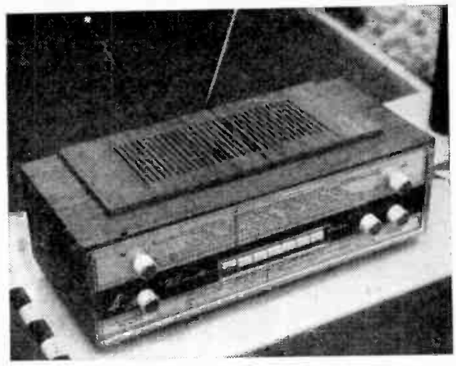
Chassis construction and layout generally follows conventional lines in Denmark, but we noted a neat modular system in Arena sets in which printed-circuit sub-assemblies are provided with hooked connecting tags which are firmly held, but can be quickly released by a half turn on each of the holding-down screws.

Quality of workmanship and good styling—in the tradition of Danish furniture and interior decoration—is again evident in sound broadcast-receivers, of which the Linnet and Laursen "Piccolo Box 622" is a good example. This is an a.m./f.m. receiver covering six a.m. ranges (including trawler band), and the v.h.f./f.m. band II, with internal ferrite aerial and an external extensible detachable dipole. No fewer than 12 transistors and 9 diodes are employed in the circuit and the power output is 2 watts. Consumption from the eight $1\frac{1}{2}$V dry cells averages 25mA (40mA max.). An elliptical loudspeaker radiates through louvres in the top and back of the teak cabinet.

Denmark is a maritime nation, and it was not surprising to find the yachtsman as well as the professional seaman well provided for. The Braviour v.h.f./f.m. marine telephone set (SD12B) has been developed to confirm with C.C.I.R. recommendations as set forth at the Warsaw conference and gives the choice of 12 channels. Both transmitter and receiver are fitted with crystal ovens and the receiver also has an i.f. crystal filter giving selectivity of 60 dB down at $\pm$ 30 kc/s. The transmitter is provided with an automatic deviation limiter. On the Braviour stand was also seen the Swedish AGA Geodimeter (Bergstand System) in which a light beam is modulated at 30Mc/s and the phase shift after reflection from a distant point is measured by



Modular construction in Arena television sets.



"Piccolo Box 622" f.m./a.m. transistor receiver (Linnet & Laursen).

Transistor marine communication receiver, "Sailor 16T" by S.P. Radio.

Bang & Olufsen 607 gramophone turntable and pickup.

means of a continuously variable delay line. Accuracy claimed is of the order of ½ inch in 30 miles.

The "Sailor 16T" marine communication receiver which was shown working under the spray from a fountain throughout the period of the exhibition is a remarkably compact design by S.P. Radio. It uses 13 transistors (OC 614 in the r.f. stage) and has a sensitivity better than $1\mu V$ on all four ranges 275kc/s—4Mc/s). Bandwidth is normally ± 3kc/s or 150c/s with b.f.o. and 1-kc/s a.f. filter. An aerial switch gives the alternatives of a normal elevated aerial or a d.f. loop with sensing. Power consumption is 15mA to 25mA at 9V and the life of the built-in Type V11-36 Hellesen cells recommended is about 150 hours. Alternatively the set can be connected to ship's supplies of 12, 24 or 32 volts.

In the field of sound reproduction the interest in stereo seems to be sustained in Denmark, though artificial reverberation is making a bid and looks like succeeding in catching the ear of the general public. Bang and Olufsen have a new high-quality stereo amplifier (Type 608) with visual indication of the slope of tone compensation characteristics on the front panel. They have also developed a stereo torsional spring reverberation unit in which the delayed echoes can be recombined in phase or anti-phase to produce interesting effects. The new B. & O. ribbon microphone (BM5) is designed for easy conversion to stereo by stacking two plug-in units. The sensitivity is -82 dB ($V/\mu bar$) and the output impedance (in the secondary of the built-in transformer) is 150 ohms. For record production B. & O. have a high-grade transcription turntable (607) fitted with a balanced tone arm which enables the pickup to track irrespective of level. A moving-iron stereo pickup cartridge has been developed with diamond stylus, a playing weight of 3gm and compliance of 5×10^{-6} cm/dyne. Channel separation is 20dB minimum. (This turntable is now available in England through Aveley Electric.) A complete record player (Model 608 VF) with transistor stereo pre-amplifier, based on the 607 turntable, was shown at Copenhagen.

Measuring instruments, medical electronics, marine communication and closed-circuit television equipment shown by Disa Electronik (a subsidiary of Dansk Industri Syndikat, Compagnie Madsen A/S) all showed a quality of workmanship and performance that will bear comparison with the world's best. One well-known Disa instrument is the electromyograph for recording activity simultaneously from three points in muscle.

Stands in the gallery of the Forum were occupied by firms making electronic components, and here we noted the very wide range of iron-cored components, including a.f. and modulation transformers and a stereo tape recorder head with >60dB separation by Jørgen Schou; i.f. transformers and small fixed inductors for suspension in the wiring, by Prahn; television units and Yaxley and push-button type switches by Torotor—all of the very highest quality.

Improving Radio Reception

USE OF TELEVISION AERIAL FOR LONG AND MEDIUM WAVES

By B. S. CAMIES

THE majority of modern receivers for sound reception are fitted with internal aerials, usually a ferrite rod for long and medium-wave reception. In regions of high field strength, reception using such small collectors is quite satisfactory and, in fact, such aerials are frequently used for reception of more distant stations such as Brussels and Hilversum although the signal-to-noise ratio is significantly worse than for local-station reception.

For good reception of Continental medium-wave stations an external aerial is desirable and ideally this should take the form of a vertical rod, mounted on a high point such as a chimney, and connected to the

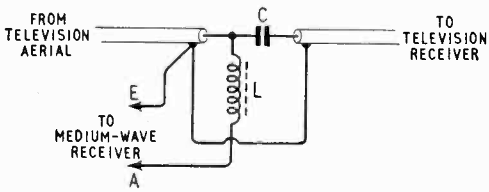


Fig. 1. Simple filter which has proved satisfactory in operating medium-wave and television receivers from a single television aerial.

receiver via a downlead. The downlead usually passes near sources of interferences such as electric motors and mains wiring and, to preserve a good signal-to-noise ratio, the lead itself should not act as an aerial. Thus a good form of downlead is a length of coaxial cable, the inner conductor conveying the signals from aerial to receiver, the outer conductor being earthed. Such a system can give good results; but even better performance is possible if the characteristic impedance of the coaxial lead is matched to the aerial impedance and to the receiver-input impedance. This requires the inclusion of matching transformers at each end of the coaxial cable.

A simple installation of the first type described above can make a striking improvement in medium-wave reception. By using such a system in London, for example, the stations at Hilversum and Brussels can be received in daylight substantially free of background noise. Few people, however, would be prepared to install a special aerial and downlead purely to improve medium-wave reception. Fortunately it is not often necessary to make a special installation because the elevated vertical rod and screened downlead already exist in many houses in the form of an outdoor television aerial and the coaxial cable connecting it to the television receiver. Experiments made with Band-I "X" and Band-I "H" aerials showed that they were effective medium- and long-wave aerials in spite of the reflector and other elements which, though useful at v.h.f., perform no useful function at lower frequencies. Results on long and medium waves were also satisfactory using television-aerial installations in which a Band-I aerial and a Band-III array are connected to a common downlead via a diplexer.

The next problem is whether a Band-I aerial can be made to feed a television receiver and a medium-wave receiver without complication or expense and, at the same time, without introducing serious losses between aerial and either receiver. Experiments showed that a simple filter such as that illustrated in Fig. 1 was all that was necessary. For successful results the reactance of the inductor L must be high at v.h.f. (to avoid short-circuiting the television-receiver input) but low at medium-wave frequencies to minimize loss of signal input to the medium-wave receiver. An inductor of 5.5μH (34Ω reactance at 1Mc/s and 1.7kΩ at 50Mc/s) has proved satisfactory. The reactance of the capacitor C should be small at v.h.f. compared with the input impedance of the television receiver and large at medium-wave frequencies (to avoid short-circuiting of the input to the medium-wave receiver). (A value of 200pF is satisfactory (16Ω reactance at 50Mc/s and 800Ω at 1Mc/s). However, the aerial circuits of many television receivers include a capacitor of approximately this value (intended to isolate the aerial connection from the chassis which is commonly in direct connection with the mains) and it is not then necessary to include another capacitor in the external filter circuit. The inductor L, if wound on a ferrite core, can be very small physically* and will fit easily inside a small terminating box for a coaxial

* A suitable component is Aladdin type PP16128/16129 5.5μH.

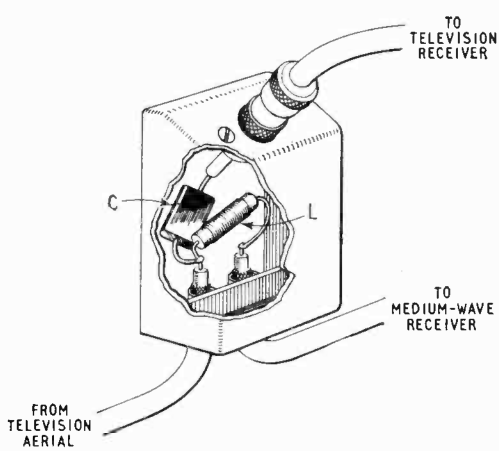


Fig. 2. One way in which filter components can be accommodated in coaxial-cable terminating box mounted on skirting board.

cable. A neat installation then results as suggested in Fig. 2.

It is, of course, not usual for the aerial connection to a medium-wave receiver to be made via a long length of coaxial cable and it is important to know whether the large capacitance of such a cable has any effect on the alignment of the receiver. This depends on the type of aerial-input circuit used in the receiver and these can be classified into the following three groups:—

1. Those using an input transformer with a small primary winding which is intended to resonate with the aerial capacitance at a frequency *above* the working band.
2. Those using a transformer with a large primary winding which is intended to resonate with the aerial capacitance at a frequency *below* the working band.
3. Those using a shunt-capacitance aerial-coupling circuit; this type of input circuit is often used when the receiver has a ferrite-rod aerial.

For aerial input circuits of Types 2 and 3 the large capacitance may cause some misalignment of the signal-frequency circuits of the receiver and this is likely to show up as a loss in sensitivity at the low-frequency end of the band (compared with the sensitivity at the high-frequency end). This loss can be corrected by an adjustment of the signal-frequency inductance, e.g., by sliding the medium-wave coil along the ferrite rod or adjustment of the core position of the aerial coil to give maximum sensitivity at say 600kc/s. Adjustment of the signal-frequency trimmer to give maximum sensitivity at say 1.5 Mc/s is also desirable to obtain the maximum benefit.

If the receiver has an input circuit of Type 1 there is a possibility that the large capacitance of the cable may resonate with the primary winding within the working band and this will cause poor alignment and poor sensitivity which cannot be corrected by re-alignment of the signal-frequency circuits. If it is suspected that this is occurring a 200-pF fixed capacitor should be connected in series with the coaxial lead to the aerial terminal of the medium-wave receiver very close to the terminal. This will prevent resonance within the working band and all that is necessary is possible re-alignment of the signal-frequency circuits of the receiver, as described above.

BOOKS RECEIVED

Transistor Circuit Analysis, by Maurice V. Joyce and Kenneth K. Clarke. Intended for use as a reference book or text book, the work presents basic analytical methods of transistor circuit design. The reader is expected to be conversant with the pole-zero pattern in network analysis, transient analysis and logarithmic gain and phase plots. After dealing with low- and high-frequency amplifiers, and pulse circuits, a chapter is devoted to the family of negative resistance devices, and a further chapter to oscillators. Problems are set on each chapter. Pp. 461. Addison-Wesley Publishing Company, Inc., 10-15, Chitty Street, London, W.1. Price 81s.

The Walter Tape Recording Book, by Joseph M. Lloyd. An instruction book covering the operation and maintenance of all types of Walter tape recorder. The book is intended for the novice, and jargon is conspicuous by its absence. Pp. 160; well illustrated. Focal Press, Ltd., 31, Fitzroy Square, London, W.1. Price 12s 6d.

Initiation à l'Electronique, by R. Faure. An introductory text on electronic engineering. A description of the physical picture of conduction is followed by a chapter on the operation and design of valves, after which some applications of valves—amplification, oscillation, transmission and frequency-modulation—are given. Semiconductors, gas tubes and photoelectric devices are described, with their uses, and the final two chapters deal with microwaves and television. Pp. 355; illustrated. Dunod, Editeur, 92, rue Bonaparte, Paris 6ᵉ. Price 29 NF.

Radio Astronomy by F. Graham Smith. Intended for the layman, this book explains in a very readable and entertaining style, the origin, detection and interpretation of stellar radio emissions. Many fine photographs are included. Pp. 264; Figs. 50; plates 16. Penguin Books, Harmondsworth, Middx. Price 7s 6d.

Translation from Russian for Scientists by C. R. Buxton and H. S. Jackson. The authors first seek to teach the Russian alphabet by giving a list of place-names in Russian which are similar to their English equivalents. Grammar is then dealt with in sections, with translation exercises based on each point. Practice in translation is given by a number of extracts from Russian publications, with help in the form of subject and verb indication. A further section gives practice in translating scientific Russian in the fields of physics, and electrical and chemical engineering. Pp. 299. Blackie and Son Ltd., 17 Stanhope Street, Glasgow, C.4. Price 30s.

Fundamentals of Digital Instrumentation by D. S. Evans. Concerned mainly with shaft-driven digitizers, the book describes several types of binary code and the reasons for the variations. Coding, decoding, sampling and storage are among the subjects discussed, and the author describes some industrial applications of digitizers. Pp. 39, Figs. 16. Hilger & Watts Ltd., 98 St. Pancras Way, London, N.W.1. Price 7s 6d.

Tubes and Circuits by George J. Christ. Designed to enable the practical man to approach complex equipment as a collection of basic circuits, the book deals first with electronic devices, and goes on to describe their application in amplifier and oscillator circuits. Gas-filled and photoelectric devices are described, and a chapter on industrial electronics is included. Pp. 192; Figs. 170. Gernsback Library Inc., 154 West 14 Street, New York 11, N.Y. Price $3.45 (paperback) $5.00 (cloth bound).

NOVEMBER ISSUE

Due to a temporary re-arrangement of our printing schedule the November issue of *Wireless World* will not appear until October 30th, a week later than usual. It will include reports on the Computer Exhibition (Olympia, Oct. 3rd-12th) and the Paris Radio Show (Sept. 14th-25th), in addition to the usual quota of technical articles, features, and news.

WORLD OF WIRELESS

S.S.R. for U.K. Air Traffic

FOLLOWING the recent trials of secondary surveillance radar at London Airport (see p. 396, August issue) the Ministry of Aviation has announced its intention to introduce S.S.R. in the planning of the future U.K. air traffic services. Its use with transponder equipped aircraft giving coded replies will provide continuous target identity information, simplify A.T.C. co-ordination and overcome many of the limitations associated with primary radar.

From about July next year it will become mandatory for all civil aircraft operating above 25,000 feet to carry transponder equipment. At a later date aircraft flying at lower altitudes will also have to carry transponders.

S.S.R. facilities will be provided at each of the long-range radar stations now being planned to form part of an overall integrated civil-military air traffic control organization.

R.E.C.M.F. in Sweden

THE fourth Stockholm exhibition to be organized by the British Radio and Electronic Component Manufacturers' Federation opens on October 9th for five days. As will be seen from the list of exhibitors below, some 40 manufacturers of components, instruments and gramophone equipment are taking part. The show, which will be the largest yet organized abroad by the R.E.C.M.F. and is being held in Ostermans Marmorhallar, Birger Jarlsgatan 18, is to be opened by the British Ambassador to Sweden.

A.E.I.
Amphenol-Borg
Bakelite
Beckman Instruments
Belling & Lee
Bird, Sydney S., & Sons
Bulgin, A. F., & Co.
Cannon Electric (Gt. Britain)
Colvern
Dawe Instruments
Electrolube
Electronic Components
Electronic Engineering
Electronic Technology
English Electric Company
Enthoven Solders
Formica
Garrard Engineering & Mfg.
Goodmans Industries
Hellermann
Heywood & Co.
Hughes International
Hunt (Capacitors)
Iliffe Electrical Publications
Linton & Hirst
London Electrical Mfg. Co.
McMurdo Instrument Co.
Morganite Resistors
Mullard
Multicore Solders
M-O Valve Co.
N. S. F.
Painton & Co.
Parmeko
Plessey Co.
Rola Celestion
S.T.C.
Steatite & Porcelain Products
Technograph Electronic Products
Telcon Metals
Texas Instruments
Thorn Electrical Industries
Wireless World

Weather Ships

THE Ocean Stations Network consists of nine radio stations in vessels supplied or paid for by eighteen member nations of the International Civil Aviation Organization whose airlines fly across the North Atlantic. The stations give surface and upper air weather information for use in meteorological forecasting, search and rescue services, navigational aid to transatlantic aircraft and act as communications relay points.

The report on the operation of the ocean stations for 1960 states that they made radio contact with 57,511 aircraft and 18,214 ships, which represents increases of 12% and 23% respectively over 1959 figures; they provided navigational assistance to aircraft in the form of 47,732 radar fixes, 44,623 non-scheduled radio beacon transmissions and 2,901 direction finder bearings. They also rendered medical assistance to seven ships and received 75 aeronautical and 423 marine SOS messages.

Italian TV on U.H.F.—Italy's second television programme will be introduced on November 2nd when the country's first eight stations to operate in Band IV are brought into service. They will serve about 50% of the population. The broadcasting authority Radiotelevisione Italiana (R.A.I.) plans to have a network of 42 u.h.f. stations in operation by the end of next year which will serve about 70% of the population. The u.h.f. stations will be sited with the existing transmitters operating in Bands I and III.

Dr. Gilbert F. Dutton, of E.M.I., is to be chairman of the session covering disc recording and reproduction at the Convention of the Audio Engineering Society in New York which opens on October 9th. He is also delivering a paper on "The assessment of two-channel stereophonic reproduction performance in studio monitor rooms, living rooms and small theatres" at the "stereophonics" session. The only other British contribution to the Convention is being made by P. J. Pyke, also of E.M.I., whose paper is entitled "The design and performance of the E.M.I. integrated stereo pickup and arm."

A.F.C.E.A.—The new president of the London Chapter of the American Armed Forces Communications and Electronics Association is Lt. Col. Sanford B. Hunt. The vice-presidents are Col. A. H. Snider, Harvey Schwartz and Lt. Col. John T. Newman. Membership of the Chapter is open to British communications and electronics engineers and there are five U.K. associate vice-presidents—Sir Reginald Payne-Gallwey, Sir Harold Bishop, Major General A. M. W. Whistler (War Office), W. G. J. Nixon (G.E.C.) and L. T. Hinton (S.T.C.).

B.B.C. Research Scholarships.—Each year the B.B.C. awards research scholarships (valued at £500 per annum) to university graduates in electrical engineering or physics, giving them the opportunity to work for a higher degree. The only condition applying to the subject for research is that it must be in those fields of telecommunications or physics which have an application to sound or television broadcasting. This year three scholarships have been awarded. J. Elliott, who graduated at Imperial College, University of London, has been awarded a one-year scholarship and two-year scholarships have been awarded to K. L. Hughes, a graduate of Birmingham University, and B. J. Tilley, who graduated at University College of Swansea.

D.S.I.R. Headquarters are now at State House, High Holborn, London, W.C.1 (Tel: Chancery 1262).

The National Lending Library for Science and Technology has been opened at Boston Spa, Yorkshire, and is due to become fully operational in the autumn of next year. This new library, which will eventually absorb the Science Museum Library, is the first of two to be set up following the recommendations of the Advisory Council for Scientific Policy. Forming a separate directorate of the Department of Scientific and Industrial Research under the leadership of Dr. D. J. Urquhart, the library will provide a loan and photocopying service of scientific literature for industrial and research organizations, Government departments and educational establishments. The second library, the National Reference Library for Science and Invention, will be based upon the present Patents Office Library, but is not expected to open until 1965.

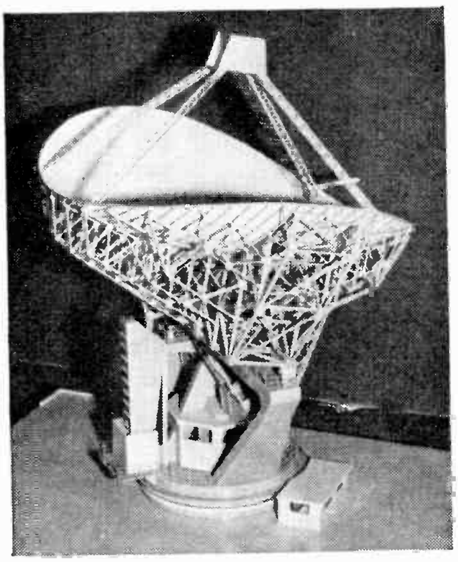
B.S.R.A. 25 Years Old.—A whole-day Audio Convention has been arranged by the British Sound Recording Association to mark its Silver Jubilee. It will be held at the I.E.E. from 10 a.m. on October 14th. Registration fee for non-members is 30s. Applications for tickets should be made to S. W. Stevens-Stratten, "Greenways," 40 Fairfield Way, Ewell, Surrey.

B.S.R.A. in Bristol.—Details of the lecture programme drawn up by the 21 founder members of the recently formed Bristol Centre of the B.S.R.A. are obtainable from P. J. Hynam, 93 Badminton Road, Downend, Bristol.

Flight Test Instrumentation.—The second International Flight Test Instrumentation Symposium will be held at the College of Aeronautics, Cranfield, Bucks., on April 16th, 17th and 18th, next year.

"Parametric Amplification with Transistors."—Since the article on p. 498 of this issue went to press, the author has asked us to make two amendments. Equation 2 should read $f_0=1/2\pi r_e C_e$ where r_e is the input resistance and C_e the total input emitter capacity, and equation 3 should read $r_e=(KT_0/q)\,(1/I_e)\,(1/(1-\alpha))+r_{bb'}$.

"Low-voltage Stabilizer Using Semiconductors."—We regret that in drawing Fig. 3 of this article in the September issue, the connection from the error-sensing device to the emitter of V4 was omitted.



Space Communication.—This model of a steerable ellipsoidal paraboloid, similar to that which will be erected on Goonhilly Down, Cornwall, by the Post Office for transatlantic communication via satellites, was shown at the Radio Show.

EDUCATIONAL MATTERS

Bradford Institute of Technology.—Dr. G. N. Patchett, head of the Department of Electrical Engineering at the Institute, has sent us a prospectus for 1961-62. It includes a synopsis of the syllabus for the four-year Dip. Tech. sandwich course and details of part-time day and evening courses for the H.N.C. with radio and electronics as the main subjects and courses for professional qualifications (I.E.E. and Brit.I.R.E.).

Higher Technology.—In order to give wider publicity to special advanced courses in higher technology being held in the London and Home Counties Region a bulletin is issued by the Regional Advisory Council for Technological Education. The issue covering the Autumn term includes 128 pages of information on courses (mostly part-time) at over 40 colleges. It is obtainable from the Council at Tavistock House South, Tavistock Square, London, W.C.1, price 3s 6d.

Hendon Technical College is running a number of short evening courses during the present term. Among them are a 12-lecture course on wave filter design commencing September 27th; a 12-lecture course on electronic digital computers (September 28th); eight lectures on high-fidelity sound reproduction (October 18th) and 15 lectures on transistors and transistor circuit design (October 24th). The fee for each of the first three is £1 and for the last 30s.

The Borough Polytechnic, Borough Road, London, S.E.1, is again providing a course of 20 evening lectures on the fundamental principles of pulse techniques. It begins on October 2nd (fee 50s). A supplementary 12-week laboratory course is also provided. This will be given on Thursday evenings beginning on September 28th and repeated on Monday afternoons from October 2nd (fee 20s). A course of 22 lectures on transistors and allied devices is being given on Tuesday afternoons and repeated in the evenings commencing October 3rd (fee 50s). The technique of technical writing is covered in a 6-lecture course beginning on Friday, October 20th, at 2.30 (fee 10s).

Twickenham Technical College, Egerton Road, Twickenham, Middlesex, is organizing a series of three special 4-week full-time courses during the present session. The first, dealing with electronic circuit design, begins on October 2nd; the second a course on transistor theory and applications from November 6th, and the third on principles of automatic control, from January 15th. The fee for each course is 3 gn.

Four new educational filmstrips were recently issued by Mullard. The first two, "Manufacture of junction transistors" and "Basic transistor circuits," are intended for grammar school pupils or the more junior students at technical colleges. The others—on amplification and amplifiers—are designed especially for the student electronics engineer or technical trainee in the Services. All four strips are available with teaching notes from Unicorn Head Visual Aids Ltd., 42 Westminster Palace Gardens, London, S.W.1. The first (in black and white) costs 15s, and the others, which are coloured, cost 25s each.

Radio Amateur Courses.—In addition to those courses in preparation for the Radio Amateurs' Examination mentioned in previous issues, we have received details of the following classes:— Bradford Technical College, Bradford 5, Wednesdays at 7.0; Spencer Park School, Trinity Road, London, S.W.11, Mondays and Thursdays at 7.30; Derby and District College of Technology, Derby, Mondays and Fridays at 7.0; Technical Institute, Bognor Regis, Wednesdays and Fridays at 7.0; Northwood Evening Institute, Northwood Hills, Middx, Mondays and Thursdays at 6.30; Montem School, Hornsey Road, Holloway, London, N.7, Mondays, Tuesdays and Wednesdays at 7.0; Birkenhead Technical College, Thursdays.

Personalities

S. S. Eriks, managing director of Mullard Ltd., has been appointed an honorary Knight Commander of the Order of the British Empire "in recognition of his valuable services to British official interests." Born in Holland in 1900, he joined N. V. Philips in Eindhoven in 1924, and was later appointed general manager of Mullard. During the war all the Philips interests in Great Britain were integrated into the war effort under Mr. Eriks. He was awarded the O.B.E. in 1948.

S. S. Eriks

G. G. Macfarlane

G. G. Macfarlane, Dr.Ing., B.Sc., F.Phys.Soc., deputy director of the National Physical Laboratory for the past two years, is to succeed **W. J. Richards** as director of the Royal Radar Establishment, Malvern. It will be recalled that Mr. Richards was recently appointed director of the new Staff College for Further Education. Dr. Macfarlane, who obtained his Dr.Ing. degree at Dresden in 1939 after two years' post-graduate research, was throughout the war at the Telecommunications Research Establishment (now R.R.E.) where he concentrated on mathematical problems in radar and microwave physics. In 1945 he became head of the Mathematical Group, and from 1953 to 1960 he was deputy chief scientific officer at R.R.E.

Brigadier J. D. Haigh, O.B.E., M.A., M.I.E.E., who joined The Plessey Company in 1958, and since February last year has held the position of divisional manager of the Capacitors and Resistors Division, Swindon, has been appointed general divisional manager of a group of Divisions. From 1939 until 1941 Brigadier Haigh was a radar instructor at the School of Anti-Aircraft Artillery. In 1946 he joined the Ministry of Supply where he was responsible for the development of army radar equipment until 1950. From 1954 until he joined Plessey, he was Director of Electronic Research and Development in the Ministry of Supply.

J. A. G. Mitchell succeeds the late **F. W. Endicott** as B.B.C. Scottish Engineer and becomes responsible for the engineering services of the B.B.C.'s sound and television studios and outside broadcast units in Scotland. He joined the B.B.C. in 1927 and since 1950 has been regional engineer, Northern Ireland, where he is succeeded by **J. D. MacEwan,** B.Sc., A.M.I.E.E., A.M.Brit. I.R.E. Mr. McEwan joined the B.B.C. in 1947. For the past year he has been engineer-in-charge (television), Birmingham, where his successor is **A. H. Hill,** M.A. Mr. Hill, a graduate of the University of Cambridge, joined the B.B.C. in 1940 as a transmitter maintenance engineer and transferred to the Television Service in 1951. He has been assistant engineer-in-charge (television) at Birmingham, since 1959.

Sir Bernard Lovell, director of the Nuffield Radio Astronomy Laboratories of the University of Manchester, is the first recipient of the Daniel and Florence Guggenheim International Astronautics Award. This Award, presented by the International Academy of Astronautics, includes a prize of one thousand dollars, and is to be given annually to an individual who has made outstanding contributions to the progress of astronautics during the preceding five years.

Donald G. Fink, recently appointed vice-president for research of the Philco Corporation, joined the organization in 1952 prior to which he was for some years editor-in-chief of our New York contemporary *Electronics*. Since 1957 he has been director of Philco's Research Division. Mr. Fink has served on many American and international committees and has been chairman of the co-ordination committee of the U.S. National Stereophonic Radio Committee and was from 1950-52 vice-chairman of the National Television System Committee (N.T.S.C.).

L. J. Davies, C.B.E., M.A., B.Sc., M.I.E.E., for the past 16 years director of research of what is now A.E.I. (Rugby), has been appointed director of research of the parent company, Associated Electrical Industries Ltd. After graduating at Oxford and carrying out post-graduate work he joined B.T.H. (now A.E.I., Rugby), in 1924. He is succeeded at Rugby by **J. E. Stanworth,** D.Sc., F.Inst.P., who joined B.T.H. in 1937 as a glass technologist.

F. K. Chorley, chief development engineer of Epsylon Industries Ltd., has been appointed chief engineer. He joined Epsylon early in 1960 from the Plessey-owned Cottage Laboratories Ltd., where he was deputy project leader of research and development on underwater detection systems. The company's new chief development engineer is **G. A. McKenzie.** He was formerly with the B.B.C. Designs Department and immediately prior to joining Epsylon last year was with the Plessey Company.

L. A. Woodhead, director and general manager of Cossor Instruments Ltd. and past president of the Scientific Instrument Manufacturers' Association, has accepted the chairmanship of the Organizing Committee of next year's International Instruments, Electronics and Automation Exhibition, in succession to the late **Philip Canning,** who died recently in Switzerland.

C. R. Russell has been appointed product planning adviser to the management of the M-O Valve Company. He joined the G.E.C. in 1947 and was engaged on valve research work at the Wembley Research Laboratories, now the Hirst Research Centre, until his appointment last December as export sales manager in the M-O Valve Company.

Michael Keegan, director of the Radio and Television Retailers' Association, has relinquished all executive responsibility at Multisignals Ltd. but remains a member of the board of that Company.

H. C. J. Tarner, A.M.I.E.E., A.M.Brit.I.R.E., has been appointed by the B.B.C. as engineer-in-charge, television news, in succession to **A. D. D. Strathairn** who has retired after 27 years' service in the Corporation. Mr. Tarner joined the B.B.C. in 1944 and has been in the Television Service since 1949.

J. P. Engels has been appointed managing director of Philips Electrical Ltd. in succession to **G. F. Hofman** who has retired after 40 years' service with Philips.

George Bradshaw, B.Sc., A.M.I.E.E., who has been on the staff of R.R.E. since 1951, where he is at present leading a team on research and development of solid circuitry, is joint author with **Colin H. Taylor,** Grad.I.E.E. (deputy leader of the team), of the article in this issue on a solid circuit microminiature oscillator. Mr. Bradshaw was at No. 1 Radio School, R.A.F., from 1939 to 1941 following which he was on radio maintenance until 1948 when he went to Leeds University. He graduated in 1951. Mr. Taylor has been with R.R.E. since 1943 except for 3 years when he was in the City of Birmingham Electricity Supply Department.

Appointments to its two latest stations—Durris and Mounteagle which are to serve the North-East Scotland area—are announced by the I.T.A. **D. H. Rennie,** who is 39 and joined the I.T.A. in 1955 after five years at the Air Ministry, has become engineer-in charge at Durris. The assistant engineer-in-charge is **G. I. Wilson.** He is 42. He joined the Authority in 1958, having previously been with the B.B.C. and with the R.A.F. on radar maintenance. **P. G. James,** A.M.Brit.I.R.E., aged 39, who is appointed engineer-in-charge at Mounteagle, was with the B.B.C. from 1946 until he joined the I.T.A. as assistant engineer-in-charge at Winter Hill in 1959. The assistant engineer-in-charge at Mounteagle is 29-year-old **G. Askey.** He has been with the Authority since 1957 prior to which he was with Pye.

R. E. Cooke, B.Sc.(Eng.), has resigned from the board of directors of Wharfedale Wireless Works Ltd., which he joined in 1955, and is forming a new company, K.E.F. Electronics Ltd. Its head office and works will be at Tovil, Maidstone, Kent. The other directors of the new company are: R. L. Pearch, I. J. Balls and M. McGrady.

News from Industry

Thorn Electrical Industries, whose domestic radio and television interests are operated under a number of trade names including Ferguson, Philco, Pilot, Ultra, His Master's Voice and Marconiphone (the last two in association with E.M.I.) records in its annual report a group trading profit of £4,113,907 which is nearly £200,000 above the previous year. The net profit after all charges, including taxation, was £1,500,000.

Ultra Electronics Ltd. has acquired from K.G. (Holdings) Ltd. the entire share capital of its subsidiary, W. S. Electronics Ltd. for approximately £125,000. It is stated by Ultra that it is intended to continue the business of W. S. Electronics as a separate entity within the group. At the annual general meeting on August 25th the parent company, Ultra Electric (Holdings) announced a group profit before taxation of £452,495 for the year ended last March.

Telefusion Ltd., announces a group trading profit for the year ended April 26th of £1,434,250 (nearly £300,000 above the previous year). After provisions for depreciation (£965,763) and taxation, the net profit was £292,257.

Semiconductors Ltd., of Swindon, Wilts., has become a wholly owned subsidiary of the Plessey Company. The Philco Corporation has sold its minority holding to Plessey. The announcement states that Semiconductors Ltd., "continues as a non-exclusive licensee of Philco with respect to the manufacture and sale of transistors". The reconstituted board of directors comprises Sir Allen Clark (chairman), John A. Clark, Dr. J. Reekie, D. H. Roberts, G. C. Gaut, and G. Campbell.

Dubilier Condenser Company's trading profit of £266,444 for the year ended last March was £86,277 less than the previous year. The chairman, F. H. McCrea, in his report referred to the agreement recently made between Dubilier and the Cornell-Dubilier Electric Corp., of New Jersey, which provides for the exchange of development and patent information.

Cable & Wireless.—The annual report and accounts of Cable & Wireless Ltd., which is issued by H.M.S.O. as a White Paper (Cmnd. 1452), records that the profit of £4,440,462 for the year to March 31st last was over £1M higher than in the previous year.

The Metal Industries Group, which includes Avo, Taylor Electrical, Lancashire Dynamo and Brookhirst-Igranic, announced at the annual meeting on September 19th a trading profit for 1960/61 of £2,436,043. The chairman, Sir Charles Westlake, stated that the company's electrical interests now account for nearly 75% of its profits and the original metals and shipbreaking side for less than 10%.

Dansette Products Ltd., which changed its name from J. & A. Margolin Ltd. and became a public company earlier this year, records a net profit for 1960/61 of £138,715—a decrease of £20,000 on the year before.

G.E.C.—The report presented at the 61st annual general meeting of the General Electric Company on September 7th showed that although the sales for the year ended in March were £118.6M compared with £116.9M the year before the trading profit fell from £4.5M to £2.9M.

Storno-Southern Ltd., of Camberley, Surrey, has taken over responsibilities of marketing, servicing and installing G.E.C. mobile-radio equipment. Some members of the G.E.C. engineering staff are being transferred to Storno-Southern Ltd., who has established an office with sales and servicing facilities and a spares depot at 2 Arbury Avenue, Coventry. (Tel.: Coventry 87521.) The two companies' products are complementary, Storno-Southern manufacturing f.m. equipment, and G.E.C. amplitude-modulated equipment.

Shure Electronics Ltd., has been formed to handle Shure products in the United Kingdom. J. W. Maunder, who has represented Shure in this country since 1960, has been appointed managing director. A sales office and service centre has been established at 84 Blackfriars Road, London, S.E.1. (Tel.: Waterloo 6361.)

Associated Transistors Ltd., which was formed jointly by A.T.E., English Electric and Ericsson Telephones some three years ago and has a semiconductor factory at Ruislip, Middx., has been acquired by Mullard. This announcement followed the news of the proposed merger of A.T.E. and Ericsson with Plessey.

Channel Electronic Industries, which operated from Burnham-on-Sea, Somerset, has gone into voluntary liquidation.

Pye-Ling Ltd., the recently formed company set up to market in this country the vibration systems of W. Bryan Savage Ltd. (a member of the Pye Group), and Ling Electronics, of the U.S.A., has announced its board of directors. The members are N. A. Twemlow, M.B.E. (chairman), P. H. Taylor (managing director) and F. R. Semark, together with two directors from the American company. Pye-Ling's headquarters are at 7-8 Dalston Gardens, Stanmore, Middlesex. (Tel.: Wordsworth 0226.)

James Scott (Electronic Engineering) Ltd., formerly the electronics division of what is now James Scott (Electrical Holdings) the parent of a group of Scottish companies, has made a reciprocal arrangement with Laboratory for Electronics Inc. (L.F.E.) of Boston, U.S.A., for each company to represent the other in its own territory. I. Sclar is chairman of the Scott group and is also chairman and joint managing director of James Scott (Electronic Engineering). The other joint managing director is A. L. Whitwell and N. Williams is a director and chief engineer. The company's headquarters are at Carntyne Industrial Estate, Glasgow, E.2, and its London office is at 20 Grosvenor Place, S.W.1.

Radio & Television Trust.—D. D. Prenn, the chairman, announced at the annual meeting on August 10th that he intended to bring into the group Thermionic Products (Electronics) Ltd., in which he holds the controlling interest. Airmec and British Communications Corporation are subsidiaries of R. & T.T.

Frequency control of the carrier of the B.B.C.'s long-wave transmitter at Droitwich will be maintained to within 5 parts in 10^{10} per 24 hours by two standard frequency oscillators recently supplied by Airmec. These oscillators employ an Essen Ring Crystal in a bridge-stabilized circuit operating at 100kc/s.

Mono and stereo recordings of the same performance can be made simultaneously on a 17-channel audio mixing control console being manufactured by E.M.I. Electronics Ltd., for Levy's Sound Studios, of New Bond Street, London.

Audio and Video Rentals Ltd., of Video House, 27-29 Whitfield Street, London, W.1, has introduced a trade hire service for closed-circuit television equipment, which is available to dealers, public address operators, etc.

A third weather ship, formerly the frigate *Rushen Castle*, is to be equipped by Marconi's with new radio-communication and automatic d.f. equipment and to have its present radar gear modernized. Marconi's recently completed similar conversions in the O.W.S. *Weather Adviser* and *Weather Monitor*.

Tung-Sol Electric Inc., of New Jersey, U.S.A., has appointed Walmore Electronics Ltd., as distributors of its valves and semiconductor products in the United Kingdom. Also included in this arrangement are "Chatham" valves manufactured by a subsidiary.

Telephone Cables Ltd., of Chequers Lane, Dagenham, Essex, formed in January this year and jointly owned by A.E.I. and Enfield Cables, is now handling all home and export business in paper and polythene insulated telephone cables, and in coaxial and other telecommunications cables for both companies.

Aero Electronics Ltd., of Gatwick House, Horley, Surrey, has been appointed the sole U.K. distributor for the United Transformer Corporation, of New York, who manufacture transformers, filters, magnetic amplifiers, etc.

Pinnacle Electronic Products Ltd., of Pinnacle House, Howland Street, London, W.1, has opened a division catering exclusively for industrial valve users. A. H. Oldham, who recently joined the organization from A.E.I., is in charge of the division.

E.M.I. Electronics is to supply the transmitting aerials and feeder systems at five new stations being built by the B.B.C. Television and v.h.f. sound broadcasting arrays are being provided for the stations at Redruth, Cornwall; Beckley, Oxford; Ashkirk, Cumberland; and Llandrindod Wells, Radnorshire; and a television aerial at the Morecambe Bay, Lancs., station. All will be horizontally polarized with the exception of the television array at Ashkirk.

Soundcraft Magnetics Ltd., with premises at Haddenham, Bucks., has been formed to market in this country Soundcraft tapes, discs and cutting styli produced by Reeves Soundcraft Corp., of Connecticut. The chairman of the new company is Sir Eric Ohlson, with F. S. G. Codling as managing director. The other directors are Sir Robert D. Ropner, D. Salisbury Green, T. G. Ohlson, G. Talbot Willcox, and J. C. M. Silvant.

Mullard Equipment Ltd. has moved its commercial divisions and most of its production staff to a new factory at Manor Royal, Crawley, Sussex. (Tel.: Crawley 26386.)

Decca Radar Ltd., recently opened a radar training school at Lambeth Pier in place of the one at Blackfriars which had been in operation since 1950. The school provides 2-day courses in the operational use of radar for ships' masters and officers.

Aerialite has provided recently equipment for communal aerial facilities in one of the largest blocks of flats erected in Great Britain—a 1,000-dwelling unit at Sheffield. Installation was by the Tinsley Electric Co.

R.G.D. and Regentone have opened sales headquarters and trade showrooms at Brook House, 47 Davies Street, London, W.1. (Tel.: Hyde Park 7901.)

Grundig Closed-Circuit TV.—Wolsey Electronics has been appointed U.K. distributor of Grundig closed-circuit television equipment and measuring instruments.

OVERSEAS TRADE

Microwave Communications network to link the towns of Arequipa, Lima, Trujillo, Chiclayo and Piura in Peru is to be provided by the G.E.C. The network, comprising ten terminal and fifty-four both-way repeater equipments will extend for 1,100 miles along the Pacific coast. A main and a protection radio-frequency channel operating in the 2000Mc/s band, each with a capacity of 240 speech channels, will be provided on all routes. In the event of failure or degradation of the working channel changeover to the protection channel is automatic. The G.E.C. is supplying similar equipment for a radio link between the Jamaican terminal of the U.S.A.-Jamaica submarine telephone cable and the Central Telegraph Office in Kingston.

Societa Generale Semiconduttori (SGS), of Milan, Italy, has begun manufacturing and marketing the products of the American company Fairchild Semiconductor for the European market. Fairchild Semiconductor is a Division of Fairchild Camera and Instrument Corporation, Syosset, Long Island, N.Y., and owns a one-third interest in the Italian semiconductor firm.

V.H.F. radio-telephone equipment is being supplied by Cossor Communications Company for the nine passenger ferries being built on the Clyde for service on the Bosphorus and Sea of Marmara, Turkey.

Raytheon Company, of Massachusetts, has formed a new subsidiary, Raytheon-Elsi AG, with its headquarters in Zug, Switzerland, to market electronic components in Europe.

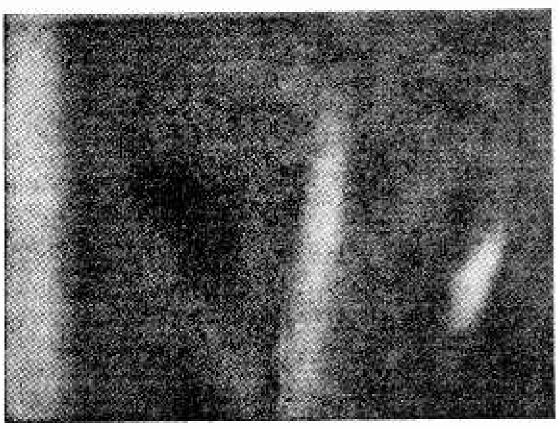
Mobile Radio.—Hassan Faraj Aldabi, of Sabah Street, Kuwait (P.O. Box: 2427), wishes to import British radio-telephone equipment for mobile radio installations.

NATIONAL RADIO SHOW REVIEW

TECHNICAL TRENDS AND HIGHLIGHTS REPORTED BY "WIRELESS WORLD" STAFF

TELEVISION

There was some reference to a possible change of standards on most exhibitors' displays; but to avoid confusion, and it must be recorded that this was rife at the show, we will, before delving into details, first define our terms. Briefly the situation is that the Television Advisory Committee have recommended a change of standards to 625 lines, 50c/s field rate using negative modulation and f.m. sound spaced 6 Mc/s from the vision carrier. There are several different 625-line standards recognized by the C.C.I.R. and in use already, but the one that is most widely used (Holland, West Germany, Switzerland, Italy and Spain, for instance) is the "Gerber" standard, which is often loosely called "C.C.I.R." This differs from the T.A.C. recommendation in channel-width needed (Gerber 7 Mc/s, T.A.C. 8 Mc/s), sound-vision carrier spacing (5.5 Mc/s, 6 Mc/s) video bandwidth (5 Mc/s, 5.5 Mc/s) and vestigial-sideband characteristics (0.75 Mc/s, 1.25 Mc/s). The main advantages of the T.A.C.-recommended system compared with the Gerber are slightly sharper pictures due to the wider video bandwidth and a reduced propensity to "streaking" (wider vestigial sideband).



Composite picture showing parts of 405- and 625-line pictures side by side. Original photographs were taken from two 23-in Stella receivers and the reproduced portions here are about twice life size, i.e., corresponding to picture about 28-in high.

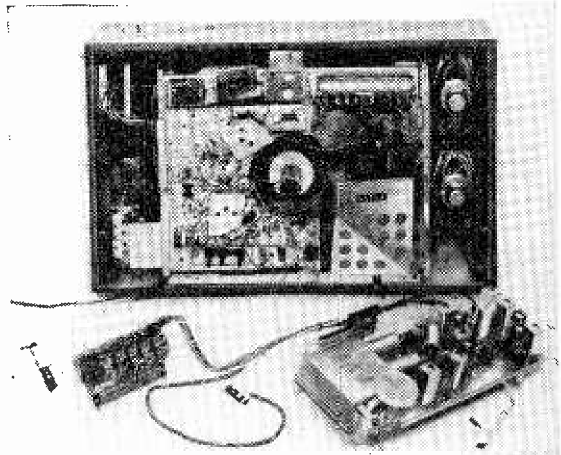
Picture Qualities.—The 625-line pictures shown used a Gerber-type signal distributed at the high-frequency end of Band III (C.C.I.R. Channel 11), and converted to u.h.f. (about 500 Mc/s) at each stand for manufacturers having u.h.f. tuners in their receivers. Pye supplied the equipment. The "live" picture was of a tank of fish (G.E.C. used a model railway at their own show at Horticultural Hall) and the 405-line broadcasts did not carry the same picture, thus a fair comparison of 405 with 625, let alone T.A.C. 625, was not possible. However, armed with an idea of the theoretical advantages over 405 lines we set to work.

The first advantage should be slightly sharper pictures. In practice this proved hard to see. Secondly, the visibility of scanning lines should be reduced. Pairs of similar sets running side by side were approached until the 405 scanning lines could just be perceived (optimum viewing position for seeing maximum detail on 405). But the lines of the 625 picture could then be seen also and this was attributed to 50c/s flicker between fields of the complete picture. Thus the only conclusion that emerges is that the field rate should be raised. The difference in structure was more obvious, though, when brightness and contrast were reduced to the point where flicker was not annoying.

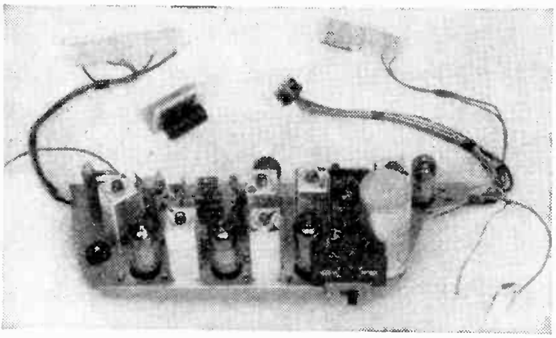
Conversion Methods

To meet a possible—some say a probable—future in which there will be television in this country in 625 as well as 405 lines, manufacturers have disclosed various plans.

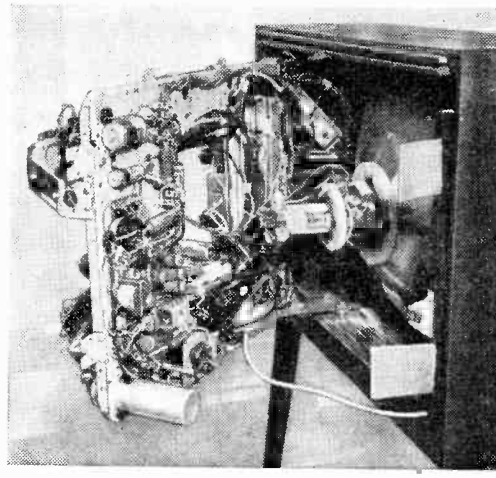
Convertible Sets.—Thus we come to the first alternative; that of claiming that receivers are convertible "if or when". Strictly speaking this is true of any set, however old: the scan coils, frame timebase, c.r.t., a.f. system and power pack should be capable of operation on practically any standard; but the tuner, i.f. stages, sound detector, video amplifier and line timebase would need to be replaced. The modern set with its unit construction lends itself to this exercise, especially as most modern line timebases can be changed to 15 kc/s operation, and although this type of conversion might be the most expensive to carry out in the event of dual-standards switching being necessary, it allows the lowest first price. A particularly noteworthy example of this technique was by Ultra, who showed a standard 405-line set with a prototype conversion kit. The conversion



Ultra Model 19-84 405-line television receiver and kit of parts for conversion (in a few minutes) to a fully switchable 625/405-line receiver.



625-line conversion " kit " for Ferguson " Senator " receiver. Note slide switch on i.f. unit for raising frame-timebase frequency and amplitude for 60c/s frame-rate transmissions.



Pye dual-standard television receiver with chassis swung out to show interior.

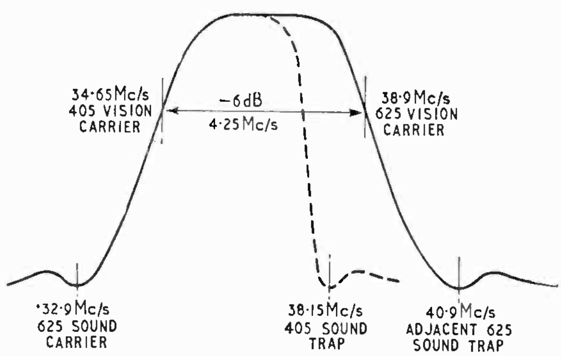
results in a switchable set: if a switchable set is not necessary, then the change could be made by replacing units only.

Switchable Sets.—The second and third approaches assume that 405- and 625-line services will exist side by side with different programmes so that a dual-standard set will be necessary; but the second is realistic in the sense that it incorporates only the switch and other mechanical circuit provisions for switching.

Good examples of this technique were shown by Ferguson, His Master's Voice, Marconiphone and Murphy. In the Murphy set the switch is locked, only to be brought into play when it is coupled up to an additional unit which was, for illustrative purposes, shown as a 3-in high plinth added to the base of the set. The prototype unit incorporated a u.h.f. tuner and alternative i.f. strip, video circuits and sound detector of the intercarrier type. (Vision and sound signals pass down the same i.f. strip. They beat at the vision detector and the sound signal is extracted at a second i.f. corresponding to the sound/vision carrier spacing. This technique can only be used with f.m. sound and negative video modulation because the vision signal is never allowed to fall to zero—" whiter than white "—and it minimizes oscillator-drift effects because the second sound i.f. depends only on sound-vision carrier spacing.) The Ferguson set has a switch that can be operated but, until extra components are fitted by dropping them onto the lugs provided and " plugging in ", some sections of the switch are short-circuited by " clip-off " wire links to avoid damage. A silicon h.t. rectifier replaces the valve so that higher h.t. (220 to 235V is common for 625-line working) is available when required—it " loafs along " with a high-value series resistor until called upon. The e.h.t. rectifier filament is fed through an inductor mounted on the socket, so that its heater current is stabilized. Should 405-line u.h.f. transmissions be started, an extra contact assembly clips into the existing tuner and u.h.f. diode-mixer " biscuits " are fitted; but the system capabilities are realized to the full on 625 lines with an additional i.f. amplifier, sound detector, video amplifier, sync separator and flywheel timebase-control chassis clipped on at the back. The prototype unit shown by this company has at its own back another switch which raises the frame timebase amplitude and its frequency by 10c/s, for 525-line, 60 c/s frame-rate transmissions. Ferguson's stabilized timebase techniques pay off here too, because they reduce height and width changes by a factor of 4 or 5.

This type of conversion facility has, on average, added two or three pounds to the cost of the set, with the prospect of conversion costs rather below those of the first group, should a switchable receiver be required.

Switched sets.—The third solution is to hold one's nose firmly, assume all details of the standard to be used, and jump in at the deep end with the production of a set capable of operation now on 625 lines. This is what Pye and Ekco have done, both firms patriotically choosing the T.A.C.'s proposed standard. Pye's set uses only 14 valves and has the performance of a fringe-area set on 405 lines. The standards knob operates a slide switch mounted across the receiver panel of the set and affects the tuner, sound i.f., detector, video-amplifier and line-timebase circuits. The design assumes that 625-line programmes would be on u.h.f., thus h.t. is switched to the u.h.f. tuner in this mode, the vision i.f. being 38.9 Mc/s and the sound 32.9. The i.f. amplifier has a response roughly that required to give a vision pass-band of 4.25 Mc/s but the detailed shaping of the response is accomplished by the tuner-to-i.f. amplifier coupling circuits which are individual to each tuner. Vision and sound signals pass together through the two frame-grid amplifier valves and the beat between vision and sound carriers is extracted after detection, amplified further at 6 Mc/s in the two sound i.f. valves and is demodulated by a ratio detector. The line timebase h.t. is raised to about 220V and the ratio between flyback and scan time is kept the same as on 405 as this simplifies the switching.



Representation of i.f. response of Pye dual-standards set. Note change-over of carrier relationships and narrowing of bandwidth on 405 lines.

On 405 lines, the v.h.f. tuner (and its own rejector circuits) is switched in and the 6 Mc/s sound i.f. is changed to the standard 38.15 Mc/s, fed from the tuner. The video-amplifier bias is altered and the line p.r.f. dropped to 10k/sec. The h.t. to the line-output stage drops to 190V; but the remainder of the set's h.t. remains at 220V, which enables longer valve-life to be achieved, particularly in the frame timebase. The receiver costs some £4 to £5 more than a 405-only fringe-area set, and the u.h.f. tuner costs about another £5.

The Ekco receiver has no visible standards switch, as this function is carried out by setting the v.h.f. tuner knob to u.h.f. A cam on the tuner operates the slide switch on the receiver panel by means of a Bowden cable and on u.h.f. the frequency changer in the v.h.f. tuner is used as an extra i.f. amplifier. Trap circuits are switched in the vision i.f. amplifier to provide the desired alteration in response. In the line timebase the coupling between the e.h.t. and anode windings is changed so that the resonance of the leakage reactance is raised for the new shorter flyback time.

The use of part of the v.h.f. tuner as an extra i.f. amplifier on u.h.f. compensates for the low gain of the u.h.f. tuner frequency changer (Pye have an optional add-on stage for this). In fact, a lower i.f. gain is sometimes an advantage when signals are weak and tuner noise factors are poor, (10dB is a good factor at u.h.f. whilst 4 to 5dB is common at 50 Mc/s).

Colour Television

Demonstrations of colour television were given at Earls Court by the B.B.C., who installed a studio equipped with two cameras, slide-scanning equipment and telecine facilities. The "programmes" were transmitted by cable to three public viewing lounges and two "display" sets, all of which had an adjacent standard black-and-white 21-in receiver for comparison purposes and assessment. Experimental colour receivers made by Bush, Ekco, G.E.C. and Murphy were operating on the 405-line N.T.S.C. system with positive modulation and a.m. sound.

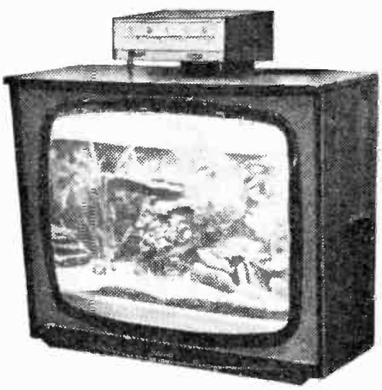
Naturally, there were differences between the pictures displayed: it is just as "wrong" to compare two colour receivers as it is to view side-by-side the same scene photographed with two different film processes. In each case, however, the pictures were wellnigh impeccable and most pleasing. The lack of obvious line structure extracted the erroneous comments, "Well, of course, this is 625 lines" from some "well-informed" bystanders and it is to be regretted that the B.B.C.'s neat 2-in-high notices "405 lines" were not more noticeable. Most of the members of the public to whom we spoke were most impressed and indeed the most often heard remark was, "Why can't we have this at home?"

Receiver Details.—Both the Bush and Murphy prototype receivers were using the new tube with short-persistence sulphide phosphors. The high brightness achievable seems to lead to some interlace flicker when viewing close to the set.

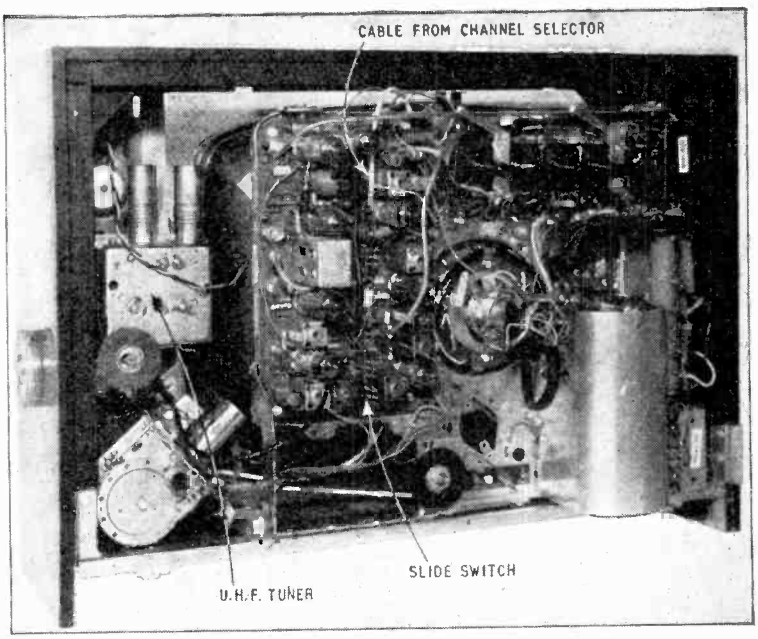
Recent work on the receivers has made them both more reliable and simpler to set up. The Bush receiver has 27 valves and has the convergence controls arranged so that the relation between control movements and results on the c.r.t. is logical. Balanced colour-demodulation circuits are used feeding three separate video amplifiers which drive the tube with colour difference signals, whilst the luminance (or black-and-white) signal is applied by a fourth amplifier. Black-level clamping for the difference signals and direct coupling in the luminance channel are aids to good picture quality.

The Ekco experimental set uses only 21 valves—fewer than some "de-luxe" black-and-white sets. This economical circuit uses the same bandwidth for both chrominance signals (one of which is transmitted with a bandwidth of about 1 Mc/s, the other about 0.3 Mc/s) so reducing the effects of noise and giving a free choice of demodulation axes. The effect might be visible as poor definition of vertical edges between different colours of the same brightness, but this was not apparent. If this set is ever produced in its present form, servicemen will bless Ekco's foresight in fitting a socket on the back to enable easy connection of a convergence generator. This is supplied with locking signals from the transmission being received but the pattern overrides the picture display: thus it is possible to set up the receiver using properly locked timebases running at the correct frequency.

N.T.S.C. v. SECAM, 405 v. 625.—G.E.C., at the Horticultural Hall, were showing 405-line pictures from a studio using E.M.I. vidicon cameras and the B.B.C.'s experimental broadcasts. 625-line pictures were derived from slides and were shown on both SECAM and direct red-green-blue displays. An effect of the use of 625 lines is a "beat" between the picture structure and the pitch of the tube shadow mask, resulting in slight vertical striations. We examined carefully the SECAM pictures for evidence of vertical misregistration but this was not



Above: Some large-screen TV receivers do not have sufficient room inside for all the conversion components — this Marconiphone set has its u.h.f. tuner mounted in a neat external case.



Right: Ekco 625/405-line switchable set (Model T398).

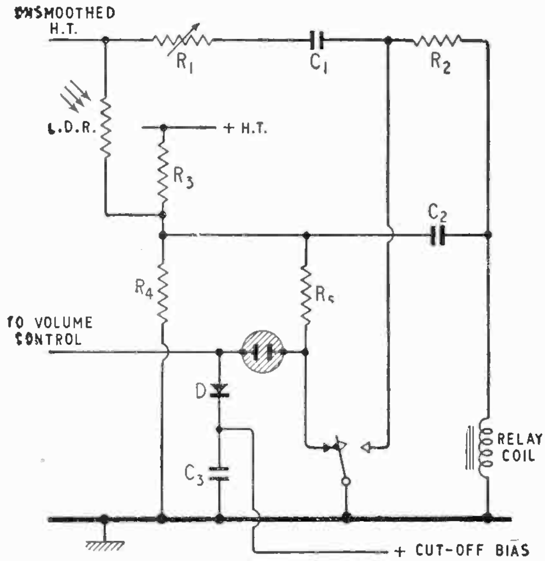
apparent. It will be remembered that, whilst N.T.S.C. utilizes continuous transmission of two-colour signals, SECAM uses line-sequential transmission, storage from line to line of the field scan by a delay line in the receiver providing for simultaneous display, one signal being identified by the presence of a sub-carrier burst during the sync period.

Sympathy with G.E.C. must be recorded, for on several occasions when we visited their exhibition various technical troubles were plaguing the colour demonstrations. Thus the only comparisons that we were able to make would indicate that SECAM is not noticeably inferior to a direct r-g-b display. Comparing the memory of the 625-line r-g-b, or SECAM, pictures with the 405-line N.T.S.C. at Earls Court would seem to be a chancy business, but if our memory serves us correctly, there would seem to be little to gain for colour from 625 lines, 50 c/s field rate, using the present shadow-mask tubes.

Standards and Systems.—From the demonstrations seen it may not be wise to try to draw any conclusions as to the most suitable system and standards for colour transmissions. There are too many additional factors involved; for instance SECAM should, because of its f.m. colour subcarrier, be less affected by interference than N.T.S.C. with its phase-modulated subcarrier. However, SECAM's vertical misregistration of colour, though not visible on 625 lines, might be apparent on 405. In any case, the effect, even on 405 lines, is theoretically of less serious extent than the lack of colour definition with N.T.S.C.

Our present narrow-bandwidth positive-modulation signal with a.m. sound is peculiarly suited to the production of best results with the N.T.S.C. system. Briefly, saturated (pure) colours of high brightness, such as yellow, result in a large subcarrier amplitude. Now even the best transmitter distorts the signal to some extent, particularly near zero power, and with a negative-modulation system this distortion would be worst when saturation and brightness are simultaneously at a maximum; but with positive modulation the distortion is worst on dark pure colours, where it is not so noticeable. F.m. sound can cause difficulties also as it is obviously not possible to lock the sound carrier to the vision signals and beats can thus become more visible.

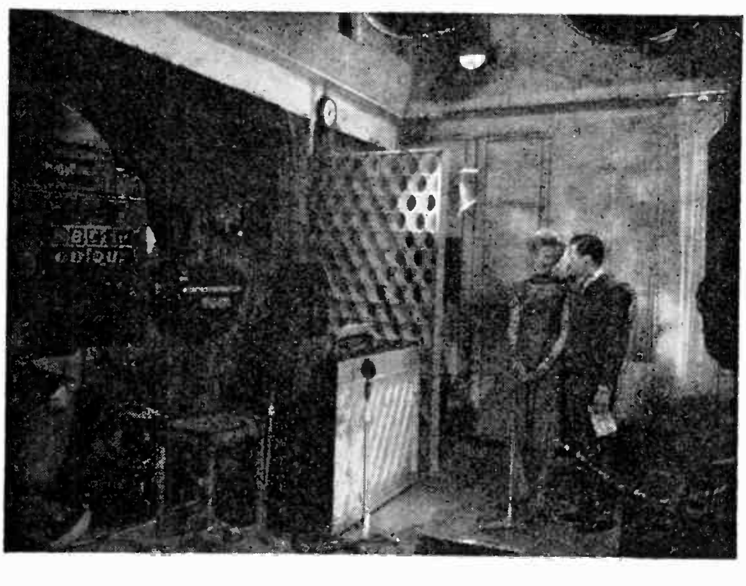
Even a 625-line system using positive modulation and a.m. sound may be worse than 405 lines in fringe areas because the wider bandwidth required for roughly the same resolution must result in more noise. For monochrome TV this is not so important because the appearance of the noise "grain" is slightly finer as the resolution is slightly higher, but with colour signals the noise can beat with the subcarrier and produce a coarser effect.



Much-simplified circuit of Philco "Selectaflash" remote-control sound-muting arrangement. Full circuit contains compensation for variations in temperature, lighting, etc.

Remote Control.—Last year's minor trend towards remote-control facilities for television has, this year, become a major one particularly with the widespread use of motor tuning. Most manufacturers were showing some form of wired control, but the main development was in sound—and light—operation (*son et lumière?*)

The sound-operated controls usually employ two ultrasonic "gongs" struck by plungers or keys on the control box. The "noise" produced is picked up by a microphone, amplified and used to energize relays to alter the sound volume and change channels (Murphy for instance, mute sound, while Dynatron provide two preset volume levels).

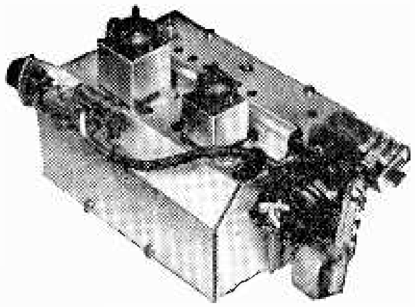


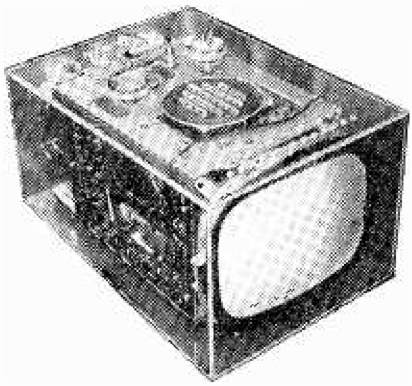
Part of B.B.C.'s colour television studio at the Radio Show.

Light-operated controls were shown by Ekco and Philco, both using ordinary hand torches as the "control" unit. The Ekco "Magic Ray" system uses a light-dependent resistor (l.d.r.) as the sensitive element, and, to avoid changes in room lighting changing channels, this is followed by a pentode pulse amplifier tuned to 12c/s. Wobbling the beam across the l.d.r. starts the action. Following the amplifier is a pulse-counter circuit using two diodes which, after receipt of at least 3 cycles of 12c/s, produces a potential sufficient to cut on a triode relay amplifier (in the same envelope as the pentode) and so start the tuner drive motor.

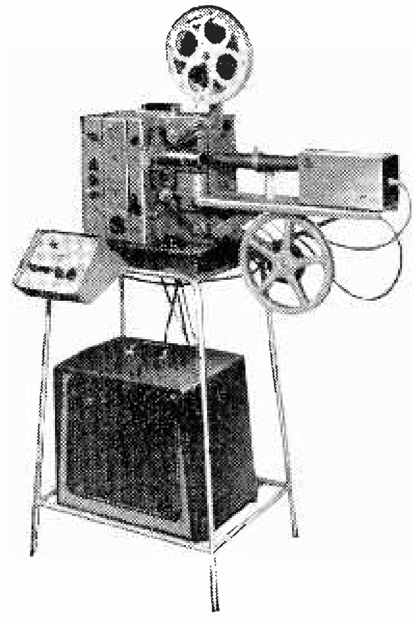
Philco, in their "Selectaflash" models, also employ l.d.rs, but their circuit is as fiendishly ingenious as Ekco's is æsthetically pleasing. The l.d.rs are mounted one on each side of the c.r.t. Channel-changing is relatively simple: a relay energized, via a dropper resistor, from the h.t. line and the l.d.r. is shunted across its

Right: Tuner of Alba receiver for use with "Concord" remote control unit. Solenoids energized by discharge of capacitor pull over switch "dolly."





Left: Perdio $8\frac{1}{2}$-in television receiver in display case, showing panel construction. Usual case is wrap-round type.



Right: Nev-eye telecine machine by Nottingham Electronic Valve Co.

coil. The l.d.r's resistance falls when illuminated (baffle plates prevent room lighting from affecting it) and shunts the relay, which then starts the tuning motor. The other l.d.r. provides sound muting and is much more complex in its action (see simplified circuit). A short flash mutes the sound and lights a neon pilot lamp; a second flash then restores the sound and extinguishes the light. Alternatively a prolonged flash mutes sound and, when turned off, restores it.

Lighting up the l.d.r. reduces its resistance and results in a positive pulse and an increase of a.c. from the unsmoothed h.t. being fed through C_2 to the relay coil. The relay pulls in and sticks as the contact changeover has removed the "unsticking" a.c. fed through R_1 C_1 R_2.

Also the changeover lights the neon, its current passing through the diode D: the diode thus short circuits the a.f. through C_3. Should the light now be cut off the l.d.r. resistance rises, but the relay remains "stuck" by residual magnetism and C_2 charging from the higher potential at R_3 R_1 junction. Nothing happens at the start of the second flash (the relay is already "stuck") except a further charging of C_2; but when the light is cut off the l.d.r.'s resistance rises producing simultaneously a decrease of a.c., tending to demagnetize the core, and a negative discharge pulse which helps to throw it out, extinguishing the neon and restoring sound.

If a long flash is applied, C_2 charges up to maximum h.t. potential; but as soon as charging is complete cessation of the light causes, as with the second short flash, simultaneous discharge of C_2 and demagnetization so releasing the relay and restoring sound. Variation of R_1 provides a variation of the "unstick" a.c.

Alba showed last year their "touch button" sets with push-button selection of two stations. The tuner uses a slide switch and toggle arrangement and this year, with the "Concord" wired remote-control unit, the tuner has been adapted very simply by the addition of two solenoids which pull over an extended "dolly."

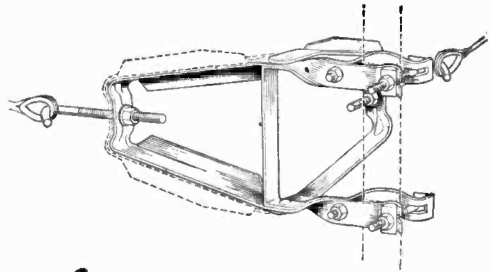
Transistor Receivers.—Perdio, well known for their transistor radios, were showing a 27-transistor set called the "Porterama." This uses an $8\frac{1}{2}$-in c.r.t. and contains a 10Ahr nickel-cadmium accumulator and charger. The line timebase is of the direct-drive type and employs the 120-V Bendix transistor designed for this application. Full "big-set" facilities are provided (a.g.c., flywheel timebase, etc.) and the sensitivity achieved is 10μV on Band I, 20μV on Band III.

Telecine Facilities.—One of Nottingham Electronic Valve Co.'s miniature transistorized cameras was used as part of their telecine machine. The projector was a standard R.C.A. type modified by the addition of a 4-in telecine lens with an iris diaphragm and a frosted, instead of clear, lamp to reduce the light intensity. The storage effect of the Vidicon is called into play to avoid the need for synchronizing the projector shutter and the frame scan. As the picture produced on the Vidicon is erect, the frame scan is reversed to give erect presentation on a standard TV receiver.

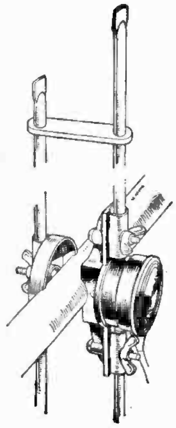
AERIALS

"Trumatch", a matching system developed by Antiference, shows promise of being extremely useful as it can not only ensure good aerial-to-cable matching over a wide range of impedances without a transformer but also because it widens the bandwidth over which the aerial remains matched.

The ordinary dipole behaves as a rather "lossy" (corresponding to radiation) series-tuned circuit which, as the frequency rises above resonance, becomes inductive and, as the frequency falls below resonance, becomes capacitive. A parallel-tuned circuit has exactly the opposite behaviour and, by connection of such a circuit (a short-circuited $\lambda/4$ stub) to a dipole the bandwidth and matching of an aerial can be improved. "Trumatch" goes a step further though as a parasitic element, which has a similar effect to the stub, placed near the aerial elements but not electrically connected to them, is obviously very simple and less costly than, say, a folded dipole. The impedance achieved depends on both the spacing and the length relationship between aerial and rod: an aerial of two elements almost $\lambda/2$, which normally has a very high impedance, can be brought down to 80Ω, whilst a simple dipole in a large Yagi array, normally of 10 to 15Ω impedance, can be raised easily to 300Ω. Stacking is easier too; adjustment of the "Trumatch" element can make the aerial im-



Above: Aerialite fold-flat chimney lashing bracket with swing-out bolts to permit insertion of completely assembled and wired aerial without "threading" of feeder. Dotted section at left shows folded position of bracket.



Left: "Trumatch" by Antiference provides wide range of impedance adjustment. Cross-member is plastics moulding to maintain element spacing, "True-match" element is on left.

pedance suitable for most stacking arrangements whilst needing one standard set of stacking bars.

Mechanical developments by Wolsey and Aerialite have resulted in easier-to-store easier-to-use chimney brackets. The new Aerialite lashing bracket folds down to a small bulk for storage and has captive swing-bolts on the mast clamp so that the mast can be inserted without the need for threading through of the feeder after erection of the aerial or complete removal of the retaining bolts. Wolsey's new bracket is in two pieces so that it packs flat. It is put together by locating two lugs on one half in slots on the other half, rather like a mammoth-sized (and very much stronger) tin-plate toy.

Indoor aerials too have undergone some development during the past year: for instance both Telerection and Aerialite were showing new aerials consisting of a complete Band-III dipole with a coaxial Band-I element emerging from the upper half of the Band-III section. This construction offers improved isolation between the two sections. New from Belling and Lee was the "Monitor" rabbits' ears set-top aerial, which features push-button coarse tuning of the loading coils used to bring it to resonance on Bands I, II and III and has a "trimming" loading coil whose slug is moved by an edge-wise control knob. The fourth push-button, labelled u.h.f., switches out the coils. Wolsey's "Hermes" V-aerial is more conventional in form, but incorporates an external ornamental Band III matching loop as well as a tunable Band-I inductor.

SOUND RECEIVERS & REPRODUCERS

Receivers.—Most of the new models are now transistorized. New signs of the old trend towards giving such receivers a specification similar to their valve mains (table) counterparts (except, of course, that they run from batteries) are the fitting of extension speaker sockets (noted in the Fidelity "Coronet" and H.M.V. 1421) and the increasing provision of a tone control (treble cut) as, for example, in the K.B. "Cavalier". This receiver, in addition to having the now frequently provided car aerial and tape-recording sockets, is unusual in being fitted also with a microphone input socket to enable it to be used as a baby alarm.

The reverse of the above trend—the use of transistors to produce very small receivers—has also reappeared this year.

To enable such receivers to be more easily tuned, slow-motion slide-rule type controls were provided by several manufacturers. These were usually only miniature versions of the standard cord drive system, but one exception was in the K.B. "Bikini". Here a simple two "gear" type of reduction is used—the "gears" are actually discs, one of which is sandwiched in a circumferential slot in the other to give a friction drive. A pointer is provided at the end of a plastic tape which winds on and off the larger (tuning condenser) disc.

Alloy diffused and other new types of transistor are being increasingly used because of their higher gain. In almost all cases this increased gain was directly used to increase the overall receiver sensitivity. One exception however was in a circuit shown (privately) by Mullard in which this increased gain was used rather to allow the number of (a.m.) i.f. stages to be reduced from two to one.

A revival which we noticed was the increasing provision on the long waves of only the Light programme rather than full coverage. This was generally done by attaching to the tuning condenser a switch for adding in parallel the appropriate larger capacitor to tune in the Light programme. The switch generally acts somewhat before rather than exactly at the point of maximum variable capacity swing. This allows some variable tuning around the Light programme which can be used to take up mistuning produced by variations in the switch changeover position, padding capacity or coil.

To avoid feedback at the intermediate frequency (in a.m. receivers) from radiation which must inevitably be produced due to the non-linear nature of the detection process, Dynatron have found it necessary to double-screen the detector in their "Gypsy" receiver.

The simultaneous provision of a.m. detection and amplified a.g.c. by means of a collector-bend detector was noted in the Defiant A53 and A55 receivers.

Reflexing was employed to increase the sensitivity of a simple t.r.f. local station prototype a.m. receiver shown (privately) by Mullard—the r.f. transistor was used also as the first audio amplifier.

A pilot lamp is not normally provided in transistor receivers owing to its prohibitive current drain. Those provided in the new McMichael M105BT and Sobell S305 BT receivers (which were exhibited at the G.E.C. show) are, however, intended to be only momentarily illuminated for viewing the tuning scale in the dark.

V.h.f./f.m. transistor sets (generally covering medium waves also) were introduced last year by several manufacturers. This year's new models almost all employed the same type of circuit in which a separate r.f. and combined mixer/oscillator two-transistor front end is used only for f.m. reception, and the three f.m. i.f. stages are modified on m.w. to form a combined mixer/oscillator and two i.f. stages.

One exception to this general circuit arrangement is in the new Murphy B585. Although this uses the same basic circuit on v.h.f./f.m., all the transistors are still used for m.w. reception; the r.f. amplifier remains an r.f. amplifier, the combined mixer/oscillator becomes a separate oscillator, and the three i.f. stages become a mixer and two i.f. stages. This receiver also uses three (rather than the more usual two), stages in the audio amplifier. The extra gain thus obtained on m.w. allows an ordinary pull-out metal rod aerial rather than a ferrite rod to be used. Permeability tuning can then be used on m.w. as well as on v.h.f.—the latter is in any case desirable to keep microphony low.

Two other interesting features in this Murphy receiver are the operation of the third and fourth transistors in series (as far as d.c. is concerned) to conserve battery current, and the arrangement of the a.m. overload a.g.c. diode. The bias on this diode, and thus its resistance, depends on the collector potential of the r.f. transistor, and this, in turn, depends on the a.g.c. voltage. Rather than use this as a normal damping diode to vary the gain by altering the damping across a tuned circuit, Murphy have connected it as one arm of a potentiometer in the forward feed path of the r.f. The proportion of the r.f. signal fed through thus depends on the diode resistance and in consequence also on the a.g.c. voltage.

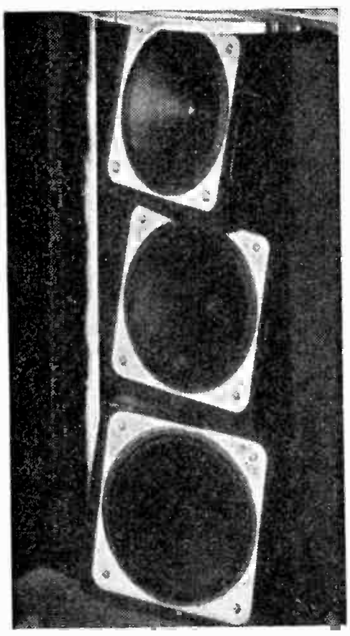
A diode is also used in an unusual way in the Philco 304 a.m./f.m. transistor receiver—to stabilize the f.m. oscillator voltage and thus maintained optimum conversion gain. In this receiver the combined mixer/oscillator transistor has its base fed from a much higher than normal voltage through a high resistance. The diode is connected between the base and the oscillator output. Any change in oscillator output then changes the current through this diode and thus the oscillator transistor base current, these changes acting so as to reduce the change in oscillator output.

An unusual feature of a prototype a.m./f.m. transistor receiver exhibited by Mullard is that a standing bias is applied to the diodes of the ratio detector. This loads the secondary tuned circuit and thus gives good a.m. rejection even at low signal levels.

Several improvements in transistor a.f. stages were noted. In the K.B. a.m. "Tango" receiver for example (and also in their record reproducers) a transformer is used in the push-pull output stage not for connecting the speaker (which is in fact directly connected across the transistor collectors) but rather for providing current feedback (6dB) to the output transistor emitters. With the addition of 14dB overall voltage feedback to the driver input, the crossover distortion is considerably reduced so that the battery can be used down to a lower voltage than is usually the case.

Crossover distortion is reduced in the push-pull output stage of the latest version of the Hacker "Herald"

Right: Murphy a.m./f.m. pocket transistor receiver.



Left: Three angled and rotatable tweeters used on each channel of the Decca 700 a.m./f.m. radiogram.

by individually stabilizing the output transistor base voltages. This is done by feeding these bases (via potentiometers) from the (relatively) constant voltages dropped across the two sections of a full-wave metal rectifier connected by suitable resistors to the battery supply. By varying the potentiometer settings, individual adjustment of the quiescent current in each transistor is made possible. The voltages across the rectifiers vary with temperature so as to provide additional thermal stability.

In the E.A.R. 1000M series of transistor medium and long wave receivers and record reproducers a usable output of 1000mW has been obtained by reducing the distortion in the push-pull amplifier in two ways. One of these is simply to increase the overall feedback. Stability problems which might arise are avoided by decreasing the phase shift by using a centre-tapped choke, rather than a transformer, to feed the (high-impedance) speaker. The distortion is also reduced by increasing the quiescent current in the output transistors so that they operate nearer to class AB. This requires an increased emitter resistance and good heat sink to maintain thermal stability.

The elimination of both the driver and output transistors by making use of a p-n-p/n-p-n complementary output pair was demonstrated by Mullard.

Fully transistorized car radios are still rather rare—one example is the Murphy "Voxson" described on p.612 of our December 1960 issue. Mullard were, however, exhibiting prototype all-transistor car radios with single-ended 3W class-A or push-pull 7 or 9W output stages.

New valve receivers show an increasing tendency to be f.m.-only models. One example is the Hacker "Mayflower" in which a very high sensitivity and a.m. rejection are obtained by means of three i.f. stages preceding the ratio detector. This set also features a preset r.f. gain control (which varies the bias on the variable-μ first i.f. valve) and a seven-watt push-pull output. Another feature of this receiver is the provision of adjustable local-station markers.

In capacitively tuned a.m./f.m. receivers the two sizes of capacity which are required are generally provided by separate sections on the tuning condenser. In a new Fidelity a.m./f.m. radio-gram, however, the smaller f.m. tuning capacity is obtained simply by switching a fixed capacitor in series with the larger a.m. variable capacitor. This set is also unusual in using printed circuit f.m. coils—these, it is claimed, reduce the tuning drift.

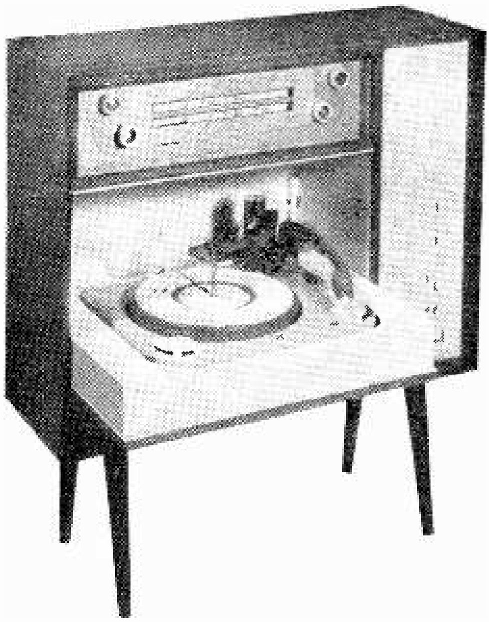
Radio-grams and Record Reproducers.—In stereo radio-grams the trend is now definitely towards long single-cabinet models.

The use of unusual stereo loudspeaker arrangements by Decca, exemplified last year in their Deccola, is continued by them this year in their 700 a.m./f.m. radio-gram. In this the middle and upper frequencies (cross-over around 350 c/s) of each stereo channel are handled by three 4-in loudspeakers. These loudspeakers are mounted in a vertical line, adjacent units being inclined about a vertical axis by about 30° relative to each other. Each set of three speakers can be independently rotated, also about a vertical axis, by up to 55°. This allows alterations to be made both in the apparent overall width of the sound source and in its direction.

Earphone sockets for private stereo listening are an unusual feature of a.m./f.m. radio-grams shown by Ferguson (their 660 and 661) and by H.M.V. (their 1644).

One smaller trend in radio-grams which we noticed in several Ace models (exhibited at an independent show) and also in the Alba 5601 was to mount the record player so that it could be hinged vertically when not in use. This reduces the cabinet depth to only 8 or 9 inches.

A useful servicing feature noted on two Sobell and McMichael stereo radio-grams, is that the receiver chassis can be readily hinged right out at the front. This chassis is normally partially hinged out when in



Ace "Slenderline" 8¾-in deep drop-front radio-gram.

use and, for servicing, the hinge stop can be rotated out of action.

The provision of artificial reverberation is an unusual feature of the H.M.V. 1644 a.m./f.m. stereo-gram. This reverberation is obtained by means of a mechanical (spring) echo delay system similar to that introduced last year by Ferguson in their 658RG a.m./f.m. stereo-gram.

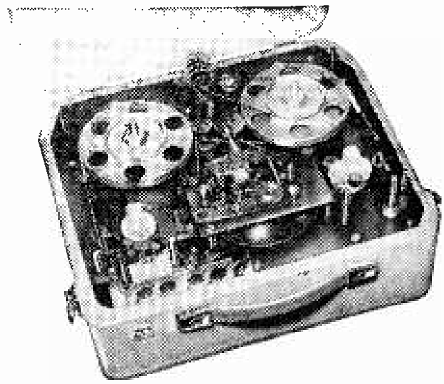
The increasingly popular slim-line shapes can be awkward acoustically. Pilot in their "Coffee Table" a.m./f.m. radio-gram (shown on the Ultra stand) have found that an awkward front-to-back column resonance can be cured by reflex mounting with the port much nearer the loudspeaker than is usual.

In portable record reproducers the trend is, if anything, away from stereo—many of the models on show were, we felt, quite unashamedly mono. If stereo is required in a portable unit a detachable second loudspeaker/lid arrangement is more convenient than a separate speaker/amplifier unit.

A very unusual feature of a transistor battery portable record reproducer introduced by E.A.R.—the Autobat—is that it incorporates a four-speed autochanger. This is the B.S.R. UA 14, and it is powered by a high-efficiency motor. This unit is also available as the Radio-Autobat with a transistor radio incorporated.

Tape Recorders.—No new general trends were noticed in this field although a number of unusual details were found.

A much closer than usual integration of transistors with valves was noted in the new Simon SP5 recorder. This is basically transistorized but valves are retained at three points in the circuitry (in the low level input, the high-level mixer, and between the meter level indicator and its associated signal rectifier) in order to obtain a high input impedance more readily. In addition, low noise can be more easily obtained in the low-level input and mixer stages (in the latter the series buffer resistors provide too low an input current for low-noise operation with transistors). The transistor power amplifier uses a push-pull driver and class-A push-pull output (feeding a balanced auto transformer) to give 5W at less than 0.5% distortion. A transistor push-pull erase and bias oscillator is also provided. The record level meter can



K.B. "Twin-Four" tape recorder using a new deck.

also be switched to read bias and this can be adjusted from an external control. Separate record and replay amplifiers and stereo heads are provided so that a signal can be re-recorded from one track on to the other with the addition of other signals should this be desired. The deck in this recorder is the new E.M.I. model used in the E.M.I. "Voicemaster" recorder.

An unusual feature of a new single-speed (3¾in/sec) four-track recorder (using a new deck) which was introduced by K.B.—the "Twin Four"—is that two tracks can be replayed simultaneously. This allows superimposition to be obtained without destroying the original signals so that one of these can be subsequently altered if required.

A method of automatic head demagnetization used by Bush in their new recorder is to momentarily connect a 0.05μF capacitor (charged through a 2.2MΩ resistor from a 26V screen-grid supply) across the record/replay head on changing from record to replay. This produces a heavily-damped ($Q \approx 4$) train of oscillations (at a frequency of about 15kc/s) in the head which effectively demagnetizes it.

In order to avoid having to under-bias the tape, and thus increase the noise and distortion, the frequency response at 7½ in/sec has been deliberately restricted beyond 12 kc/s in the new Magnavox TM 840 (exhibited at an independent show). This recorder also features a push-pull erase and bias oscillator.

Transistorized tape record replay amplifiers were exhibited by G.E.C. and Mullard. An unusual feature of the original version of the latter circuit is that the push-pull erase oscillator coil is wound directly on the head. This reduces losses and saves about 20 mA in battery current drain (in 100 mA) at the cost of a more expensive head. With more modern high-efficiency erase heads which have been specially developed for transistors, this integral coil may not be necessary—sufficient power may even be obtainable from a single-ended oscillator. Record/playback heads tapped at a lower point than the centre are also now available. This allows the head impedance on record to be reduced and a constant-current drive more readily obtained. By using the erase oscillator also as the replay amplifier, only five transistors are needed in the Mullard circuit.

Audio Amplifiers.—Two stereo amplifiers designed round their new ECL 86 valve were published by Mullard. Since with this valve at full output the second and third harmonic distortions are only about 0.7% each (without feedback) the distortion in the driver stage can become a significant factor.

A transistorized 2 × 15-watt stereo amplifier shown by Pye uses complementary n-p-n/p-n-p transistor pairs to allow both the driver and output transformers to be eliminated. An advantage claimed by Pye for transistors

(*Continued on page* 521)

in audio power amplifiers is that they are less susceptible to load impedance variations such as are usually offered by loudspeakers.

TEST AND MEASUREMENT

A series-stabilized power supply by Heathkit offers stabilized and unstabilized outputs of 200-410V and 190-510V respectively. The current at the stabilized output is 0-225 mA, depending to some extent on the voltage, and is at an output impedance of 0.5ohm at 500 kc/s. The output voltage is continuously variable in three ranges and total noise content is less than 1 mV at full load. The a.c. output is 6.3V c.t. at 4.5A. Two 3-in meters monitor the output voltage and current.

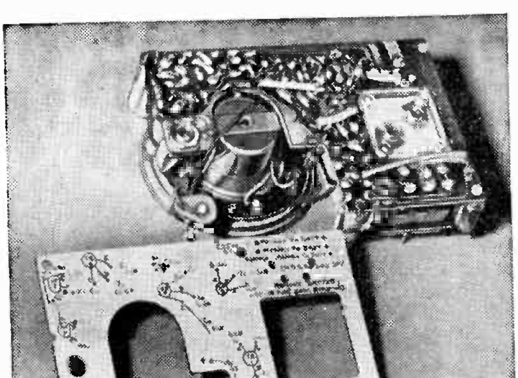
A sweep generator covering the range 4-210 Mc/s on fundamentals was shown by Taylor. The frequency-shift element is a ferrite reactor and provides a deviation of 14 Mc/s maximum, the actual deviation depending on the frequency in use. The r.f. output does not vary visibly over the maximum deviation, and is variable by coarse and fine attenuators up to a maximum of 300 mV. The waveform of the deviation is sinusoidal and the modulating signal is provided at the front panel for use with an oscilloscope. Blanking is applied to the oscillator at the end of each sweep, to obtain a base-line on the oscilloscope screen.

An educational kit, the Electronic Workshop "20" was exhibited by Heathkit. This consists of a set of electronic components and a ready-drilled chassis, from which can be made 20 different pieces of equipment. A 3-transistor radio, voice transmitter and burglar alarm are among the items which may be built up.

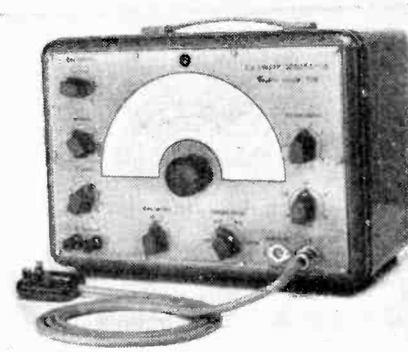
The first prize in the *Wireless and Electrical Trader* servicing competition was awarded to A. Looseley for a printed-board masking card, which consists of a piece of thick card, cut to the shape of the printed-board being serviced. The card is punched with holes which correspond to the component holes and test points on the copper side of the board, and each hole is identified with the corresponding component. In use, the card is located accurately over the board, when the required point for the application of probes, etc., is easily found.

An arc-detector, entered by E. Surtees, was awarded second prize. Very simple in conception, it consists of a length of coaxial cable with a search loop at one end and a plug at the other. The cable is plugged into the aerial socket of the television receiver and the search loop moved about in the vicinity of suspected arcs, when trouble becomes apparent as an audio or video output from the receiver.

In an effort to isolate intermittent component faults which are caused by heat, B. Gregson has modified a standard soldering iron by replacing the copper bit by a short ceramic rod, and was awarded third prize for the idea.



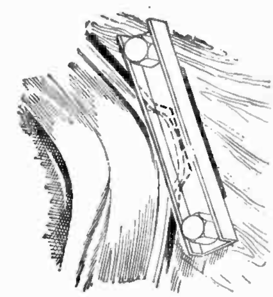
First-prize winner in the servicing competition was A. Looseley's masking card for printed-board servicing.



The Taylor 92B Sweep Generator designed to cover 4-210 Mc/s using fundamentals only.

VALVES & TUBES

The 19 and 23-in television c.r.ts are now in almost universal use, but the new bonded-face tubes are only used by a few manufacturers. Brimar had, side-by-side and displaying identical pictures, the three versions of the bonded-face tube using glass, Diakon and matt glass face-plates. A simple and direct comparison with a hand-lamp quickly demonstrated the reflection-free properties of the last type. The diagram shows the simple mounting arrangement.



Simple mounting in cabinet is a feature of bonded-faceplate television c.r.t. (Brimar).

Useful for stereo tape-recorder level indication and for f.m. use is the double EMM802 (Brimar) "magic eye." This has two independent sections governing the illumination of the fluorescent stripe on the bulb. The lighted areas "grow" from the ends of the bulb towards the middle as bias is applied to the control grids so that, by adding a rudimentary scale, two voltages can be compared. Another Brimar valve, the double triode 13D7, is designed for use in low-level low-noise preamplifiers. It has an amplification factor of 140 and can provide an average grid-hum level of only 3μV—slightly more than low-noise a.f. pentodes—with a total valve gain of over 5,000.

From Mullard comes the PY33 mains rectifier valve for television, a valve which produces 10V higher output than its predecessors running under the same conditions. The necessary close spacing of anode and cathode is made possible by a technique giving a very smooth, hard cathode surface: this involves the "pressing" of the emissive materials, instead of the usual spraying or dipping. Another valve from Mullard is a triode-heptode, Type ECH84, which is particularly suitable for sync separation in negative-modulation TV receivers. Noise pulses often rise well above the sync-pulse level of the signal and, with a normal separator, give spurious sync outputs and block off the proper pulses. One way of avoiding this is to use a dual-control valve, such as a heptode, the noise pulses being separated and used to cut off the sync-separator electron stream, so preventing the third grid, to which video and sync signals are applied, from drawing current and thus blocking the following sync pulses.

Thorn-AEI, who last year as Ediswan-Mazda introduced the first variable-μ television frequency-changer (30C17) this year showed a range of new valves for television including a cascode double-triode giving the highest gain achieved so far from a single valve of this type (30L17). Slope is 15 mA/V, using frame-grid construction, and to overcome instability an arrangement which harks back to early days has been adopted. Two cathode connections are necessary, thus a ten-pin base would be necessary to allow earthing of the screening separately from the earthed grid. To avoid the introduction of a new base the screening is connected to one heater pin which must be isolated and bypassed to r.f. New video-amplifier valves (6F28 and 30FL12) allow for 405/625 working as an anode load as low as 4.7kΩ can be used while not dropping the peak-to-peak v.f. output below 100V at 190V h.t.

LETTERS TO THE EDITOR

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

Series and Parallel Feedback

TO my mind the correspondence under this heading (August issue, p. 423) does not do enough to clarify the main points at issue and I am sure that many readers would have preferred a simple numerical presentation of the argument.

Consider first the amplifier shown in Fig. 1 and assume that it has a voltage gain of 100 and an infinite input impedance, measured at its input terminals. If its output voltage is 10 the requisite input is 0.1 V, the relative polarities being as shown. Across the 10kΩ feedback resistance R_1 there exists a potential of 10.1V and the feedback current is thus 1.01mA. Since the amplifier draws no input current the current in R_2 (1,000Ω) is also 1.01mA and the p.d. across R_2 is 1.01V. The total input voltage E is the sum of the p.d. across R_2 and the voltage e at the amplifier input. Thus E= 1.01 + 0.1 = 1.11V. The actual amplifier gain is $E_o/E = 10/1.11 = 9$. In the ideal case the gain would be exactly equal to the ratio of the feedback resistances, representing a gain of 10. The error is about 10 per cent.

The amplifier action would be completely unchanged if the generator E and resistance R_2 were removed and replaced by a generator e of zero internal impedance. This generator would be called upon to supply the feedback current i and the observed input impedance would be simply e/i or 0.1V/1.01mA = 99Ω. Note that the amplifier itself draws no current from the source e since it is assumed to have an infinite input impedance.

Now consider the effect of shunting the amplifier input by an additional 100 ohms. If the input voltage is held constant at 0.1V the current in the 100Ω resistance is exactly 1mA and this extra current must be supplied by the source E in addition to the feedback current of 1.01mA already specified. The total current in R_2 is thus 2.01mA and the p.d. across it is 2.01V. Adding to this the amplifier input voltage (0.1V) the total becomes 2.11V, shown as E_1 in Fig. 2. The effective input impedance seen by the source e is now about 50Ω (100Ω in parallel with 99Ω).

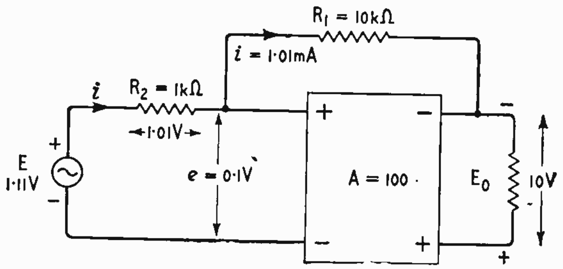


Fig. 1

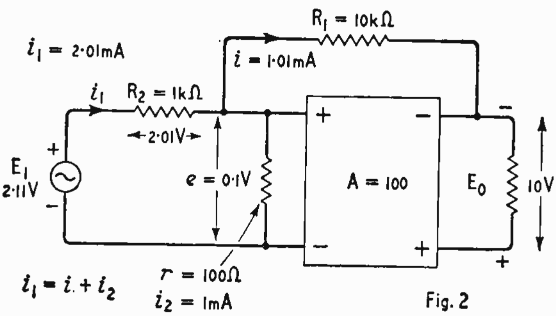


Fig. 2

The true overall gain becomes 10/2.11 = 4.8 as against the "ideal" figure of 10. Clearly an artificial reduction in the amplifier input impedance causes a large discrepancy between the actual gain and that calculated from the ratio of the feedback resistances.

It is instructive to repeat the calculations assuming that A = 1,000 instead of 100 but with the remainder of the circuit components as in Figs. 1 and 2. The results are as follows:—

Nominal gain = 10,

Actual gain for amplifier with infinite input impedance = 9.9,

Actual gain with 100Ω shunt across amplifier input = 9.1.

In this case the effect of an artificial decrease in input impedance is much less marked than in the previous case.

With the amplifier having A = 1,000 an input voltage e of 0.01V is required to supply a feedback current of 1.001mA. The effective input impedance is 9.99Ω. Naturally the effect of an additional shunt load of 100Ω is going to be less significant that it was in the earlier case for which the input impedance was 99Ω.

The foregoing arithmetical arguments are easily generalized and lead to the results below:—

$$\frac{E_o}{E} = \frac{A. R_1/R_2}{A + 1 + R_1\left(\frac{1}{r} + \frac{1}{R_2}\right)} \qquad (1)$$

= overall voltage gain with feedback.

Here E_o = amplifier output voltage,
E = input voltage, from signal source,
R_1, R_2 = feedback resistances,
r = shunt resistance connected across the amplifier input terminals,
A = open-loop voltage gain of amplifier, without feedback.

The terms of Equ. (1) have been set out in such a way as to bring out their physical meaning.

Some special cases are worth considering.

(i) $A = \infty$, r finite.

Then $\frac{E_o}{E} = \frac{R_1}{R_2}$ regardless of the value of r (other than zero).

(ii) $A = r = \infty$ (no shunt impedance).

This gives $\frac{E_o}{E} = \frac{R_1}{R_2}$ as before.

(iii) $r = \infty$, A finite.

Here $$\frac{E_o}{E} = \frac{AR_1}{R_1 + (A + 1) R_2}$$

It is worth noting that in the absence of any resistance r deliberately shunted across the amplifier input the effective input impedance depends only on the open-loop voltage gain and the value of the feedback resistance R_1 connected between output and input. The input impedance is in fact $R = R_1/(A + 1)$.

If r is added in shunt with this the new input resistance is
$$R' = \frac{rR}{R+r} = \frac{r R_1}{R_1 + (A + 1)r}$$

To conclude, equation (1) shows the dominating effect of the open-loop gain of an amplifier in controlling the properties of this amplifier when feedback is applied. By comparison, any reasonable value of shunt resistance at the input of a virtual-earth type of amplifier has a negligible effect on the performance if A is sufficiently large. With a finite value of A it is only possible to ensure that the amplifier gain, with feedback, is exactly equal to the ratio of the feedback resistances by shunting a negative conductance across the input terminals. The requisite value is given by
$$g = -\frac{1}{r} = \frac{1}{R_1} + \frac{1}{R_2} = G_1 + G_2.$$

Cheltenham. F. BUTLER

Electromagnetic Waves

IN the footnote to "Free Grid's" rake-up of the oscillating past there is a reference to "e.m. wave phenomena (as distinct from induction effects)". Wherein lies the difference between these phenomena other than that of frequency or wavelength.

The Government confirms that these "induction effects" are transmission of electromagnetic waves through space by making it necessary to obtain a wireless transmitting licence to operate them for communication purposes.

This is a pertinent point at the moment when the world's most powerful radio transmitter is in the course of erection for operating on very low frequency to give world coverage—for a special purpose.

Hertz discovered a means of generating high-frequency electromagnetic waves after others, including the British Post Office, were already communicating through space by means of low-frequency electromagnetic waves.

Incidentally, a book published a few years ago dealing with antiques and the big London sales rooms mentions that Hertz was an *habitué* of these places and something of a West End character whom the dealers—in their ignorance—regarded as a crank when he tried to impress *them* with his discovery!

Rustington, Sussex. B. S. T. WALLACE

Instructional Radio Receiver

THE instructional radio receiver described in your September issue, whilst almost wholly admirable, seems to fail in one important respect—it is altogether too well designed and executed and bears so little resemblance to the real life article that its use in the training of young service technicians may well be a subtle form of cruelty. To mention only a few shortcomings, this receiver has components which are accessible, it has no printed circuit boards or "skeleton" potentiometers, and perhaps, worst of all, it can be stood on its head without suffering fatal injury. For the feature in which it most nearly approaches reality—the manner in which the components are fastened—the designer seems apologetic. He does himself much less than justice in this.

I was astonished to read of the inability of various manufacturers to supply dummy or defective parts—this really is carrying British diffidence too far, since, to my personal knowledge, most of them have managed to maintain a steady flow of such items over the past thirty years. It is true that wartime conditions presented special problems (what with such things as A.I.D. and unlimited money), but even in those dark days, some of these manufacturers managed to make no small effort in this field. In this, as in many other types of production, there is bound to arise the challenge of the Common Market and I trust that I will not be accused of excessive patriotism when I predict that in this business of dummy or defective parts, we are in a strong position to meet any challenge from over the water!

Canterbury. K. DICE

Stepped Volume Controls?

I WOULD be interested in having the views of your readers on the following:

In my experience over many years, probably the weakest unit in wireless sets is the volume control. As the majority of volume controls incorporate a switch, the resistance track very soon suffers from abrasion and becomes noisy. Also, with the development of transistorized circuits, the track can be damaged by current surges.

Would it not be possible to mount the track in a protected position to allow the rota to pick up six to twelve metal stud positions equally around the track? I feel this would ensure a much longer life.

I am sure that a simple form of drilled or moulded holes with the segments assembled by the punched staple method, i.e. fixed in a similar fashion to the connecting tags, would add something less than a shilling.

What the manufacturers overlook is that it may cost a couple of guineas to change the volume control which, in itself, costs only a few shillings and I have plenty of evidence that many switched volume controls need changing within six months.

Margate. J. W. COVENEY

Museum Pieces

THE letter in your July issue from Mr. Munning certainly rings very true, and a good many service engineers and amateurs will probably have nodded their heads in agreement with him.

I have a pre-war radio-gram which has continuous coverage from 500kc/s to 70Mc/s in six bands, contains an r.f. amplifier, separate oscillator and mixer, two i.f. stages, and push-pull 6V6's driving a generously sized loudspeaker in a generously sized cabinet of substantial construction. It also incorporates two-speed tuning and a "magic-eye" tuning indicator. The layout, wiring standards and chassis finish are excellent, and the coil-pack is a joy to behold. Consider now the modern receiver, with its series-heaters, five-inch speaker, two or possibly three wavebands on a tiny glass scale. Consider also the transistor receiver at its best and one shamefully realizes that Mr. Munning is correct in every detail.

Surely, however, it is public demand that dictates what a manufacturer produces? Also the fact that radio has taken second place in favour of the "goggle-box" despite the many hours of genuine entertainment and instruction one can obtain from sound broadcasting. It is sad, but true, that the days of quality at the domestic level are all but gone and are only attainable at a price. No wonder so many of us build our own.

Brixham. GRAEME M. YOUNG.

Electronics at Farnborough

THE gradual transference of pilot and navigator from the Front Bench to the spectators' gallery continues, and one is struck by the thought that there may soon arise from the ranks of the Black Boxes a cry of "Strangers!"

Computers were once again very much in evidence; navigation and routine "driving" operations are now the province of diverse pieces of computery—in military and heavy civil aircraft at least—and many aids have been evolved to ease the remaining pressure on the aircrews' faculties. Reliability is receiving its proper share of attention, the extensive use of semiconductors helping to make airborne equipment mechanically and electrically very robust indeed.

A typical example of both an airborne general purpose computer and of the high component packing-densities now being achieved, is the Autonetics Verdan, marketed in the U.K. by Elliott Bros. The computer consists of three sections—a general-purpose section, a digital differential analyser and the input/output equipment. The d.d.a. is effectively a digital integrator which, while performing operations normally associated with an analogue computer, such as the integration of the outputs of accelerometers used in inertial navigation, retains a digital mode of operation, with its inherent high accuracy. An unusual feature of the design is that interruption of the power supply in the middle of an operation does not result in the loss of any information, as the computer "marks its place" in the programme and stores the required information indefinitely.

The long-base S.T.C. Doppler direction-finder aerial. The only building required is the wooden scaffolding, as the Doppler signal and reference signal are fed by land-line to the indicator.

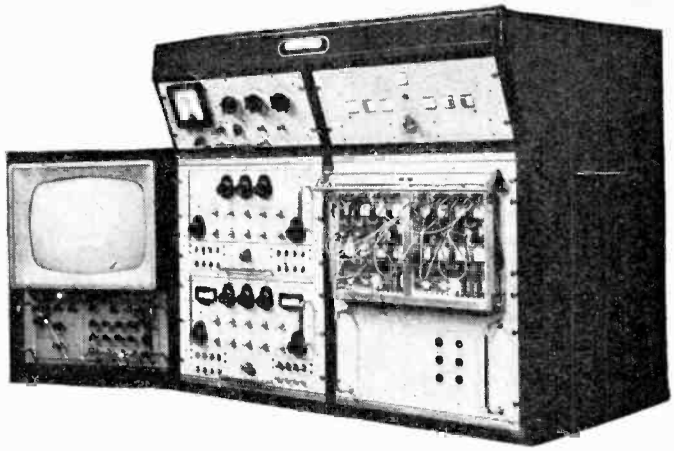
An ingenious pilot aid is the Halpins A.D.A.S., which provides a practically foolproof method of homing and navigation on both medium frequencies and the VOR band. Instead of the usual meter presentation a cathode-ray tube display is used, the higher sensitivity of the display giving a correspondingly increased range. The whole process of homing is carried out by observing the relative positions of two spots on the tube face, and I.L.S. let-downs and radio-range flying can be performed with no extra equipment.

Pilot's Electronic Eye-level Presentation (Peep for short) is a method of presenting to the pilot all relevant flight data in a way that does not distract his attention from the outside world. Information derived from navigational equipment is displayed, together with alpha numeric characters, on a vertically-mounted cathode-ray tube. A partially silvered mirror inclined at 45 degrees reflects the display to the pilot's position so that information relevant to airspeed, heading, etc., can be assimilated without the necessity for frequent furtive glances at the instrument panel. The display is collimated to avoid fatiguing changes in optical focus. Rank Cintel, who manufacture Peep, have also developed a central warning system wherein fault or incipient failure conditions are presented in alpha numeric characters in one of three differently coloured zones of a cathode-ray tube. The tube is divided into red, amber and green, corresponding to the priority of the warning, and a storage circuit is used for the amber zone whereby low-priority warnings can be presented at intervals until the fault is cleared.

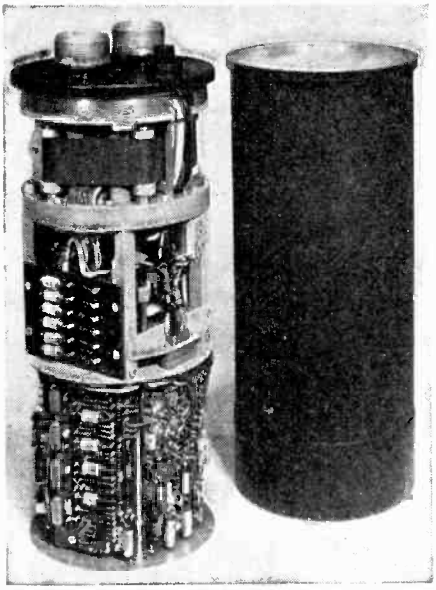
Audible instead of visual warning is provided in the Ferranti device. Signal inputs are continuously sampled by a commutating switch, any fault causing the appropriate track of a 16-track tape to be presented to a playback amplifier. Each track contains a recorded warning message which can be superimposed on radio signals.

The problem of maintenance at remote airfields is alleviated by the simple conception of the S.T.C. long-base Doppler direction-finder. The equipment requires no conventional buildings and is fully panclimatic. A 12-ft aerial rotates at 180 r.p.m. and frequency-modulates the signal received from the aircraft's v.h.f. R/T transmitter. The small percentage deviation is effectively increased by reduction to a much lower frequency while retaining the absolute deviation. A reference signal is derived by capacity coupling from the aerial drive shaft and passed, together with the frequency-modulated R/T signal, to the indicator unit. The two signals are combined in the indicator drive unit and the heading is indicated to an accuracy of 1°. Speech may be received on the same equipment, and an audio output is provided in the indicator unit. Site-error suppression is claimed to be at least seven times better than that of conventional short-base systems.

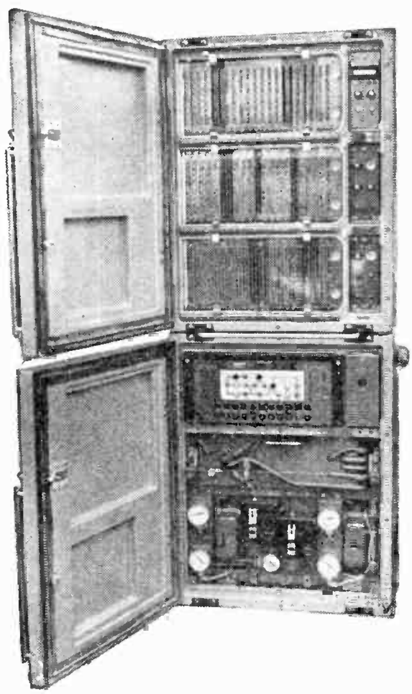
A method of mechanical design known as "environment stabilization" is employed in the Decca TDS Mk. V Display and Data Handling equipment. An integral liquid cooling system maintains all the important posts of the circuitry, which is transistorized, at a constant temperature. Reliability, it is claimed, is such that the equipment will be serviceable up to 99.5% of a 10,000 hour running period. The system is designed to provide for both analogue and digital data-handling and processing from either a single radar or several radars of different types. Compatibility with digital computers is a feature of the design, and data-handling aids, such as jet climb-out paths, map information and CRDF lines



Radic 10-20, an educational computer by Redifon. The basic 10-amplifier equipment is capable of expansion to employ 20 amplifiers and function generators.



Audible warning equipment by Ferranti. The 9-in long, 1-in wide tape is shown at the top.



The "environment-stabilized" Decca radar display and data-handling equipment. The bottom half of the cabinet contains the coolant supply and power unit.

can be presented on the viewing unit. Alpha numeric characters and symbols may be used in addition to the normal data-handling aids on the viewing unit.

Also capable of displaying received radar echoes and data-handling information simultaneously, the Marconi STD 1015 employs circuitry designed to resolve the conflict between high writing-speeds and compactness. Boost circuits are brought into operation whenever a fast spot movement is required, which means that, as the boost current is a transient waveform, large continuous currents are not required and small valves can be used. The p.p.i. display can consist of map information, range rings and IFF responses, in addition to raw radar signals. Characters displayed take the form of normal handwriting, and are based on points of intersection in an imaginary 4×4 matrix. A digital symbol computer output is converted to analogue waveforms and applied to the display during interscan period.

The Doppler navigation system DRA-12, made by Bendix, is now marketed by Elliott. Four divergent microwave beams are radiated downwards from the aircraft, and a proportion is reflected back. Doppler shift in each of the four beams is monitored by a commutating circuit in a tracker unit, and the information stored before being fed to a digital computer, which derives ground speed and drift angle. The difference in scattering properties encountered over land and sea are reduced in effect by means of a land/sea switch. The Doppler frequency is compared in the computer with a precisely-controlled crystal frequency, and in order to introduce the 1% change required over the two different surface conditions, the crystal frequency is altered by this small amount. Accuracy of the system is such that distance along track will not exceed ±1.1% of the computed distance and cross-track error is less than 1.3%.

A 24-channel lightweight transmitter-receiver working in the band 200-400 Mc/s was shown by W. S. Electronics. By a clever piece of circuitry, any one of 1,750 channels in the band may be selected by a remotely situated control unit, which provides a crystal reference frequency (24 crystals provided). The action of selecting a channel initiates the process of tuning, which is carried out by a 28V motor driving the transmitter and receiver tuning gangs, and also a ganged potentiometer. As the capacitors pass the point at which the tuned circuits resonate at the required multiple of the crystal frequency a pulse is produced which switches off a stabilized supply connected across the potentiometer. The output of the potentiometer is applied to a storage capacitor and, therefore, the voltage on the potentiometer when the tuned circuits are at resonance is retained. The motor continues to turn and as it approaches the point again the stabilized voltage is connected across the potentiometer. The charge on the capacitor is constant until the original point is reached, when a pulse is developed which short-circuits the motor by means of a silicon controlled rectifier, and the tuned circuits are set to resonance.

For communications in the v.h.f. range, Standard

Telephones were showing a very small and light transmitter/receiver, the STR-37, which gives 400 channels in the band 116-135.95 Mc/s. The equipment uses transistors and is completely self-contained. Output power is 200mW, although amplifiers are available to boost this to either 6 or 25W. Channels are crystal-controlled, all crystals being contained inside the control knobs.

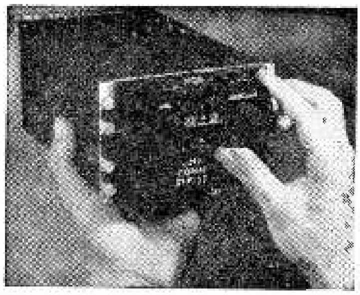
Several firms were showing lightweight packsets, notable being the B.C.C. Type 40 and the Redifon A.43. The A.43 cover the band 240-300 Mc/s, turret tuning being employed to select six channels. Power output is 2W. The Type 40 provides four channels in the range 30-174 Mc/s, and may be either amplitude- or frequency-modulated.

A transmitting amplifier designed for, among other things, aeronautical administration, was shown by Plessey. Working in the band 1.6-27.5 Mc/s, the equipment is continuously tunable and will deliver 1kW mean power into a 50Ω line. Operating modes available are double side-band full carrier, single side-band, independent side-band frequency-shift keying and four-frequency diplex.

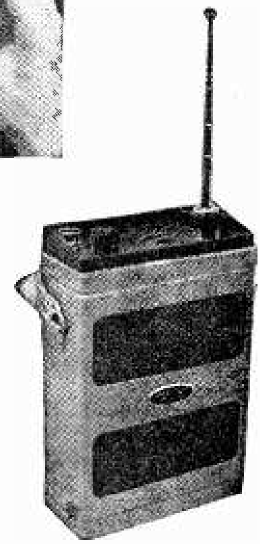
The steady procession of new electronic navigation and control aids requires, paradoxically enough, considerable training in order that their full potentialities may be realized, and simulators provide, in many instances, the only method of giving this training.

Equipment to fulfil this purpose is typified by the Solartron transistorized radar simulator. This will provide many types of simulated "crisis" and "overload" situations for solution by a potential radar air traffic controller. The equipment comprises an analogue computer which simulates the radar head and which permits adjustment of the situation presented to the trainee, and a p.p.i. indicator. Various types of modification may be injected into the system—for instance, wind speed and direction may be varied in layers, permanent echoes may be added, and the simulator can be synchronized with live radars. Realism is achieved by the addition of noise.

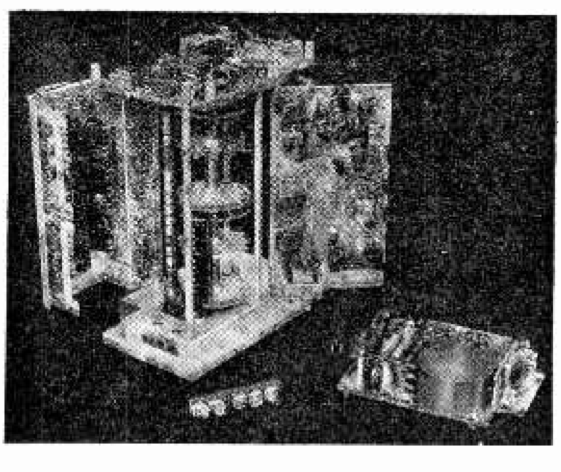
A simulator intended for a different purpose was shown by Short. The S.C.5 is designed as a tool for the testing and development of the autopilot device to be used in the Short Belfast. A 64-amplifier analogue computer receives signals from the throttles and flying controls as they are manipulated by the autopilot, and computes the effect that the autopilot's actions would have on an aircraft in flight. The result of the computation is fed back to the autopilot, and the outcome of this series of events provides information on the effectiveness of the autopilot. An automatic system-checking facility is provided to ensure that any malfunctioning lies in the operation of the autopilot, not the simulator.



Above: The STR-37 v.h.f. transmitter-receiver by S.T.C. Completely self-contained, the power output is 200 mW on 400 switched channels.



Right: B.C.C. Type 40 a.m. or f.m. packset, to work in the range 30-174 Mc/s.



Redifon's u.h.f./a.m. packset, working in the range 240-300 Mc/s. The unit is opened out for servicing.

Computing equipment designed for general-purpose applications was shown by several firms.

Corsair, designed by R.A.E. and manufactured by Rank Cintel, is a digital differential analyser. This is a type of computer which combines the accuracy and flexibility of the digital computer with the straightforward method of operation of the analogue variety. The similarity to analogue computers lies in the multiplication of identical units—integrators—and in the fact that units can be connected together by means of a patch board. Computation within the integrator is, however, digital, and the best features of each type of computer are thereby retained. Both linear and non-linear equations can be solved, and almost any equation can be re-written in a form which is soluble by the d.d.a.

An analogue computer designed for educational and research establishments is the Redifon Radic 10-20. This is a 10-amplifier instrument using the basic Radic* system. Programming is effected by patch board which shows pictorially all components and facilities which can be selected. The board is arranged so that a flow diagram can be built up using the cords instead of ink lines; this, of course, is ideal for demonstration. The computer is so designed that the basic 10-amplifier instrument may be expanded to employ more than 20 amplifiers, and various combinations of amplifiers and function units, both linear and non-linear, may be built up.

Two firms were showing recorders which are intended to aid in crash-investigation. Redifon showed an instrument which is incorporated into a data recorder on which flight parameters are recorded. In the event of a crash, a capsule containing the continuous-tape recorder is ejected, the case being designed to withstand considerable rough handling. A transponder is fitted and the battery power supply will last for several weeks prior to interrogation.

The unit developed by Armstrong Whitworth employs wire recorders which, in addition to carrying a record of flight data, include conversation between pilot and navigator. Some indication of the unit's toughness is given by the fact that it survived an ejection from an aircraft several hundred feet up flying at 520 m.p.h.

* Wireless World, August 1960, p. 369.

Solid-Circuit Microminiature Oscillator

USE OF UNIJUNCTION TRANSISTOR CIRCUIT

By G. BRADSHAW* B.Sc., A.M.I.E.E. and C. H. TAYLOR* Grad. I.E.E.

THE continuous trend towards smaller electronic components and constructional techniques, stimulated chiefly by military, space research and medical requirements, has been accelerated during the last few years by the production of semi-conductor devices—particularly the transistor and diode—with their small size and low power consumption. The other components, in many cases, have been scaled-down versions of their former counterparts, necessitating even closer tolerances in manufacture and purity of materials used. The size of such components is determined, to a large extent, by the need for substrates to support resistive elements, by the minimum thickness of dielectric film which is available and which can be handled for capacitors, and by the general requirement for mechanical climatic protection.

The techniques of microminiaturization which are now receiving attention at research and development establishments, especially in the U.S.A. and Europe, are a departure from the previous approach to miniaturization, and produce a new order of smallness and promise a higher order of reliability.

Microminiaturization can be divided into three main divisions. First, the micro-module concept where each component, both active and passive, is produced in as flat a form as possible—in many cases by vacuum deposition—on a small standard-shaped wafer of ceramic or glass. The wafers, or "micro-elements", are then stacked together and appropriately interconnected by riser wires at their edges to form micro-module circuits.

A second technique, the "micro-circuit", consists of vacuum deposition of thin-film patterns of metals and oxides on to a glass or ceramic substrate to form conductors, resistors and capacitors. Tiny diodes and transistors are then wired-in to complete the circuit. A circuit is thus produced on each substrate.

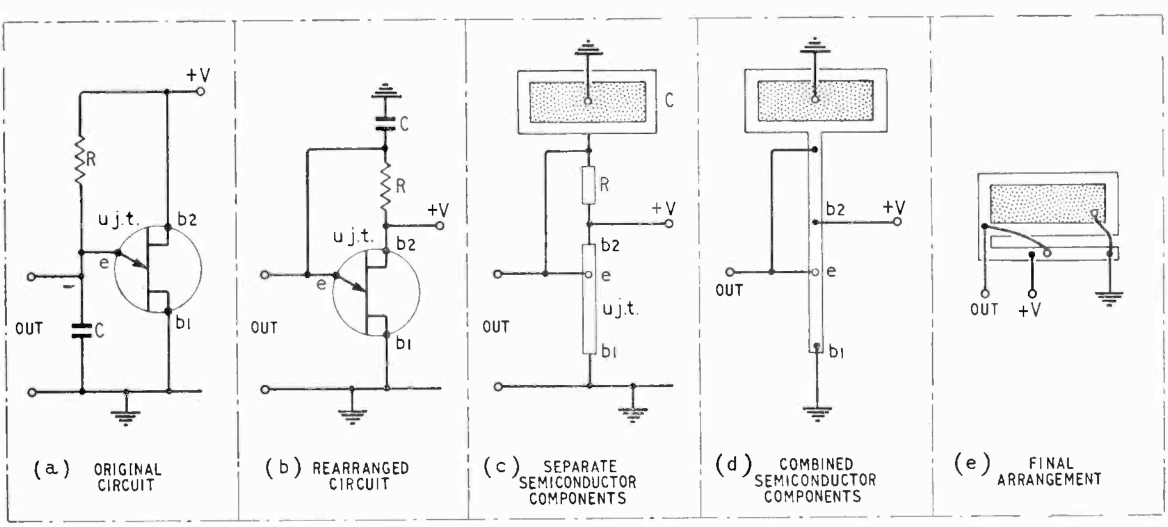
The third division of micro-miniaturization, generally called the "solid circuit", is aimed at producing a circuit function in a single block (or wafer) of semi-conductor crystal. Transistor action, resistance, capacitance, ohmic and rectifying contacts and other properties can be built into selected regions of a small piece of crystal such as germanium or silicon by semi-conductor fabrication techniques such as alloying, diffusion, gold-bonding and etching. By suitable configuration of these regions, a complete circuit function can be produced which is inherently extremely small and offers the same order of reliability as a transistor, when suitably encapsulated.

Recent work at the Royal Radar Establishment, Malvern, on this third division of micro-miniaturization has resulted in the development of a solid circuit consisting of a transistor, resistor and capacitor formed in a single wafer of silicon and which can operate from a battery source as low as three volts. This is believed to be the first solid circuit produced in the United Kingdom. A description of this device is given below.

Construction.—The evolution of the integrated

* Royal Radar Establishment, Malvern

Fig. 1. Evolution of a solid circuit.



circuit from its equivalent conventional form using separate components is shown in Fig. 1. (A version of the original circuit which was demonstrated at the 1961 Physical Society exhibition was described by P. Lloyd on p. 451 of our September issue.) The type of transistor used is called the unijunction transistor (uj.t.) or double-base diode, and consists of a short bar of mono-crystalline n-type silicon (or germanium) having ohmic contacts at each end and an emitter contact forming a p-n junction about two-thirds along its length from base 1. If a suitable steady bar voltage is applied between base 1 and base 2, and a varying voltage across emitter and base 1, then a plot of emitter current versus emitter voltage will show a "negative-resistance" region which enables the uj.t. to be used as the active element in oscillating or discharge circuits. A family of curves of a diffused silicon uj.t. for a range of bar voltages (V_{bb}) is shown in Fig. 2, and further information on these devices is given in Refs. 1 and 2. As shown in Fig. 1(d), an extension of the uj.t. bar produces a resistive region, the value of which depends on the bar cross-section, length and resistivity. A further extension of the bar coupled with an increase in width, gives a region of crystal which, if containing a large area p-n junction, can form a suitable capacitor. The value of capacitance is voltage dependant, and the circuit arrangement must be such that the junction is negatively biased. The shape of the crystal wafer shown in Fig. 1(d) can be re-arranged to form that of Fig. 1(e), and this latter shape was the one actually used, chiefly because it is more compact.

There are several methods of fabricating this integrated circuit, just as there are a variety of ways of making transistors. The method employed at R.R.E. used diffusion as the main technique, and a perspective drawing of the circuit-structure is shown in Fig. 3.

This involved the development of an entirely new uj.t.—the diffused mesa type—since the only kind of uj.t.'s known at the outset of this work were those made by the alloy process, using silicon or germanium as the bar material.

A slice of 30 ohm cm n-type single crystal silicon was lapped down to a thickness of 0.010 in. Boron was diffused into one side to produce a p-type layer

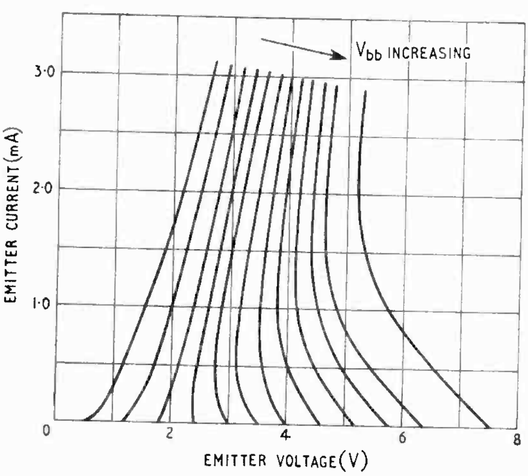


Fig. 2. Diffused silicon uj.t. curves.

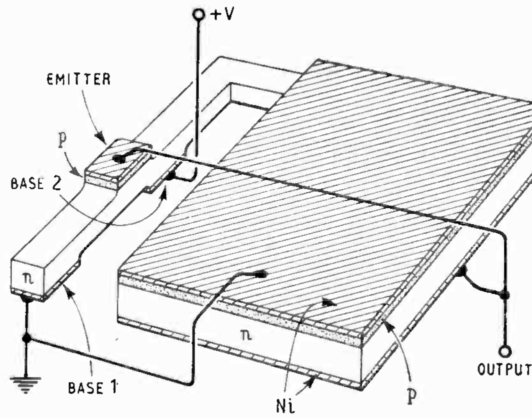


Fig. 3. Perspective drawing of solid circuit of Fig. 1 (e)

of about 12μ depth. The slice was then nickel-plated on both sides by an electroless method (ref. 3) and cut into 0.5 cm square dice. A dice was slotted parallel to one side with a wire-saw to produce a bar 0.010 in wide. At the free end of the bar, the three uj.t. electrode positions were masked-off with dots of high lead-content solder, the base connections on the un-diffused side being 0.010 in apart. The capacitor region was also masked-off on both sides with black wax, and the dice dipped into a nitric acid/hydrofluoric acid etchant for about two minutes. This process, by etching away unwanted nickel and crystal from the bar, formed the uj.t. and resistor regions simultaneously, and also removed work damage from the edges of the capacitor, thus leaving the crystal dice in the form shown in Fig. 3. During this etching stage, the uj.t. was tested on a jig to ensure that its characteristics were suited to the values of resistance and capacitance with which it was being integrated. The wax was removed, and 0.002 in diameter gold or copper leads were soft-soldered to the capacitor and to the mesa-structure electrodes of the uj.t. The device was then thoroughly degreased, washed and mounted for testing. A photograph of such an integrated circuit (compared in size with a pin) is shown in Fig. 4.

Performance.—The circuit described above is the basic uj.t. relaxation-oscillator circuit and will give a saw-tooth waveform if C is greater than about 1,000 pF, and a waveform tending to sinusoidal when C is decreased below this value—R being in the range 10-20 kΩ.

As the capacitor C charges up through R, the emitter junction is initially reverse biased due to the potential divider formed by the two base regions. When the capacitor voltage exceeds this reverse potential, the junction is forward biased but the current which flows is small until the voltage across the capacitor biases the junction about 0.7V positive. The capacitor now begins to discharge through the diode and base 1 (b1) region. The emitter current is nearly all in the form of minority carriers (holes) injected into the bar. These are swept by the d.c. field towards b1 and reduce the value of the resistance of this base region (conductivity modulation). Current flows into the bar from the capacitor. A peak is reached which corresponds to the lowest

(*Continued on page 529*)

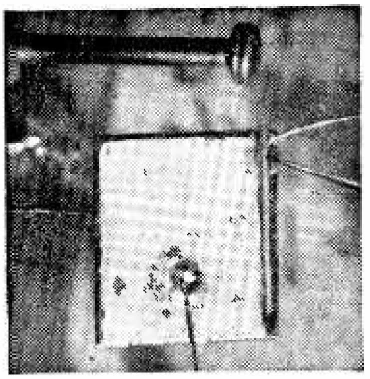


Fig. 4. Photograph of solid circuit relaxation oscillator and pin (to show size).

value of b1 resistance. The capacitor will continue discharging, but at a decreased rate, the emitter current will fall, and the resistance of the b1 region will increase, until the volts drop across the b1 region equals the capacitor voltage. At this point the resistance of the b1 region reaches its static value, the diode is zero biased, and the capacitor re-charges.

The resistivity of 30 ohm cm for the base silicon of the R.R.E. integrated circuit was a compromise between the requirements of the capacitor (low resistivity for high capacitance per unit area) and the uj.t. (high resistivity for long minority-carrier lifetime compared with transit time), but it was suitable for the resistor. Choosing a wafer size of 0.5 cm square for the circuit, the values of C were found to be 1,500, 850 and 350 pF at 0, 1.5 and 13.5 negative direct volts (V) respectively, corresponding to values of capacitance/cm^2 of 7,000, 4,000 and 1,600 pF. Except for the smaller values of V, C was proportioned to $V^{-1/2.5}$.

At these small values of C one would not expect a good sawtooth waveform output, and the actual ratio of charge/discharge periods was 3.5 to 1, with a peak-to-peak output (across C) of 1.2 V; battery voltage being 13.5. The value of R was 16 kΩ and it had a large positive temperature coefficient. The oscillation frequency was 500 kc/s at room temperature, decreasing to 300 kc/s at 120°C, this change being due mainly to the variation of R with temperature. The circuit required a load resistance greater than 40 kΩ, oscillation ceasing below this value.

The circuit described above was 0.5 cm square and 0.01 in thick, but smaller similar circuits have been fabricated, the smallest being 0.32 cm$\times$0.24 cm $\times$0.010 in. At the time of writing, each circuit has been satisfactorily operated intermittently with a total running time of 500 hours in room conditions, unencapsulated. If lower-resistivity material is used, thus increasing the value of C, lower output impedances and better saw-tooth waveforms would be obtained. Also the effect of the resistance temperature coefficient would be reduced, making the circuit less temperature sensitive. The design requirement of the uj.t. and the resistor, however, would be more difficult to meet.

Although using only the same number of processes that are required to make a transistor, this micro-miniaturization technique is capable of producing a complete circuit with dimensions smaller than those obtainable by any other known technique. In addition, many of the inter-connections between the "components" of the circuit are automatically "built in." These factors should contribute to high reliability. A possible future application is in equipments such as computers, where a large number of very reliable simple circuits are required: the extreme compactness of the circuit having a further advantage here in minimizing signal transit time. In the field of medicine, the use of "swallowed circuits" in capsule form for transmitting "inside information" suggests another future use. The promise of reliability, coupled with small size and weight, offers great advantages under the conditions of vibration and acceleration experienced by rocket-borne equipment.

The technique is also a logical way of combining and utilizing some of the large variety of interesting properties shown by mono-crystalline semiconductors, such as photo-, thermo- and mechanical-electrical effects, and novel conduction processes.

The latest transistor fabrication techniques—epitaxial growth of crystals, high temperature oxide-masking during diffusion, and photo-lithography—will greatly accelerate the development of new and more complex circuit functions.

Acknowledgements.—The authors wish to acknowledge with thanks the encouragement given in this work by Mr. G. W. A. Dummer and Dr. J. W. Granville, of R.R.E.

References

1. "More Circuits Transistorized with the Silicon Unijunction Transistor": S. R. Brown and T. P. Sylvan, *Electronic Design*, Jan. 8th and 22nd 1958.

2. "Double Base Expands Diode Applications": J. J. Suran, *Electronics*, March, 1955.

3. "Electroless Nickel Plating for Making Ohmic Contacts to Silicon": M. V. Sullivan and J. H. Eigler, *Jnl. of the Electrochemical Society*, April, 1957.

Commercial Literature

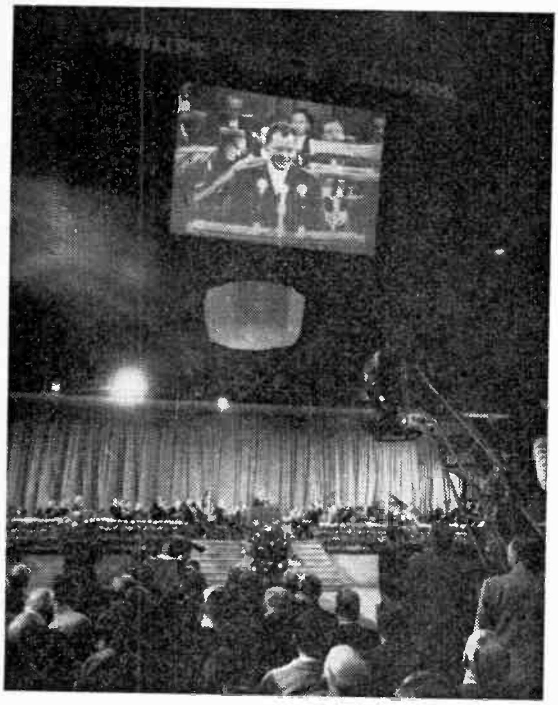
ARINC Specification No. 409, called "Selection and Application of Semiconductor Devices to Commercial Airborne Electronic Devices," offers guidance to manufacturers of both equipment containing transistors and the transistors themselves on the use of these components for civil airline use. A list of 39 American and 5 European types is included. Copies, price $1.00 each, from Aeronautical Radio, Inc., 1700 K Street N.W., Washington 6, D.C., U.S.A.

Process Timers covering the range 0.1 to 305sec are described in a leaflet from Richard Allan Radio Ltd., P.O. Box No. 3, Taylor Street, Batley, Yorkshire. Repetitive accuracy claimed is $\pm 1\%$ and a cold-cathode trigger tube is used, powered from 200-250V a.c. mains. The timers are dust and moisture proofed and the internal contacts are suitable for the interruption of 5A at 250V.

American-type Valves and cathode-ray tubes (including those for colour TV) made by R.C.A. are listed in "R.C.A. Receiving Tube Manual," together with circuits for such diverse pieces of apparatus as a 50-W a.f. amplifier, an intercommunication set with a master and two or more remote units and a valve-voltmeter. Also included are treatises on the testing and operation of valves and tables of values for RC-coupled amplifiers. Published by R.C.A. Commercial Engineering, Electron Tube Division, Harrison, N.J., price $1, or from local R.C.A. distributors (in U.K., R.C.A. Great Britain Ltd., Lincoln Way, Windmill Road, Sunbury, Middlesex, price 12s 6d).

Microwave Devices, including klystrons, magnetrons, noise tubes and monitor diodes, are described on data sheets in a loose-leaf folder from Elliott Brothers (London) Ltd., Elstree Way, Borehamwood, Herts.

BERLIN RADIO EXHIBITION



Visual as well as sound reinforcement was used during the opening ceremony in the Deutschlandhalle. The speaker, when this photograph was taken, was Herr Willy Brandt.

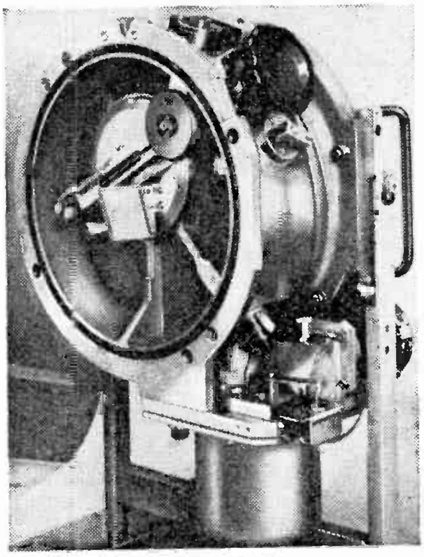
FROM 1924 until 1939 Berlin was the home of the German Radio Exhibition. Since the war (from 1951) it has been held biennially first in Düsseldorf and then in Frankfurt. To mark the return of the exhibition this year to its traditional home, the German radio industry has planned and achieved what is claimed—and not without justification—to be the biggest radio show the world has yet seen. There were 12 large halls and several small buildings with a net covered area of 13 acres, set in park-like grounds extending to 30 acres. In spite of the threatening political situation which developed just before the opening, the organizers and exhibitors determined that "the Show should go on." Their decision was fully justified and there was an audience of 7,000 in the vast Deutschlandhalle at the official opening by Prof. Dr. Erhard. The sound reinforcement system in this hall is of outstanding quality and on this occasion it was supplemented by visual reinforcement—a projection closed-circuit television system by Philips using the oil-film Eidophor principle* and giving an excellent picture approximately 22ft × 17ft. No trace of lininess could be detected from a seat near the centre of the hall and one guessed that a 800-1,000-line standard was being used. However, we were informed by Philips that the standard Continental 625-line system was in use, so it must be assumed that the refraction process, by which the powerful xenon light source is modulated, carries just the right degree of diffusion.

By a strange, one might say almost an ironical coincidence, the question of the inadequacy of existing line standards was as much to the fore in Berlin as at Earls Court. In London some manufacturers prophesy the millennium that will come with 625; in Germany, after 10 years' experience of that standard, the feeling is that the lininess on 23-in tubes (which incidentally now dominate the German market) is a serious blemish when the picture is viewed at close quarters in the average small house or flat.

Leaders in this school of thought are SABA whose optical screen, giving vertical but not horizontal diffusion, was described in this journal in its early experimental form over a year ago (August 1960 issue, p. 372). A practical close-fitting screen has now been fully developed with a higher transparency and with a graduated groove depth and spacing to correct the change of viewing angle as the eye moves from the centre to the edges of the picture. The public were able to judge the results on a dozen or more sets on the SABA stand, each with half the tube face covered by the new screen, and the accompanying untouched photograph enlarged from a film taken at the Show by *Wireless World* gives some idea of what may be expected from this development.

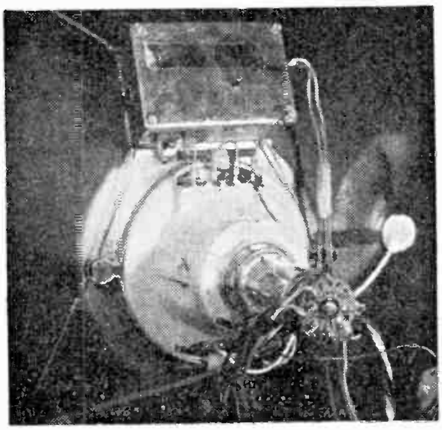
Two other firms were showing *Zeilenfrei* (line free) television. Grundig make use of spot wobble with a quartz-controlled oscillator working on a frequency of 13.56

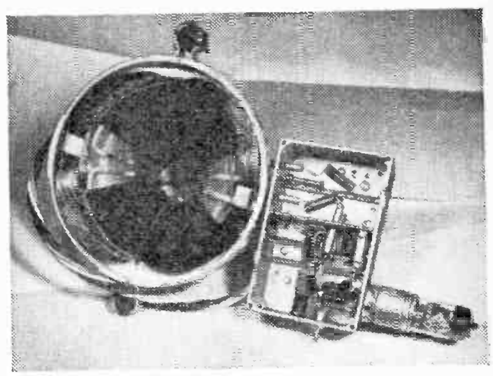
* See *Wireless World* June 1961, p. 322.



Philips Eidophor projection unit used in the Deutschlandhalle.

Untouched photographs, taken by Wireless World, on one of the SABA demonstration receivers in which the right-hand half of the picture only is fitted with the new vertically-diffusing screen. The upper picture is an enlargement showing a detail.



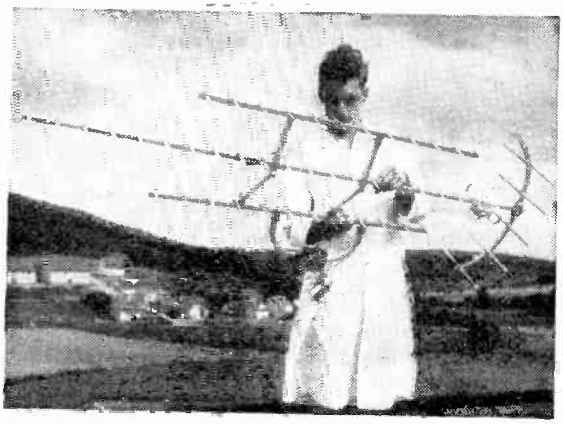


Above and right: The Grundig quartz-controlled spot-wobble oscillator is well screened and is mounted directly on the deflection yoke.

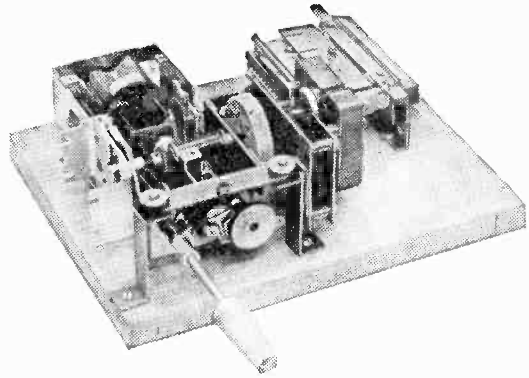
Mc/s which is allowed by the German Post Office for industrial purposes. The picture quality is excellent and a quick comparison with normal line structure can be made by an on-off push button on the front of the set. Incidentally, the harmonics of the wobble frequency fall in Band I, so a low-pass filter is provided between the oscillator and the addition winding in the deflection coil yoke.

The Telefunken "Tele-Klar" line-free system is much simpler and consists merely of permanent magnets in a plastic moulding designed to clamp on to the neck of any 110° tube. When properly adjusted the auxiliary magnets produce an elliptical spot which broadens the line. Only one set was publicly shown working (in rather strong ambient light and at somewhat reduced screen brightness) so we would prefer to reserve judgment on this system, which is what Telefunken themselves seem to be doing. It is sold separately for DM14,50 (£1 6s) and "*neue Geräte kann man künftig mit diesem Zusatz oder ohne ihn kaufen*" which may be broadly translated as "take it or leave it."

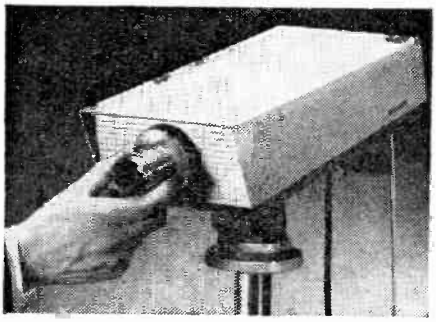
The technical upheaval apparent at the preceding Show in Frankfurt as a result of the proposals for a second programme on Band IV seems to have sorted itself out and production models of multi-band receivers, or of v.h.f./u.h.f. converters were shown by all the leading firms. Grundig claim to be so far the only firm to offer push-button selection of



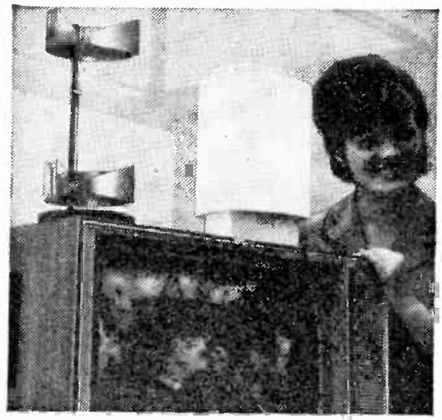
Fuba 51-element collapsible aerial for u.h.f.



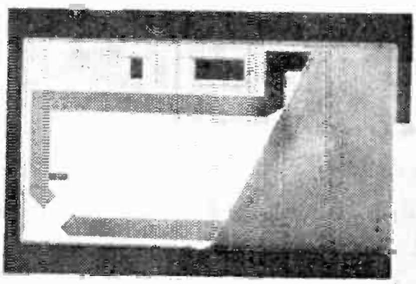
Push-button controlled, motor-driven station selector for v.h.f. and u.h.f. stations, developed by Grundig.

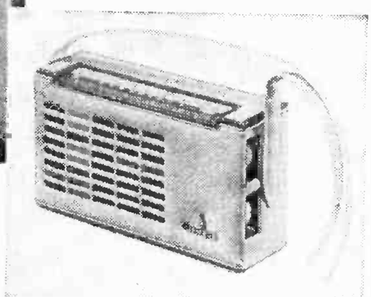


Philips EL 8000 automatic vidicon camera in which the only control is for lens adjustment.



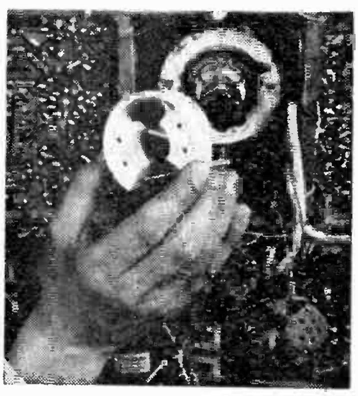
Telefunken broad-band stacked dipole TV aerial in the form of a table lamp.



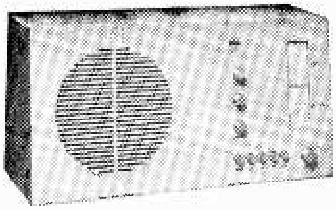


Covering material partly removed to show single-turn v.h.f. frame aerial in the Siemens RT10 transistor receiver (above).

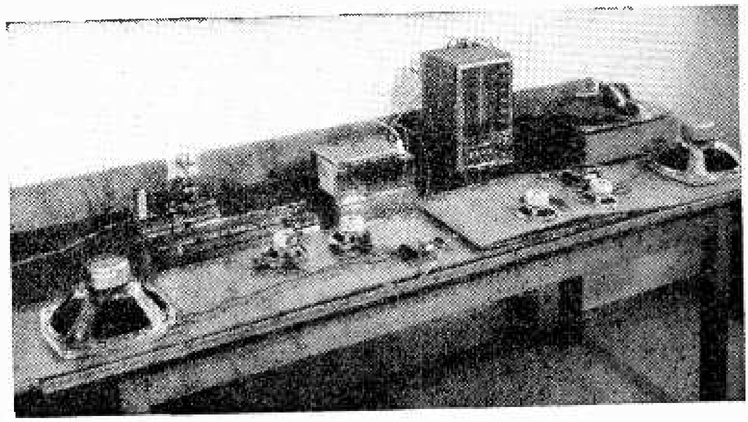
Schaub-Lorenz "Pony" pocket transistor set with telescopic aerial.



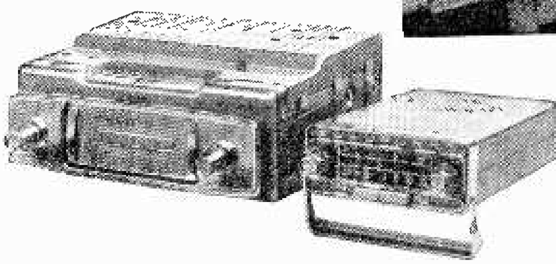
Left: A simple magnet system, produced as an optional extra by Telefunken, produces an elliptical spot when clamped to the neck of 110° tubes.



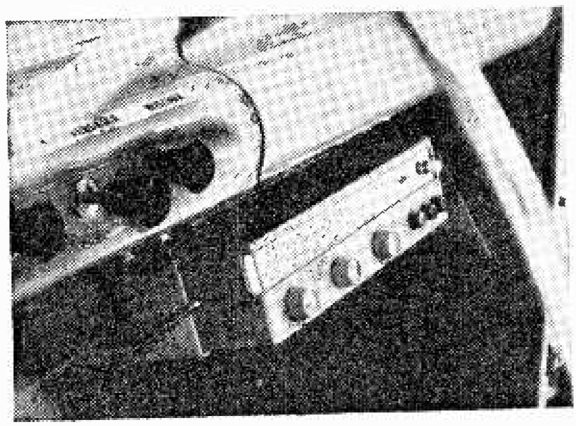
Braun RT20 f.m./a.m. receiver. The case is available with a front panel in white, graphite or natural woods.



Grundig Baustein series of high-quality units for the assembly of individual installations includes an electro-mechanical reverberation unit.



n the Blaupunkt "Capri" car radio an independently battery-operated transistor portable is inserted into a power unit giving 4/6 watts output. When the engine is switched off an electro-magnetic lock prevents theft.



Braun T52 transistor portable with quick release mounting for use as a car radio.

u.h.f. as well as v.h.f. stations. The precision mechanism of the tuning stop selector is a "mechanical marvel" (involving rotary, reciprocating and Maltese cross movements) which we should have thought would be prohibitively expensive. The Grundig reply to this comment was short and to the point: "We own a typewriter factory (Adler)."

Vollautomatik (fully automatic control of tuning, contrast, etc.) which was the catch phrase of Frankfurt is now accepted as obligatory and detail circuit refinements are hard to come by. However, Graetz have introduced in their Markgraf series *Einschaltbrummunterdrückung* to suppress noises due to overloading before the line output stage (and hence the a.g.c. system) is operating. The output from the line oscillator is rectified and applied as a negative cut-off bias to the i.f. and first a.f. stages. When the booster diode warms up, the current flow through a voltage-dependent resistor (which stabilizes the frame oscillator h.t. supply) drives the rectifier into continuous conduction and so removes the negative bias.

Blaupunkt now introduce contrast control between the video amplifier and the cathode ray tube and the control is compensated for variation of video response with contrast setting. Printed circuits are used by Blaupunkt for the first time this year. A large single horizontal panel is used and the chassis in the new Toskana set is designed to run "cool" (60°C max).

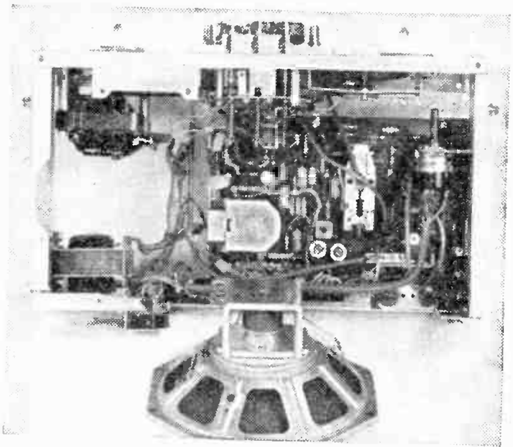
Television receiving aerials for Bands IV and V with large numbers of elements and correspondingly high gains are now becoming a common feature of the German scene. The tendency is to develop wide-band aerials covering one or in some cases both bands. The specialist aerial firms such as Wisi, Kathrein, Hirschmann and Fuba were all showing wide-band aerials of this type as well as aerials with high gain restricted to one band or a group of channels. The Fuba DFA 1 LM 51 is available for channels 21 to 60 (alternatively 14 to 53). With directors arranged in three ranks and with a total of 51 elements this aerial has a gain of 13dB. Fortunately for the installation technician the designers have made it collapsible.

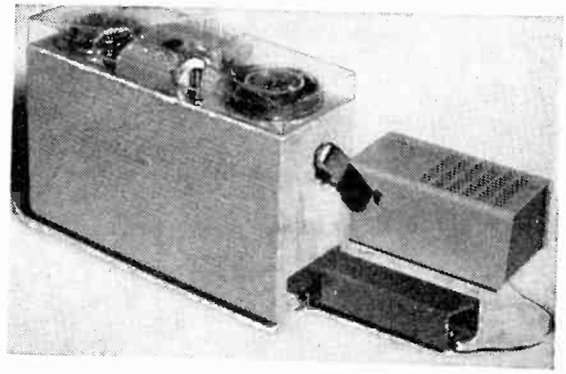
Telefunken were showing an interesting television aerial consisting of two stacked dipoles with V-shaped elements backed by semi-cylindrical reflectors. The array has useful directional properties and is effective over the whole of bands IV and V. It is housed in a translucent dust cover which also serves as a table lamp.

Before leaving television, mention should be made of the neat new Philips automatic vidicon camera (Deutsche Philips Type EL 8000) with no controls other than lens focusing. A projection display unit is available for use with this camera.

Turning now to sound broadcasting we find the German market—as elsewhere in the world—dominated by the transistor portable for reproduction from radio and/or records. The majority of German transistor radio sets now include a v.h.f. or a short-wave range—the latter to meet the demand for reception of home programmes while abroad. (The Germans are inveterate tourists.) From the vast range of models offered we have space to mention only the Telefunken "Partner IV" with its 6/9-cell battery supply, the last 3 cells acting as a "reserve tank" to give 80 hours more playing time when the first six cells have shown signs of flagging; the Schaub-Lorenz pocket portable with its extensible rod aerial for short-wave reception; the Siemens RT10 pocket receiver for v.h.f. with single-turn strip frame aerial; and the Akkord U61 "Pinguin" portable with a.f.c. in its v.h.f. range.

Many transistor portables are designed for use also as car radios with quickly detachable dashboard hous-





Vertical construction in the Philips RK5 (battery) and RK9 (mains) tape recorders gives good accessibility to the mechanism and permits the use of a larger than usual loudspeaker.

ings. This kills two birds with one stone and is cheap, but the makers of "genuine" car radios say that the stringent requirements of car radio reception call for a performance that an ordinary portable cannot properly meet. Blaupunkt, who for many years have specialized in car radio design, have met all objections in their new "Capri" receiver which has a basic 4/6-watt push-pull output unit built into the car, into which the battery transistor portable is plugged. An electro-magnetic safety device prevents the portable from being stolen when the car is unattended.

In table model domestic sound receivers the trend is towards the tilted flush-fronted style of cabinet seen for the first time at the Frankfurt exhibition and now, for example, in the Braun RT20 and the Philips "Capella-Reverbeo" which incorporates an electro-mechanical torsion spring reverberation device.

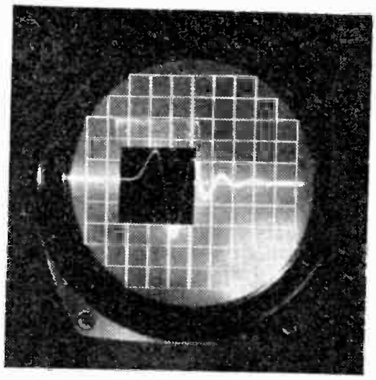
For high-quality sound connoisseurs Braun have introduced a number of new units, including a compact 4-unit moving coil, "infinite baffle" loudspeaker (L60) with 15Ω impedance. These units can be grouped in any furnishing scheme to satisfy every possible permutation and the stereo amplifier can even be adapted to play classical (mono) music in one room and jazz for the younger members of the family in another. The stereo amplifier (CSV13) has duplication of controls for each channel, mounted concentrically so that they can be tuned separately or together. Grundig, too, have a *Baustein* (building brick) series which even includes a television "feeder unit."

Among new tape recorders the Philips RK5 and RK9 are selected for mention because of their "vertical" construction which offers several advantages, including better balance for carrying as a reporting device, and the feasibility of accommodating a larger and better loudspeaker. Normally small spools are used under a plastic cover, but this can be removed and large spools used under "static" conditions.

One development which one would not expect to find in a domestic radio show (at Interkama perhaps?) is worth including. It is the development by Siemens of an extremely thin (10^{-4} mm) transparent nickel-iron magnetic alloy film for use in computer stores with a potential switching time of the order of 10^{-9} second.

No account of this exhibition would be complete without some reference to the side-shows, for these are very important in Germany. They draw the crowds, who know that in addition to anything they may find to interest them in the commercial exhibits, their entrance fee will have been well spent. In the beautifully laid out Summer Garden with its central grass arena there was a continuous programme of gymnastics, boxing and high-wire acts, with a military tattoo by the British Forces as a grand finale. And, of course, the Deutschlandhalle where for 20 pfennigs one could take one of the 12,000 seats during the afternoon or evening for the live broadcast performances laid on by the constituent Länder members of ARD—the national broadcasting association in Germany.

The *Sonderschauen*, or special shows, included a chain of studios and control rooms from which broadcasts were made while the public watched through soundproof glass. These incidentally were constructed inside one of the large halls months before the show opened. The small token exhibit "B.B.C. Greets Berlin" with its model of the new TV Centre, and some enlargements showing home and overseas coverage may have been somewhat overshadowed by the immense efforts of the ARD, but your reporter saw evidence of genuine interest.



Oscillogram of a 2musec demagnetizing cycle in thin transparent nickel-iron magnetic film developed by Siemens, viewed through a specimen of the film.

"Berlin on 400 Metres" was the theme of the German Post Office exhibit, which occupied the whole of the Marshall Haus, traced the history of broadcasting in Germany and the contribution of German scientists to the establishment of radio communication. The treatment was exhaustive, not to say exhausting, and must have represented many thousands of man-hours in collecting and arranging historical apparatus and documentary material.

As at Earls Court, there were stands devoted to the work of the civil authorities, and the police had a special exhibit, including their combined radar and flash camera mobile equipment for speed checks; the fire services also demonstrated their communication methods. Incidentally fire and ambulance foot patrols on duty throughout the grounds showed themselves to be good customers of radio by each carrying a walkie-talkie set, and the German Lufthansa airline maintained a radio station in which the public were able to hear messages exchanged with their aircraft on the various Continental routes.

At the time of going to press total attendance figures were not available, but they cannot have been very much below the predicted 750,000 in spite of the closing of the boundary between the eastern and western halves of the city. The exhibition was a complete success, and it provided a diversionary interest and a steadying influence during a particularly trying period for the west Berliners.

Loudspeaker Reactance Measurements

BRIDGE CIRCUIT FOR MEASURING IMPEDANCE AND PHASE ANGLE

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

OVER the frequency range 20 c/s to 20 kc/s the impedance of a moving-coil loudspeaker varies enormously and the phase angle swings over a wide arc. In the band 200-600 c/s the impedance is mainly resistive and for this reason the nominal impedance for matching purposes is commonly assumed to be the value measured at 400 c/s. Taking the case of a representative 10-inch 15-ohm speaker mounted on a plane baffle, it may well be found that the impedance rises to more than 300 ohms at the bass resonant frequency, sinks to the nominal value at some higher frequency and then increases to around 70 ohms at 20 kc/s. Below the resonant frequency the phase angle may reach 60 degrees lagging, fall steeply to zero at the bass resonant frequency and swing to as much as 60 degrees lead at a slightly higher frequency. At very high frequencies the coil inductance becomes important, causing a progressive increase cf phase angle which may reach 30 degrees at 20 kc/s.

The low-frequency end of the response curve is profoundly modified by the type of enclosure in which the speaker is mounted and the acoustic performance depends on the output impedance of the driving amplifier. Quite clearly it is impossible accurately to match such a reproducer to the power source over a wide frequency range. At frequencies for which the impedance is high it is difficult to transfer sufficient power to the speaker from a constant-voltage source. When the impedance is low the mis-match betwcen amplifier and reproducer may be such as to cause intolerable distortion. Few amplifiers designed for a 15-ohm load will accommodate a 50 per cent reduction in load resistance without distress. A question of stability is also involved. Modern amplifiers commonly use so much feedback that the use of an excessively reactive load may provoke oscillation. Clearly there is much to be gained from a study of the loudspeaker as a complex electrical network and it is remarkable that so little has been published on this particular topic.

The general dearth of information serves to emphasize the value of one informative paper[1] by R. E. Cooke which was published in the journal "Technique", issued by the Muirhead Company. In this the author gives the results of a large number of measurements made on different types and combinations of loudspeakers with the aid of a Muirhead D-728 Impedance Angle Meter. The aim of the present paper is to describe how similar measurements may be made with simpler equipment at the cost of some increase in the time required to take enough readings to make an accurate plot.

Fig. 1 shows in principle how both impedance and phase angle measurements may be made. Here the loudspeaker of impedance Z and phase angle θ, represented by $Z\underline{/\theta}$, is associated with the resistances R_1, R_2 and R_3 in a bridge circuit driven from an amplifier indicated as a signal source of constant voltage E.

The resistances R_1 and R_2 form a potential divider across the source and if $R_1 = R_2$ then $E_1 = E_2 = E/2$, since current and voltage are in phase. Suppose R_3 is now adjusted until it is equal to the modulus of the impedance Z. Then E_3 and E_4 will become equal numerically but in general they will be out of phase. Nevertheless the vector sum of E_3 and E_4 must be equal to the source voltage E as shown on the vector diagram, where θ is the phase angle between E_3 and E_4.

In the special case when $E_3 = E_4$ and $E_1 = E_2$ it can be seen from this diagram that $\tan \theta/2 = e/E_1 = e/E_2$. But $E_1 = E_2 = E/2$ so that $\tan \theta/2 = 2e/E$.

To sum up, the unknown impedance Z is measured by adjusting R_3 until the voltage across R_3 is the same as that across Z, in which case $R_3 = /Z/$ (the modulus of Z). The phase angle θ is determined by reference to trigonometrical tables from the expression $\tan \theta/2 = 2e/E$ where θ is the voltage between the points B and D on the diagram and E is the amplifier output voltage.

This procedure leaves undetermined the algebraic sign of the phase angle. It can be detected by adding known reactance in one arm of the bridge and noting the resulting change of phase angle. From this the sign of the original phase angle can be inferred. A simple technique is to add a small high-Q inductance in series with Z, re-balance R_3 for equal voltages E_3 and E_4 and note the change in the voltage reading e. An increase implies that Z is inductive and that θ is positive, corresponding to a lag between the applied voltage and the current in Z. A decrease in e shows that θ is negative and that Z is capacitive.

For measurements on 15-ohm loudspeakers it is

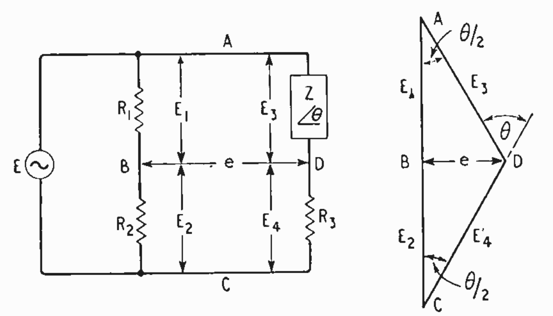


Fig. 1. Elementary circuit for measuring impedance and phase angle.

convenient to make up a small ferrite-cored coil with five taps brought out to a switch so that inductance values between 0.5 and about 100 mH can be selected to give satisfactory indications at all frequencies in the test range.

R_3 should be variable over the range 0-500 ohms and E should be held constant at, say, 5V. We may set $R_1 = R_2 = 100$ ohms and the sole restriction on the measuring voltmeter is that its impedance should be much higher than any of the bridge arm impedances.

The principal objection to the instrumental set-up shown in Fig. 1 is that it is tedious to keep switching the voltmeter over in order to check the equality of the voltages developed across Z and across R_3, then transferring it to measure *e* and E. A simple null detector using diode rectifiers as shown in Fig. 2 can

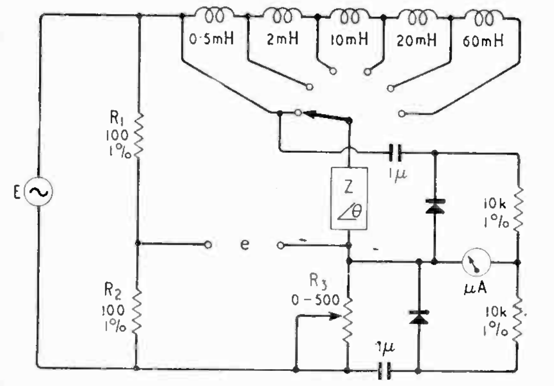


Fig. 2. Circuit using null detector for checking equality of voltages across R_3 and Z, and tapped choke for determining sign of phase angle θ.

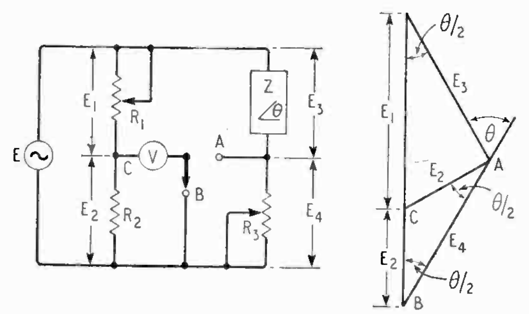


Fig. 3. Phase angle measurement method due to Scholes and Macfarlane.

be employed to speed up the operation. The circuit also includes the tapped coil, used as described above, to determine the sign of the phase angle. A centre-zero microammeter, say 100-0-100μA, makes a sensitive null detector. Almost any type of point-contact or low-power junction diode may be used as the rectifier element but matched pairs are desirable. The 1μF coupling capacitors to these diodes should also be matched to within 5%.

A recent article[2] on impedance measurement suggests further modifications which can be made to the basic circuit to give an alternative way of measuring the phase angle. The principle is shown in Fig. 3. As before, the resistance R_3 is varied until equal voltages are developed across R_3 and Z. To measure the phase angle, a variable resistance R_1 is connected in series with a fixed resistance R_2 across the supply voltage E. A voltmeter V is connected as shown and R_1 is adjusted until the same voltage reading is indicated with the switch in either of the positions A or B. The vector diagram shows that when this condition is satisfied the phase angle is given by $\cos\theta = (R_1 - R_2)/2R_2$. For convenience in reading, it is useful to set $R_2 = 100$ ohms and to join a fixed resistance of 100 ohms in series with R_1. When this is done it can be seen that $\cos\theta = R_1/200$ where R_1 is the setting of the variable resistance.

At the expense of a little extra complication a second null detector of the type used in Fig. 2 may be used to check the equality of the voltmeter readings in the switch positions A and B shown in Fig. 3 and the switch can then be omitted. The final arrangement becomes that shown in Fig. 4.

The measurement procedure is as follows:—

(a) With the switch SW_1 in the off position and R_1 set to zero, connect a variable-frequency audio oscillator to the amplifier input and set the gain contol to give a suitable output voltage E. About 5 V r.m.s. is suggested though the precise value is immaterial.

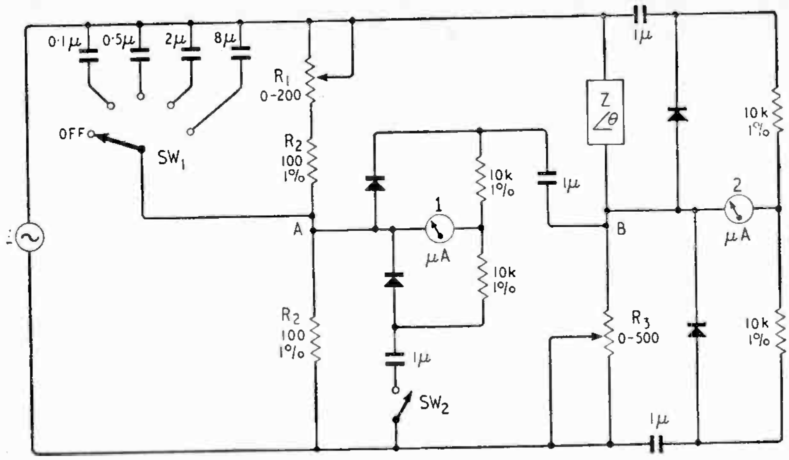
(b) Adjust R_3 until the output null detector reads zero (no current in microammeter No. 2). Read the value of R_3 at balance. This is the modulus of the loudspeaker impedance at the selected frequency of measurement.

(c) Proceed to the phase angle measurement with SW_1 still in the "off" position and, leaving the impedance balance unchanged, adjust R_1 for a null reading on microammeter No. 1. The switch SW_2 should be closed while this measurement is being made. Determine θ from the expression $\cos\theta = R_1/200$.

(d) It remains to check the sign of the phase angle. To do this the switch SW_1, provided with an "off" position, is used to connect a capacitor of suitable value across the resistances R_1 and R_2. In this way the potential divider $(R_1 + R_2)/R_2$ is given a reactive component in one arm so that there is some phase difference ϕ between the voltages developed across the two arms. As before, the vector sum of these two voltages E_1' and E_2' is equal to the supply voltage. The effect of the shunt capacitor is to reduce the impedance of the upper arm of the potential divider and so to increase the current in the pure resistance R_2 which constitutes the lower arm.

A higher voltage is therefore developed across this resistance. The vector diagrams in Fig. 5 show how this circumstance can be exploited to detect the sign of the phase angle of the loudspeaker load. Here (a) corresponds to Fig. 3 after both null balances have been made with a purely resistive potential divider. Assuming that the loudspeaker impedance Z is inductive, (b) shows the corresponding vector diagram after connecting shunt capacitance across one arm of the voltage divider, introducing the phase difference ϕ between the voltage drops across the two arms. Clearly, there is an increase in the voltage originally measured between the points A and B. If Z had been capacitive the points A′ and B would both lie on the same side of the vertical line and the voltage drop would be smaller than that observed before connecting the voltage-divider capacitance.

Opening the switch SW_2 converts the phase-angle null detector into a voltmeter suitable for measuring



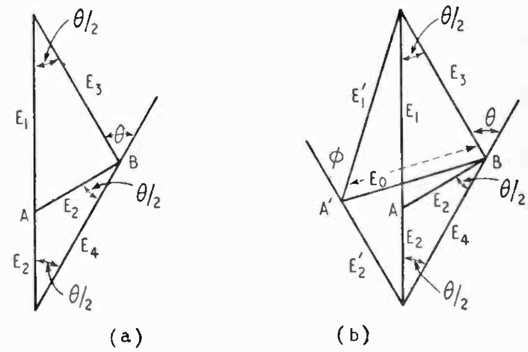
Left: Fig. 4. Final circuit for impedance and phase angle measurement.

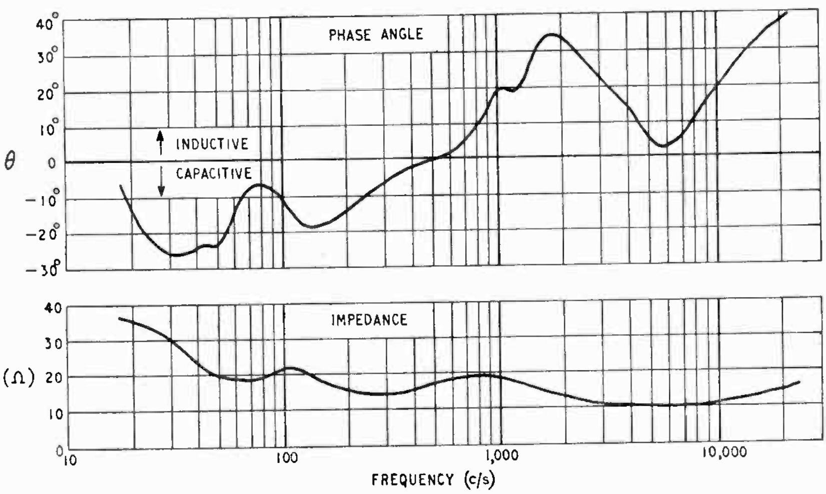
Below: Fig. 5. Vector diagrams for determining sign of phase angle in circuit of Fig. 4.

the potential between A and B or A′ and B by disconnecting one half of the circuit.

To summarise, the phase angle θ is positive and the loudspeaker impedance Z is inductive if the connection of a capacitance across the voltage divider arm, $R_1 + R_2$, leads to an increase in the voltage between A and B. A drop in this voltage indicates that Z is capacitive. All voltage measurements are made with the switch SW_2 open and with the amplifier output set to give about half-scale deflection on microammeter No. 1.

For use over a very wide range of signal frequencies it is convenient to switch in different values of capacitance, ranging from 0.1 μF for the highest frequencies up to 8 μF for low frequencies. If desired, a special switch may be used to add in parallel the successive capacitance steps.

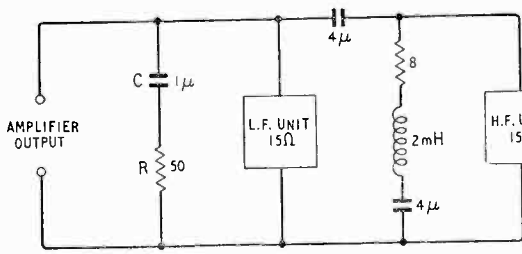




Left: Fig. 6. Impedance and phase angle of loudspeaker system of Fig. 7.

Below: Fig. 7. Circuit of loudspeaker system giving results shown in Fig. 6.

Fig. 6 shows the plot of 40 individual measurements of the impedance and phase angle of the loudspeaker combination shown in Fig. 7. Many more measurements at much closer frequency spacings are required to show up minor irregularities, but the smoothed curve through 40 points is good enough for use in the design of equalizers to correct the most glaring defects of the system. In Fig. 7 the low-frequency unit is a 15-inch Plessey speaker Type CP73025/12/5 and the h.f. unit is a G.E.C. Presence



Unit, Type BCS 1853. The nominal impedance of each speaker is 15 ohms. The function of the passive CR network, 50 ohms in series with 1 μF, is to restrict the rise of impedance of the loudspeaker combination at high frequencies. It serves to maintain stability in an amplifier using a very large amount of negative feedback. The LCR circuit shunting the h.f. speaker is similar to one recommended by the manufacturers to improve the smoothness of response.

The loudspeaker enclosure is a non-vented 6 cu ft rectangular cabinet, rigidly constructed from ¾-inch thick heavy mahogany wood. It is fitted with a screwed back panel and is lined with soft building board lagged with thick sound-absorbent wadding. There is little audible evidence of the single low-frequency resonance commonly observed when a speaker is mounted in a plane baffle, or of the double-humped resonance which one associates with some vented enclosures.

An examination of the impedance curve shows that Z is high at low frequencies. A constant-voltage amplifier with a flat frequency response would give an inadequate bass output unless there was a compensating increase in the electro-acoustic efficiency of the reproducer in this part of the spectrum. There is a less marked rise in high-frequency impedance but here too there would be a significant drop in output at the top end of the range, subject once more to a qualification concerning speaker efficiency. The drop would in fact be worse than appears from the curve since the net rise of impedance has been checked by the use of a passive RC combination. The speaker alone has a much higher impedance.

A study of the impedance variations will suggest the amount of equalization required in the amplifier to give constant acoustic output at various frequencies, but it must be remembered that variations in loudspeaker efficiency over the frequency range will influence the amount of compensation needed.

Using the equipment shown in Fig. 4 in conjunction with a wide-range audio oscillator it is easy to make loudspeaker impedance and phase angle measurements of sufficient accuracy for many practical purposes The most inconvenient feature is undoubtedly the arrangement for detecting the sign of the phase angle θ. The difficulty is to find a method which is equally sensitive and effective over a wide frequency and impedance range.

From a series of measurements the effects of different enclosures on the low-frequency response of the speakers can be investigated. At the high frequency end of the range, one can devise passive networks to control the impedance and phase angle of the composite load in order to maintain stability in amplifiers using a large amount of negative feedback.

It may be objected that during actual measurements the loudspeaker is connected to the driving amplifier through a pure resistance which is always equal to the modulus of the speaker impedance. This corresponds to the use of an amplifier with an abnormally high output impedance. Even so the damping is almost critical and in any case most other methods of impedance measurement suffer from the same disadvantage.

By using more complex instrumentation it is possible to make measurements of $/Z/$ and θ with a very much lower resistance in series with the loudspeaker so that damping of the latter by the amplifier output impedance would be almost unimpaired. It is doubtful if the extra complication is justified though it is worth bearing in mind that, in feedback amplifiers, both gain and feedback depend on the magnitude and phase angle of the load impedance. In turn, the output impedance is affected and so is the damping of the loudspeaker movement. Thus, ideally, the impedance of the loudspeaker should be measured under the actual conditions of use.

References

1. " Impedance and Phase Angle of Loudspeaker Loads", R. E. Cooke, *Technique*, April 1959, p. 11 (issued by Muirhead).

2. " Measurement of Impedance at Audio Frequency", N. P. Scholes and J. E. Macfarlane, *Electronic Technology*, March 1961, p. 106.

COMPUTER EXHIBITION

THE U.K.'s Electronic Computer Exhibition opens at Olympia, London, on October 3rd. Some fifty manufacturers and users of computers (see list) have taken space at the Exhibition which will remain open until October 12th (Sunday excepted). It is organized jointly by the Electronic Engineering Association and the Office Appliance and Business Equipment Trade Association which also organizes the British Efficiency Exhibition running concurrently at Olympia. On three consecutive days during the Show (4th-6th) an Electronic Data Processing Symposium will be held at which during six sessions speakers from both manufacturers of data processing equipment and users will deal with the applications of computer techniques.

Admission to the Exhibition costs 2s 6d. Applications for tickets for the Symposium, which cost 2½ guineas per session, should be sent to Mrs. S. S. Elliott, 64 Cannon Street, London, E.C.4.

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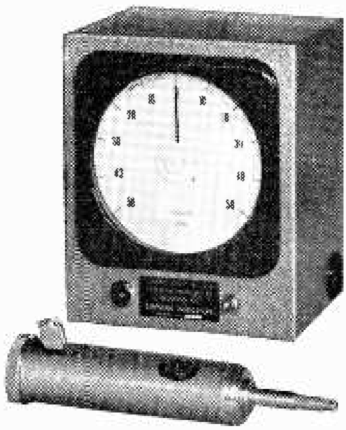
MANUFACTURERS' PRODUCTS

NEW ELECTRONIC EQUIPMENT AND ACCESSORIES

Displacement Transducer

THE Lintran is a device for the indication of physical phenomena capable of producing a physical displacement, e.g., temperature, pressure, etc. The transducer consists of an axial spindle which operates the moving core of a differential transformer, which is arranged to give high sensitivity and linearity at an energizing frequency of 50c/s. The transformer output is fed to a detector, which delivers a unidirectional voltage proportional to the original spindle displacement. This voltage is indicated on a large moving-coil meter, which can be either centre-zero or single-ended. The full-scale displacement ranges, depending on the transducer, are from 0.01in to 1in. Output of the transducer is



James Scott displacement transducer.

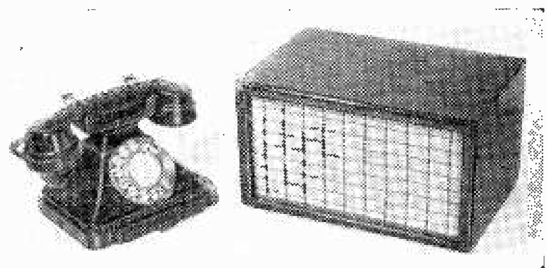
±150mV and the linearity is better than ±1%. Further details may be obtained from James Scott (Electronic Engineering), Ltd., Carntyne Industrial Estate, Glasgow, E.2.

Microwave Tuning Unit

TO extend the range of the Polarad Microwave Receiver Model R, Brüel and Kjaer are to market a plug-in tuning unit and a set of mixers. The tuning unit, known as the RE-T, covers 45.3Gc/s to 84.2Gc/s, and its sensitivity is between 0.5μV and 3μV. With the tuning unit and the appropriate mixer in position, the receiver covers the range 400Mc/s to 84.2Gc/s. Details are available from B. & K. Laboratories, Ltd., 4 Tilney Street, Park Lane, London, W.1.

New Flexing Loudspeaker Cabinet

IN the new T.S.L. "High-Q Flexette" bass reflex loudspeaker enclosure the front and back panels are designed and adjusted to resonate (with a low Q) at the cabinet and loudspeaker bass resonant frequency (90c/s). This, it is claimed, so damps the loudspeaker resonance as to extend the response down to 40c/s although the cabinet dimensions are only 11½in by 6½in by 7½in. The treble response remains constant within ± 3dB up to 15kc/s with a 6dB/octave roll off thereafter. The electro-acoustic efficiency remains constant for input powers ranging from 10mW up to 8W—the maximum peak power which can be handled. A 4½-in round, 4-

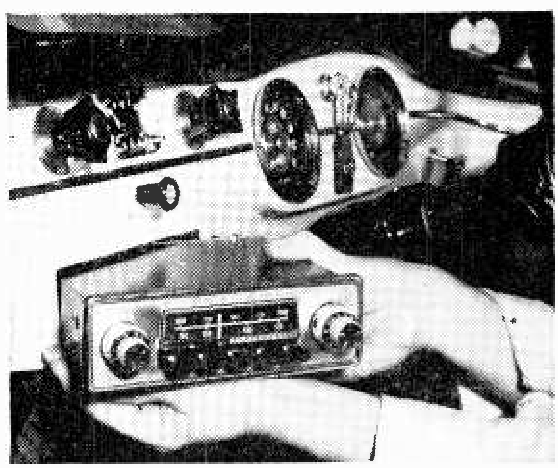


T.S.L. "High-Q Flexette" loudspeaker cabinet.

Ω loudspeaker is used. The "High-Q Flexette" costs £5 19s 3d and is available from Technical Suppliers Ltd., of 63 Goldhawk Rd., London, W.12.

Fully Transistorized Car Radios

THE new 600T series of car radio receivers made by Smith and Sons (Radiomobile) consists of three models, all of which have the same external appearance, dimensions (2in high by 7in wide by 7in deep or, including control knobs, 8½in deep) and weight (5½ lb). Other common features of these models are that they are fully transistorized, cover five pre-set push-button selected stations as well as, continuously, medium and long waves, incorporate a continuously variable treble cut tone control and operate from 12-V batteries. In addition the 600T incorporates six transistors, has a 3-W single-ended output and operates from positive earth supplies, the 601T is similar but can operate from positive or negative earth supplies, and the 620T incorporates nine transistors, has an 8-W push-pull output (3% distortion) and can operate from positive or negative earth supplies. The 600T costs £29 4s 3d, the 601T £29 9s 5d and the 620T £32 16s 0d. Accessory fitting kits range in price, according to the car model, from under £1 10s to £4, aerials range from £1 17s 6d to £2 12s 6d and loudspeakers cost £1 15s 11d each. The receivers are manufactured by S. Smith and Sons



Smith and Sons (Radiomobile) fully transistorized car radio.

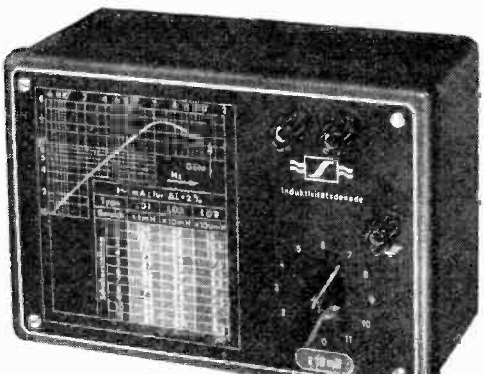
(Radiomobile) Ltd., of Goodwood Works, North Circular Road, London, N.W.2.

Stabilized Voltage Source

THE "Convolt" provides a direct output voltage (variable within ±10%) which is stabilized to within ±0.001% per 10% change in input voltage or °C temperature change. Model A is suitable for an input of 110V a.c., model B for 230V a.c. and model C for 28V d.c. The normal output potential is 1.05V at 10 mA and this current must be maintained within ±0.25 mA to achieve the stated temperature coefficient: other output voltages and currents may be supplied. The stabilized output is drawn from a Zener diode at such a current that its temperature coefficient is nearly zero, the residual temperature coefficient of this and other components being cancelled by a second Zener diode and a thermistor. The dimensions of these units are only $3\frac{3}{4}$in by $2\frac{3}{4}$in by $2\frac{3}{8}$in (excluding terminals) and models A and B cost £17 19s 6d and model C £16 8s 6d. These units are manufactured by Communications (Air), Ltd., of Half Moon Street, Bagshot, Surrey.

"Convolt" stabilized voltage source.

Below: Grundig Inductance Decade Type LD2 covering the range 10mH-110mH.

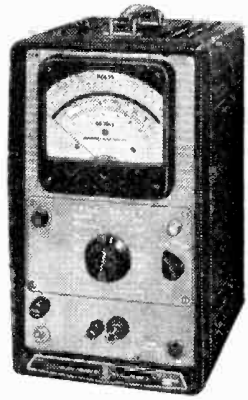


Inductive Decades

DECADE substitution boxes for use in inductive filters, equalizers, etc., are marketed by Wolsey Electronics, Cray Avenue, St. Mary Cray, Orpington, Kent. The range 1μH to 1.1H is covered by three separate instruments, and the boxes may be used at frequencies between 50c/s and 10kc/s. Accuracy is ±2%, and the price is £23 10s for one decade. The equipment is made by Grundig.

Sensitive Valve Voltmeter

WITH a bandwidth of 10c/s to 11Mc/s (±1dB) the Ballantine Model 317 Voltmeter will measure from 300μV to 300V, in a 1-3-10 range progression. The instrument may be used as an amplifier with a gain of 1000 from 6c/s to 11Mc/s. Input impedance is 10MΩ + 5pF with the cathode-follower probe in use and 2MΩ plus a maximum of 24pF without the probe.



The 11 Mc/s, 300μV valve voltmeter made by the American firm of Ballantine Laboratories.

The metering circuit responds to mean values and is calibrated to read volts r.m.s. Details are available from the Export Manager, Sylvan Ginsbury Ltd., 8, West 40th Street, New York 18, N.Y.

High-Stability High-Q Coils

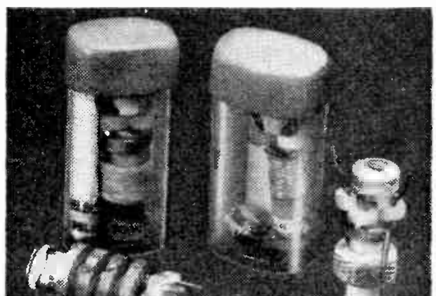
ELECTRONIQUES (Felixstowe) Ltd. offer a wide range of high-quality, high-stability tuning coils, named "Stabqoils." There are three basic types for use with two different maximum tuning capacities (500pF and 320pF) and for two different i.fs (470kc/s and 1.6Mc/s), the coils for the higher i.f. being available for the low-capacity circuit only. Coverage of 150kc/s to 32Mc/s is achieved with five coils with, of course, a break between 400 and 530kc/s and, for a 1.6Mc/s i.f., between 1.5 and 1.7Mc/s. Also available for 470kc/s i.f. are coils giving a general coverage s.w. band of about 6 to 18Mc/s.

The coils are wound on small moulded formers using the new hexagonal-hole adjustable cores: mounted on the end of the former is a trimmer chosen to compensate for the normal temperature coefficient of the winding. Q-values range between 120 and 210 and are high (approx. 150 to 170) in the s.w. types. A single $\frac{1}{4}$-in hole is required for mounting.

Also available are series and parallel i.f. rejector-coils, b.f.o. coils, three types of r.f. choke and bandspread coils for amateur use. The retail price is 6s each (b.f.o. coils in can 7s 6d).

"Quoilpax" use Stabqoils and Trolex-insulated switches and carry the valveholders for r.f. and f.c. stages as well as the correct tuning capacitor. Models for 470kc/s and 1.6Mc/s i.fs, broadcast and amateur bands are available.

Electroniques (Felixstowe) Ltd., Bridge Road, Felixstowe, Suffolk.



Shown here are four coils from Electroniques "Stabqoils" range, including an r.f. choke. Note correct padding capacitor packed with oscillator coil in right-hand container.

HYBRID AMPLIFIERS

COMBINING VALVES AND TRANSISTORS

By G. W. SHORT

SURPRISINGLY little work has been done on combined valve and transistor circuits. The emphasis has, perhaps naturally, been on circuits in which transistors rival valves, yet each device has its own virtues, and it seems logical to use both in the same piece of apparatus. At present, much transistor equipment is battery-operated. But the day of mains-operated transistor radio receivers and audio amplifiers must surely dawn soon, when the prices of transistors fall to about the same level as those of valves. When this happens, the main bar to using both devices in the same apparatus will be removed, and the only disadvantage will be the cost of providing two different supply voltages.

Fortunately, the h.t. supply can be used as the collector-voltage supply, even for p-n-p transistors. An l.t. supply is still needed—at the moment. For those for whom even this is too much, there's still the thought that there are some people at Birmingham University and elsewhere who are working on solid-state devices which will be *exact* equivalents of thermionic valves, but which won't need heaters. So it's not unreasonable to think about hybrid circuits, even if they won't be used for a while.

Infinite Variety

Since there are three useful ways of connecting a triode valve, and three ways of connecting a transistor, there are nine ways of cascading the two devices. And since one can put either the valve or the transistor in the first stage, the number is doubled. There are thus eighteen basic combinations, but don't worry, this article only covers two of them which happen to be of immediate interest (Fig. 1).

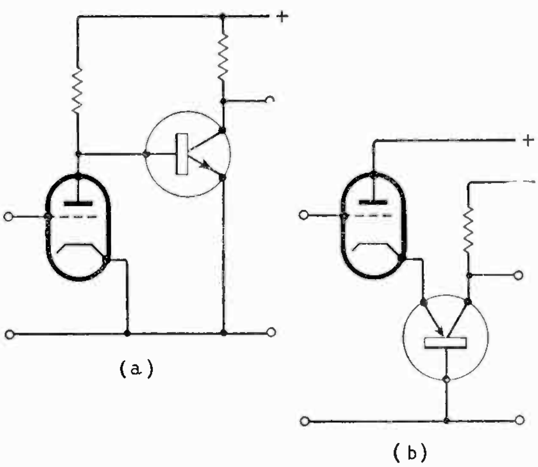


Fig. 1. Two of the eighteen basic hybrid circuits: (a) common cathode—common emitter, (b) common anode—common base.

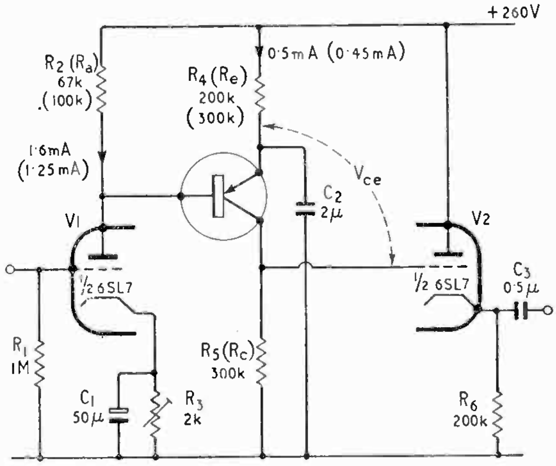


Fig. 2. Practical amplifier based on Fig. 1(a). Note that, despite the change to a p-n-p transistor, the h.t. supply can still be used to operate the transistor.

Each of these eighteen circuits is capable of individual variations, and one can use n-p-n or p-n-p transistors, so the total number of possible circuits is very large, and forms a rich field for exploration. At present, some combinations, such as common collector transistor followed by common anode valve, don't look particularly useful. But the chances are that somebody will discover a use for them all, in the long run.

Valve Input, Transistor Output

The high input impedance of a valve is often useful. Transistors in the common-emitter circuit, which can be regarded as the normal one, have a low input resistance—about 1 kΩ for the usual low-power transistors. Even the common-collector circuit, which has the highest input impedance of the three basic transistor circuits, has a lowish input resistance (a few hundred kilohms) by valve standards.

So in a voltage amplifier, driven from a high-impedance source, it is logical to put the valve first and the transistor in the second stage.

A possible combination is c.k.+c.e., i.e. common-cathode valve followed by common-emitter transistor. This is shown in Fig. 1(a), and it has been translated into practical terms in Fig. 2, which also shows a second valve (actually the other section of a double triode) connected as an output cathode-follower.

The cathode-follower provides no voltage gain, and the first valve provides only a small voltage gain, since it is working into a c.e. transistor, which

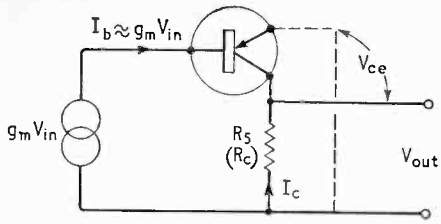


Fig. 3. Simplified circuit for calculating gain of Fig. 2 circuit.

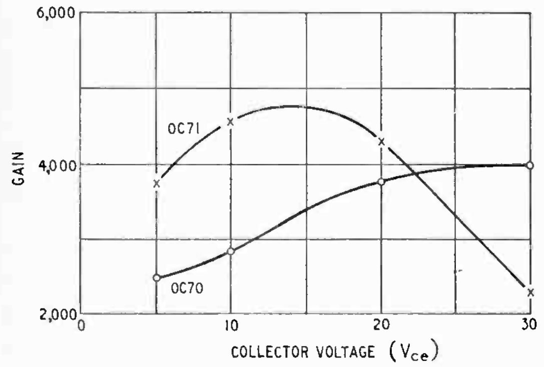


Fig. 4. Effect on gain of varying transistor collector-emitter voltage.

has an input impedance of the order of 1 kΩ. It may seem surprising that this circuit can provide gains in excess of 1000, but this is the case.

The voltage gain, or most of it, comes from the transistor. For practical purposes, the valve can be regarded as a current generator producing a current g_mV_{in}, and the cathode-follower "gain" can be taken as unity. So for the purpose of calculating the gain the circuit reduces to that shown in Fig. 3. The transistor input current is g_mV_{in}, and the collector current is β(or α') times this. The output voltage is I_cR_5, which is $\beta\ I_bR_5$, which is $g_mV_{in}\beta R_5$. Thus the voltage gain is $g_m\beta R_5$. If we insert practical values, such as $g_m = 1.4$mA/V, $\beta = 30$, and $R_5 = 300$ kΩ, we get a figure for the gain of 12,600, which turns out to be much larger than the measured gain! Evidently something is wrong.

The error lies in putting in the value of 30 for β. It is quite possible to get transistors with this sort of current gain, but the figure quoted by the transistor maker is the current gain with no collector load. The usual type of transistor audio amplifier stage operates with a very small load—the input impedance of the following transistor—and the current gain is virtually the same as the quoted figure. But the effect of a high load impedance is to reduce the current gain drastically.

To get a proper value for the gain we must use this reduced value for β. Let's call it βw, which means the working value of β.

Then $A \approx g_m\beta_wR_5$

The value of β_w is given by

$$\beta w = \frac{\beta r_c}{R_5(1+\beta) + r_c}$$

where r_c is the transistor collector resistance in the T equivalent circuit. This is a bit cumbersome, but in the present case we can make an approximation. For a small alloy transistor, r_c is likely to be about 1 MΩ. We have $R_5(1+\beta) = 300\ \text{k}\Omega \times 31 \approx 9\text{M}\Omega$, so it is reasonable to neglect r_c in the denominator and put

$$\beta w \approx \frac{\beta r_c}{R_5(1+\beta)} \approx \frac{r_c}{R_5}$$

Then $A \approx g_mr_c$

This gives an over-estimate since in fact it is the "amplification factor" of the valve-transistor combination. But is is quite a good approximation in practice, in high-voltage circuits where the collector load runs into hundreds of kilohms.

Some practical results are given in Fig. 4, which shows how the gain varied with the voltage across the transistor (V_{ce}) for two transistors. Note that these were two individual samples. It would be dangerous to suppose that they represent typical OC70s and OC71s. They were both several years old, and had been in service in a normal transistor amplifier for many hours.

The gains shown in Fig. 4 are in excess of those predicted by the formula $A = g_mr_c$. However, one should remember that transistor characteristics are subject to large tolerances. If the tolerances on β can be taken as a guide to those on r_c, one would expect a range of 2 or 3 to 1.

Transistor Ratings

The collector voltages shown in Fig. 4 go well over the upper limit imposed by the manufacturer. In the case of the OC70, the gain increased with V_{ce}, but the gain of the OC71 fell off above 10 V. This

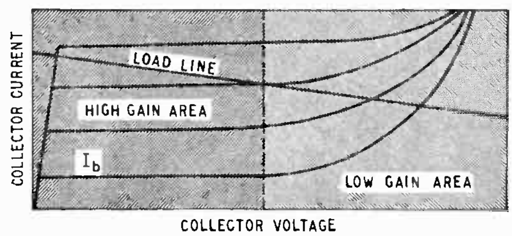


Fig. 5. Transistor collector voltage-collector current curves, showing the effect of excessive collector voltage.

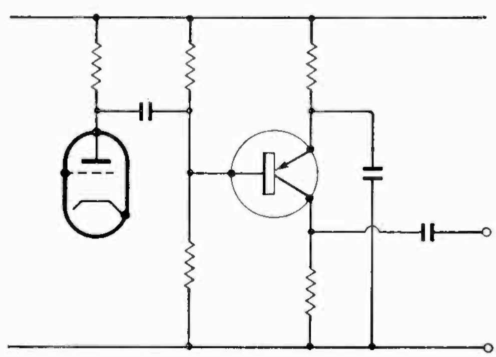


Fig. 6. A.C. coupling of valve to transistor permits wider choice of operating conditions but destroys the simplicity of the direct-coupled circuit.

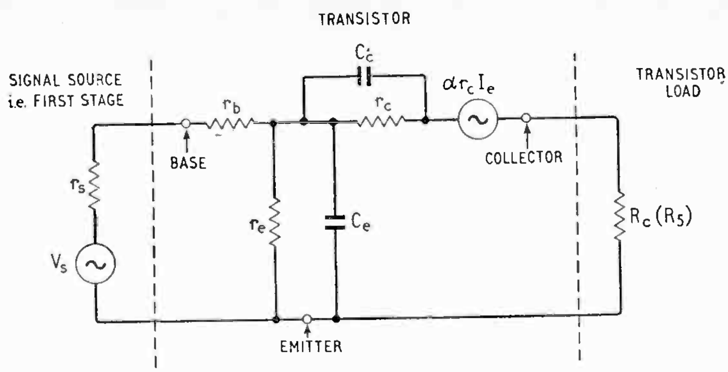


Fig. 7. Transistor T equivalent circuit showing internal capacitances.

falling off of gain is the result of collector "softening". This is another effect which is not apparent in low-supply-voltage circuits. At high collector voltages, the collector voltage-collector current curves are distorted as shown in Fig. 5. The result is a reduction in voltage gain when the working point lies in the "softening" region.

In circuits like the one we are discussing, it may be very difficult to avoid exceeding the maximum V_{ce} rating for a low-voltage transistor. High-voltage transistors, with V_{ce}(max) ratings of up to about 100V, are in existence, and are clearly the most suitable for hybrid circuits where the valve h.t. supply runs to hundreds of volts. However, it is worth noting that the maximum collector dissipation rating need never be exceeded. Provided always that the cathode-follower (V_2 in Fig. 2) does not take grid current, there must be at least 300kΩ in series with the collector. In these circumstances the power dissipated in the transistor is a maximum when the transistor itself behaves like a resistance of 300kΩ. The transistor voltage is then half the h.t. voltage and the dissipation is $E^2/R = (\frac{1}{2}E_{h.t.})^2/$300kΩ. Supposing that the h.t. voltage goes up to 300 V during a switch-on surge, then the dissipation is $\frac{150 \times 150}{3 \times 10^5}$W $= \frac{22,500}{3 \times 10^5}$W = 75 mW. A 75 mW transistor should never get overheated.

In any case, this dissipation will only occur for short periods if the circuit is set up to give operating conditions within the permitted limits.

The circuit is simple to design. For our purposes the emitter current $I_e = I_a R_a / R_e$, because I_b is small compared with I_a, and I_e is to a first approximation independent of the current gain of the transistor in a circuit like ours where $R_e > R_a$. (This latter condition also makes for good temperature stability.) To set up such a circuit by means of the variable cathode resistor R_3, it is safest to connect, in place of the transistor, a resistance equal to V_{ce}/I_e, where V_{ce} and I_e are the desired values—say 15V, 0.5 mA, which gives 30 kΩ. Then connect a high-resistance voltmeter across the inserted resistor and adjust R_3 to get the required voltage reading. (If the voltmeter resistance is not negligible, the value of the temporarily connected resistor must be chosen to make the combined resistance V_{ce}/I_e.) Then switch off the h.t. supply and connect the transistor. On switching on, one should find that V_{ce} is close to the required value.

Of course, one can avoid all this setting-up nonsense by using a circuit such as Fig. 6, where the transistor operating conditions don't depend on V_1, but only at the expense of a departure from the simplicity of the original circuit.

Frequency Response

Here again, one is liable to get a surprise. I did. The frequency response was 3 dB down at 1.7 kc/s using the OC70 and at 1.1 kc/s using the OC71, V_{ce} being 10V in each case. Using different values of V_{ce} produced very little improvement.

The poor h.f. response is the result of the internal capacitances of the transistor. These are shown in Fig. 7. Here c_c is the collector-to-base capacitance, r_b is the internal base resistance and r_e is the internal emitter resistance. The capacitance c_c is roughly analogous to the output capacitance of a valve, but because it does not come directly across the output, but is connected back to the input, it gives rise to negative feedback which reduces gain at the higher frequencies. The effect of the emitter-base capacitance c_e in parallel with r_e is to shunt the higher frequencies.

If r_b and r_s were zero, c_c would behave like a simple output capacitance and would have no effect as a feedback path. Since r_b is inside the transistor, nothing can be done about it, but r_s, the signal-source resistance, is under control. While there is not much practical value in reducing r_s (which leads to a reduction of gain and an increase in distortion) it is instructive to do so in order to confirm the importance of the capacitances in determining the performance of the circuit.

The signal-source resistance, i.e. the output resistance of the valve stage, was reduced by connecting various resistors across the anode load R_2, in series with a large capacitance. The results of this experiment are shown in Fig. 8. They were obtained using R_2 = 100kΩ and R_4 = 300kΩ. The transistor was a "no name" type with $\beta = 26$ at I_c = 1 mA. The cut-off frequency was increased by a factor of 4 when r_s was really small. This proves that the

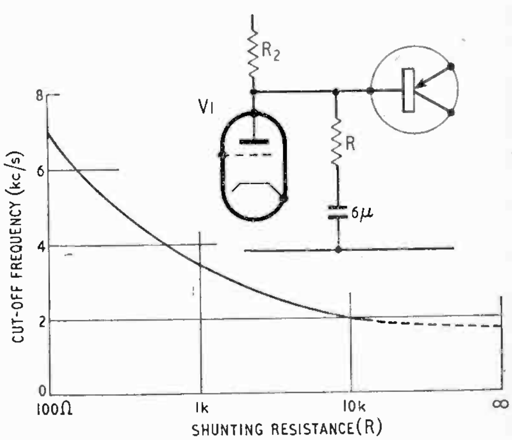


Fig. 8. Effect of base shunting resistance on cut-off frequency, using a low-frequency transistor.

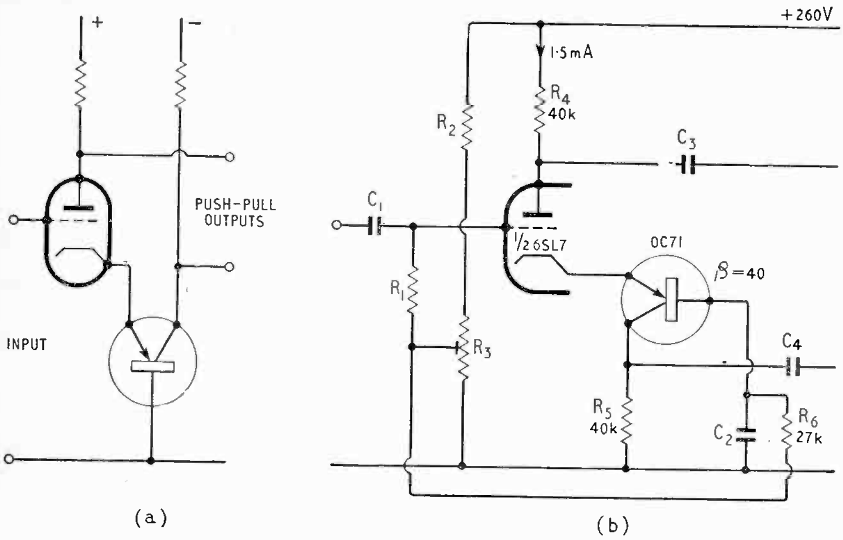


Fig. 9. Hybrid "concertina" phase-splitter (a) Basic circuit, using a modification of Fig. 1(b). (b) Practical circuit using only one h.t. supply.

transistor capacitances are very important, even at audio frequencies. To get a good frequency response, a transistor with lower capacitances must be used; i.e. an r.f. transistor. Unfortunately, the writer's one and only r.f. transistor was in use elsewhere, and in view of the unfortunate demise of his second-best transistor as the result of an accidental short-circuiting of R_5 he didn't feel like risking another accident. That miniature receiver is used every morning, to listen to the news, in bed, and putting it out of action merely for the sake of a few figures on a piece of paper, other than a bank book, would, he felt, be received unsympathetically by another member of the household.

An OC73, which has a cut-off frequency ($f\alpha$) of 500 kc/s, was substituted, with no reduction of the natural r_s of the valve circuit (say 50 kΩ) and the upper cut-off frequency jumped from 1-2 kc/s to 5 kc/s, which was encouraging. Another transistor, of unknown type, gave a cut-off of 17 kc/s. This, it is felt, is enough to prove that the right transistor will give an adequate frequency response for audio purposes.

It is hoped that it has now been shown that at least one hybrid circuit is useful, and designable by rule-of-thumb methods. Before leaving this one, a few points about it are worth noting. 1. Since β_w is much less than β, and approximates to the ratio of two resistances, the effect of variations of β in different transistors is largely obliterated. 2. For high gain, one wants a high r_c. Some grown-junction transistors have r_c's as high as 10 MΩ. The actual amplification factor (μ_{21}) of the transistor* is r_c/r_e, but r_c is the important thing in the hybrid circuit, because if r_e goes up, reducing the amplification factor, the transistor input resistance increases. This causes the valve to deliver a higher voltage to the transistor, so the decrease in amplification factor tends to be compensated. The two devices make good partners. They do so in other ways as well. The low anode load results in a low Miller input capacitance. And the high output impedance of the valve reduces the distortion produced by the non-linear input impedance of the transistor.

Hybrid Phase-splitter

This is a variation on Fig. 1(b), and is shown in Fig. 9. It is a phase-splitter which is in some ways similar to the "concertina" triode phase splitter, but it gives a substantial gain to either output.

The input impedance of the transistor, which is in the common-base connection, is low—of the order of 50 Ω. This impedance in the cathode circuit does not cause much negative feedback, and the triode gain is only a little lower than in a normal single-ended stage operating with the same load and voltages.

The cathode current is the same as the emitter current and the collector current is αI_e, which with almost any transistor, is nearly equal to the emitter current. So, to a good approximation, we can write $I_c \approx I_a$. The triode output voltage is $I_a R_4$, and the transistor output is $I_c R_5 \approx I_a R_5$, so by making $R_4 = R_5$ the two outputs are made equal. There is a phase reversal in the triode, but not in the common-base transistor, so the two outputs are in anti-phase. Most transistors have $\alpha > 0.95$, so the unbalance due to the error in the assumption that $I_c = I_a$ is only a few per cent.

The performance of this circuit, using an OC71 with $\beta = 40$ at $I_c = 1$ mA, was as follows: frequency response, -3dB at 25 kc/s (with 200 pF load

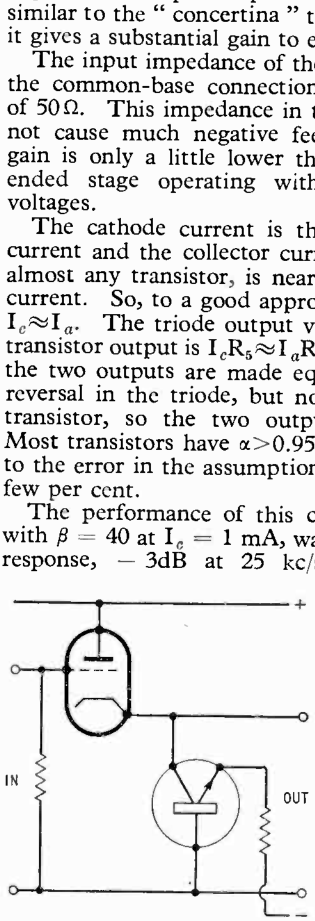


Fig. 10. Hybrid "cathode-follower" using transistor as the load impedance for the valve.

*Not to be confused with the constant μ, or more properly μ_{12}, which appears in transistor equivalent circuits, and has a value of about 1/1000!

capacitance); gain 25 to either output; peak output voltage 6 V with V_{ce} = 10 V, 10 V with V_{ce} = 15 V.

There are various ways of arranging the supply voltages. Using the one shown, we have:

$$V_a \approx V_{ht} - I_a(R_4 + R_5) - V_{ce}$$
$$I_c \approx I_a$$
$$I_c \approx \beta I_b \approx \beta V_g/R_6$$

Note that, in this circuit also, the valve and transistor are good partners. To avoid the distortion which can arise from the transistor's non-linear input impedance, one wants to drive it from a relatively high source impedance. The source impedance is actually $(R_4 + r_a)/(1 + \mu)$ which is considerably greater than the impedance looking into the emitter from most combinations of valves and transistors.

Alternative Phase-splitter

It is also possible to modify the Fig. 2 type of circuit to provide a phase-splitter. This was done by removing the 2μF emitter decoupling capacitor and taking outputs from emitter and collector. A gain of 37, 3dB down at 25 kc/s, was obtained, using $R_2 = 100$ kΩ, $R_4 = R_5 = 300$ kΩ. The main disadvantage of this circuit is that the output voltage cannot be more than half the voltage provided by the first circuit, since it is shared between the two outputs. To provide enough voltage to drive a pair of output valves, a high-voltage transistor may be needed.

This article has tried to show that genuine hybrid circuits, in which valves and transistors are combined to form working units with useful properties, are worth investigating. The two circuits discussed here represent a mere scratching of the surface of the subject. They were chosen because their possible use in audio work seemed more likely to be of immediate interest than hybrid r.f. circuits. This may be quite wrong.

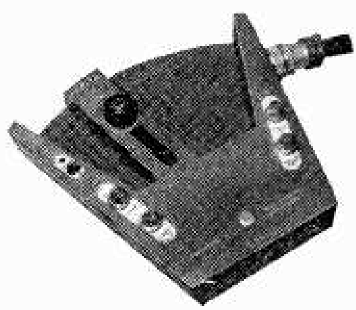
In addition to the many practical variations of these hybrid circuits, there exists another, quite distinct, group of hybrids. Here we have considered circuits in which the elements are connected in cascade. The other group consists of circuits in which one element acts merely as a load for the other. For example, one might use the collector impedance of a common-base transistor as the load impedance of a cathode-follower, as shown in Fig. 10 In this way, the valve could be given an electronic load of, say, 1 MΩ, yet the voltage drop across this load need be no more than a couple of volts. This is something which cannot be done by conventional means; consequently, there may be no immediate use for it. But a cathode-follower with a " gain " of 0.99 is likely to prove to be of use to somebody, and so is a " constant current " valve with an impedance of 20 MΩ, capable of working from a 250 V h.t. supply, and of passing 50 mA. Both appear to be quite possible with the circuit of Fig. 10.

MICROPULSATIONS OF THE EARTH'S MAGNETIC FIELD

USE OF GIANT LOOP AERIAL DETECTORS

By MICHAEL LORANT

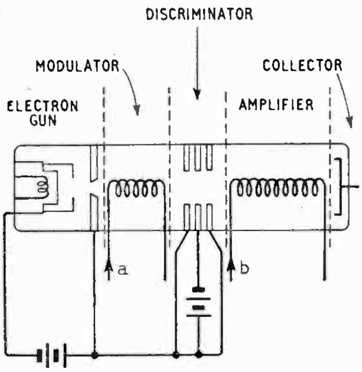
OSCILLATIONS of the earth's magnetic field may be divided according to their periods into three general groups:—the giant pulsations, which are often observed on standard magnetometer records, and which generally have periods of about one to three minutes and amplitudes reaching ten or so gamma (1 gamma = 10^{-5} œrsteds); micropulsations with oscillation periods ranging from 5 to 30 seconds and with amplitudes reaching several gamma; and oscillation periods in the range 0.5 to 3 seconds, which appear more rarely than the other two groups, with amplitudes occasionally reaching one gamma. The outstanding features of the three groups are their nearly sinusoidal form and the fact that their periods and average amplitudes both alter roughly by powers of ten. The second group of oscillations, which have periods from 5 to 30 seconds, is now under intensive study by the U.S. National Bureau of Standards. These micropulsations have been known to the scientific world since as long ago as 1861, but little is understood about their origin or why the oscillations occur as they do. It is, however, known that the signals are much stronger in the auroral zones and that they are probably associated with the influx of electrons into the ionosphere after the occurrence of solar storms. To detect such micropulsations, the Bureau are building a number of special loop aerials. Each of these is 6½ft in diameter and consists of 32,000 turns (130 miles) of nylon-coated copper wire. These aerials will in fact be used to study oscillations with periods throughout the range 200 seconds to 0.1 second. They will also be of value in the study of two other types of oscillation: extra-low-frequency sferics, which originate from lightning discharges, and giant pulsations with periods of from one to three minutes, which are caused by resonance of the outer atmosphere when bombarded by charged particles from the sun.



This is the control unit Type 862/1 for the E.M.I. remote-control television camera. " Panning " (angular movement of the camera in a horizontal plane) is achieved by swinging the lever on which the large knob is mounted from side to side, whilst " zoom " of the lens is controlled by rotating the knob, and tilt by moving the knob toward or away from the operator. Subsidiary controls at either side of the unit cover adjustments for focus, camera-lens iris diaphragm and coarse adjustment of tilt and pan.

TECHNICAL NOTEBOOK

Microwave Computer Element described by P. R. McIsaac and I. Itzkan in an article in the July 1960 issue of *Proc.I.R.E.* (p. 1264) offers the possibility of decreasing computer switching times and operating speeds by a factor of the order of one hundred. The device is shown schematically in the diagram (based on Fig. 1 of this article.) When a high-level r.f. signal (*a*, say) is fed to the helical modulator, information is impressed on the electron beam in the form of a decrease in its longitudinal velocity. This decrease is detected



using a velocity-sorter discriminator which passes only those electrons having a longitudinal velocity greater than a certain value (which is set just below the d.c. beam velocity). This discriminator consists of three plates; the outer plates are at the final beam accelerating voltage and the centre plate at or near the cathode voltage. In an experimental discriminator of this type the fraction of the beam transmitted decreased from 90 to 10% for a beam velocity decrease of only 17%. The beam—if transmitted by the discriminator—then passes through a conventional t.w.t. helix amplifier fed with a different r.f. signal (*b*, say) from that which is fed to the modulator (*a*). The t.w.t. amplifier then only gives an output if there is both a signal *b* at its input and no signal *a* at the modulator input. This device thus performs the logical operation (NOT *a*) AND *b* and it can be shown that such devices can be used to build a complete computer. In an experimental 9kMc/s device, operation with 1mμsec long pulses was achieved: no output was obtained with synchronous pulses, but if one pulse was delayed as little as 0.5mμsec, full output was obtained. A possible disadvantage of this device for computer use—the time taken ($\approx$7mμsec) for signals to pass through it—would, however, only be serious with computers in which the operations must be carried out sequentially. This device—which the authors' call a longitudinal-velocity sorter tube (abbreviated LVST)—has several other potential applications besides its use as a logic element. Similar to this use would be its application as an anti-coincidence detector. It could also be used as a frequency converter by operating the two helices at different frequencies. Finally, if a continuous r.f. signal were fed to the helix amplifier and a portion of the output fed back through a delay line to the helix modulator, this device would give an r.f output pulsed with a period twice that of the delay time.

Stereo Headphones are not suitable for normal stereo recordings since these are intended to be reproduced from two loudspeakers when, unlike the case with headphones, each ear hears both stereo channels. Two circuits which provide electrical cross-coupling between the two earphones similar to that normally occurring at each ear between signals from the two loudspeakers are given in an article by B. B. Bauer on p. 148 of the April 1961 issue of the *Journal of the Audio Engineering Society.* This cross coupling between the two signals at each ear depends both on their time difference (caused by the difference in path lengths from the two speakers to the ear) and on their amplitude difference (caused by diffraction of one of them round the head). The above-mentioned circuits approximately allow for these two effects in the case of an 8-in diameter head at equal distances from the two speakers such that the two lines of sight to them are at right angles. One circuit is for earphones with impedances of 5Ω or less and the other for earphones with impedances of 2000Ω or more.

"Charactron"—a character-forming c.r.t. developed in the U.S.A. by the Stromberg-Carlson division of General Dynamics Corporation—can display up to 20,000 characters per second by deflecting an electron beam through the gaps in a tiny metal stencil within the tube itself. The stencil openings are etched by means of a photo-engraving process in which each character is reduced to a height of 0.035 in. The electron beam is first deflected through one of the stencil openings and then converged towards and re-deflected along the optical axis of the c.r.t. before entering the deflecting-coil system. A post-deflection accelerator is also used. This is made up of resistive material deposited in the shape of a helix on the inner surface of the final portion of the tube.

Microwave Moisture-content determination in building structures, without the necessity for destructive testing, has been developed at the Building Research Station at Garston. It has been found that a linear relationship exists between the water content of building materials and the attenuation, expressed in decibels, suffered by a microwave signal in the structure. The equipment, engineered by A.E.I. Electronic Apparatus Division to B.R.S. specifications, comprises a transmitter and receiver, both of which are hand-held and employ semi-conductors throughout, with the exception of the microwave oscillator. The transmitter output is 3Gc/s, square-wave modulated at 3kc/s and provides 0.5W to a horn, and the receiver consists of a crystal detector, selective amplifier and meter, with a micrometer attenuator at the input.

In use, the two units are set up facing each other and separated by a distance equal to the thickness of the structure to be examined. The receiver attenuator is adjusted for a centre-scale reading on the meter, and the attenuator setting noted. The process is repeated with the structure between the units and the new attenuator setting required for centre-scale reading obtained. The difference in attenuator settings provides a basis for moisture-content determination.

A.F.C. Defeat system—the Micro-Tune—used in new American Fisher tuners and described in an article by R. F. Scott in the July 1961 issue of *Radio-Electronics* (p. 44) uses the stray mains voltage picked up from the hand when this touches the tuning knob. This voltage is amplified and rectified, and the rectified output applied so as to cut on a valve in series with the coil of a relay. This pulls in the relay which earths the a.f.c. line. Thus, whenever a hand touches the tuning knob, the a.f.c. is automatically defeated.

Computer Output Display using a cathode-ray tube has been developed at Manchester University and described in the *Journal of Brit.I.R.E.* It is used for displaying the digital output of the computer in the form of a curve, so obviating the labour required to plot the curve manually from computed co-ordinates.

The working area of the c.r.t. is divided into a 256 × 256 matrix of points, each corresponding to two co-ordinates at the computer output. As each co-ordinate can have 256 possible values, it requires eight bits of information to define it. The Mercury computer output is in the form of ten-bit words at a 1Mc/s clock rate, and a co-ordinate is therefore specified in 8μsec, with 2μsec left for digital-to-analogue conversion. The two co-ordinates are defined in successive 10μsec periods, with a storage operation between the two. The binary code of the computer output is converted to analogue form by a series of summing resistors switched in and out of circuit by diode gates which are fed by the computer outputs; low converter output impedance is obtained by the use of anode followers. Storage of the converter output is effected by a Miller charging circuit, which is gated on and off by a diode network in series with the charging resistor. The stored, amplified analogue voltages are applied to the X and Y plates of the c.r.t. and are displayed by brightening the trace for a period of 20μsec.

OCTOBER MEETINGS

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

LONDON

4th. Brit.I.R.E.—"Methods used for the study of vibration in aero engines" by D. A. Drew at 6.0 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

5th. I.E.E.—Presidential inaugural address by G. S. C. Lucas at 5.30 at Savoy Place, W.C.2.

6th. I.E.E.—"What is pH and its measurements?" by Dr. G. Mattock and G. R. Taylor at 6.0 at Savoy Place, W.C.2.

10th. Society of Relay Engineers.—"Television distribution by coaxial cable" by G. J. Hunt (General Piped Television) and C. F. Whitbread (Belling & Lee) at 2.15 at 21 Bloomsbury Street, W.C.1.

11th. Society of Instrument Technology.—"Process control in paper mills" by H. B. Whitehouse and M. I. MacLaurin at 7.0 at Manson House, 26 Portland Place, W.1.

12th. Television Society.—"Transistorized line timebases for 405- and 625-line systems" by K. E. Martin (Mullard Research Laboratories) at 7.0 at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, W.C.2.

12th. Radar & Electronics Association.—"Space communications" Part 1 by L. F. Mathews (Associated TeleVision) at 7.0 at the Royal Society of Arts, John Adam Street, W.C.2.

17th. I.E.E.—Discussion on "The place of digital computers in the teaching of electrical engineers" opened by Dr. P. D. Aylett at 6.0 at Savoy Place, W.C.2.

18th. Brit.I.R.E.—Symposium on "Digital differential analysers" at 6.0 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

23rd. I.E.E.—Discussion on "Is automation making satisfactory progress?" opened by Professor A. Tustin at 5.30 at Savoy Place, W.C.2.

25th. I.E.E.—"Global communication" by R. J. Halsey, chairman Electronics and Communications Section, at 5.30 at Savoy Place, W.C.2.

25th. Institute of Navigation.—Annual General Meeting followed by "Navigation and the science of the sea" by Dr. G. E. R. Deacon at 3.0 at the Royal Geographical Society, 1 Kensington Gore, S.W.7.

26th. Television Society.—"Television from Moscow" by W. Ward and L. F. Mathews (Associated TeleVision) at 7.0 at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, W.C.2.

BIRMINGHAM

23rd. I.E.E.—"Space-charge-limited dielectric devices—successors to the transistor?" by Dr. G. T. Wright at 6.0 at the James Watt Memorial Institute.

26th. Brit.I.R.E.—"Instruments for the first U.K. Scout satellite" by Professor J. Sayers at 6.15 at the Electrical Engineering Department, The University.

BRISTOL

11th. Brit.I.R.E.—"General introduction to inertial navigation" by R. Collinson and "Components and techniques employed in inertial navigation systems" by E. Bristowe at 7.0 at School of Management Studies, Unity Street.

17th. Society of Instrument Technology.—"Instrumentation and control at the Hinkley Point nuclear power station" by R. B. Quarmby at 7.30 at the Department of Physics, University of Bristol, The Royal Fort.

CARDIFF

4th. Brit. I.R.E.—"The S.E.C.A.M. colour television system" by G. B. Townsend at 6.30 at the Welsh College of Advanced Technology.

20th. Television Society.—"British broadcasting" by the Rt. Hon. R. T. B. Wynn at 7.30 at the Royal Hotel.

CHELTENHAM

6th. Brit.I.R.E.—"Colour television" by P. S. Carnt at 7.0 at the North Gloucestershire Technical College.

DERBY

12th. Society of Instrument Technology.—"The commonsense approach to instrument manufacture" by C. E. T. Cridland at 7.30 at The Derby and District College of Technology, Kedleston Road.

GRANGEMOUTH

19th. Society of Instrument Technology.—"Computers" by J. Keay at 7.0 at the Leapark Hotel, Bo'ness Road.

LEICESTER

25th. Brit.I.R.E.—"Achieving high reliability in electronic equipment" by Dr. N. B. Griffin at 6.45 at the University of Leicester, University Road.

LIVERPOOL

16th. I.E.E.—"The 12 MeV Van de Graaff accelerator to be installed at Liverpool University" by B. S. Halliday at 6.30 at the Chadwick Laboratory, the University.

18th. Brit.I.R.E.—"Colour television" by Dr. G. N. Patchett at 7.30 at the Walker Art Gallery.

MANCHESTER

24th. I.E.E.—"A general method of digital network analysis particularly suitable for use with low-speed computers" by M. N. John and "Digital computers in power system analysis" by Dr. P. P. Gupta and Professor M. W. Humphrey at 6.15 at the Engineers' Club, Albert Square.

MIDDLESBROUGH

12th. Society of Instrument Technology.—"Automation in the Post Office" by N. Burley at 7.30 at the Cleveland Scientific and Technical Institution.

NEWCASTLE-UPON-TYNE

11th. Brit.I.R.E.—"V.H.F. Communications receivers and transmitters using transistors" by A. J. Rees at 6.0 at the Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road.

18th. Society of Instrument Technology.—"Design of instruments and control panels" by A. A. Ardley at 7.0 in the Conference Room, Roadway House, Oxford Street.

SALFORD

23rd. I.E.E.—Discussion on "How long do we go on teaching our subject historically?" opened by Dr. E. R. Laithwaite and P. Hammond at 6.15 at the Royal College of Advanced Technology.

STOKE-ON-TRENT

23rd. I.E.E.—"The development of communication, indication and telemetering equipment for the British grid" by G. A. Burns, F. Fletcher, C. H. Chambers and P. F. Gunning at 7.0 at the North Staffordshire College of Technology.

LATE-SEPTEMBER MEETINGS

26th. Brit.I.R.E.—"Lightning—facts and fancies" by Dr. W. A. Gambling at 7.0 at the Technical College, Farnborough.

27th. Brit.I.R.E.—Symposium on "The new graduateship syllabus and the Institution's recommendations for practical training" at 10.30 a.m. at University College, London.

27th. Brit.I.R.E.—Papers on some recent developments in television tape recording by Dr. P. E. Axon, K. Machein and Aubrey Harris at 6.0 at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

27th. Brit.I.R.E.—"The single crystal circuit" by Dr. D. H. Roberts at 7.15 at the College of Technology, Wolverhampton.

RANDOM RADIATIONS

By "DIALLIST"

What Do You Think?

WELL, if you went to the Earls Court Radio Show you had the chance of making a direct comparison between the 405-line and 625-line television systems. Do you agree—I most certainly do—with the opinion expressed in a *Wireless World* editorial a month or two ago that the 625-line picture is better, though only marginally so? To me it seems that the improvement is so small that the change is hardly worth making. And don't forget that whatever definition we adopt now we are tied to it for the next score of years or so. The Radio Industry, with the switchable and convertible models that it's putting on the market, seems convinced that the Pilkington Committee will recommend 625 lines. I don't feel at all sure about that and I very much hope that when their report comes along next year it will plump for a very much larger number of lines, for Continental manufacturers of 625-line receivers are now introducing methods to reduce lininess.

And Then Colour TV

NO doubt, too, if you visited the Show you saw and admired the B.B.C.'s demonstrations of colour television. And quite likely you went to the G.E.C.'s own show and saw the S.E.C.A.M. system in action. There's no doubt that the results achieved by both N.T.S.C. and S.E.C.A.M. processes are good. But the main problem still defies solution: how to make a colour receiver to sell at a price which will prove attractive to John Citizen. Sets using the S.E.C.A.M. system would be a bit less costly than those using the N.T.S.C., but not enormously so. I don't think that colour is likely to make a wide appeal until some way is found of manufacturing receivers to sell for less than the £250 recently quoted by John Stanley, of Pye. Even at that sort of price there'd always be a certain number of buyers; but would there be enough to make colour TV a paying proposition from the manufacturers' point of view?

Is Your Transistor a Nuisance?

IT had to come, I suppose. To the man-in-the-street a transistor portable receiver is now just simply a transistor. One hears complaints that "there's no peace on the beach nowadays with all those transistors blaring away." And some of the lay papers have adopted the term. It began, I believe, in France, for I saw a transistor portable referred to in a French magazine as *un transistor* a good while ago. The French have a fondness for shortening things in that way; a self-induction coil, for instance, has been reduced to *un self* and I could quote many more. If you have "a transistor" I hope you don't let it make a nuisance of itself.

A Super-magnet

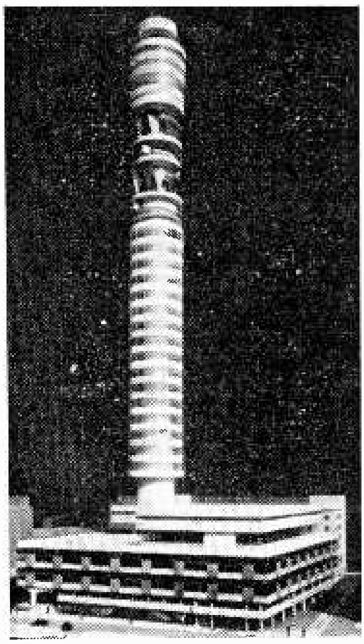
YOU may have seen the note in "Technical Notebook" (August) on the tin-niobium compound developed by Bell Telephone Labs. Like many other metals this compound can be made superconducting at very low temperatures. But there's one big and important difference between the tin-niobium compound and the others. In all of those previously used the superconductivity comes to a full stop in the presence of a strong magnetic field. In tin-niobium this doesn't happen. Even if the magnetic field reaches the very high figure of some 80,000 gauss, the current goes on flowing round the coil. Bell Laboratory scientists are planning to build a large tin-niobium magnet for experimental purposes. This should be finished early next year and some amazing results are expected with it.

Lunar Exploration

PROVIDED we don't blow ourselves to bits in the meantime, we're likely to know a good deal more about the moon's make-up in the next few years. The Americans have a whole series of projects for exploring the moon's surface by instruments and television and these should yield interesting information. The first part of the programme is due to begin in the next few months, when space vehicles will be sent into orbit round the moon, and will send back information by wireless and television about the radiation and the particles encountered. Then between 1962 and 1965 quite a few unmanned landings are scheduled. Drills will dig into the surface, the bits and pieces brought up will be analysed and the results televised back to earth. After that come quite a few big probes, which it is hoped to get back to our world. There is no mention of any attempt to land men on the moon in any of the programmes and one can't really wonder at that. Unless and until we've solved the problems of enabling men to live in temperatures ranging from far above that of boiling water to a long way down towards absolute zero the moon hardly seems a place for human beings.

Eagles Now

A WHILE ago, I told you of the damage done by large birds to the horizontal aerials used in this part of the country for TV reception, which they insist on using as perches. I've never seen anything bigger than a gull doing so; but a man who lives near me looked out of the window the other day and could hardly believe his eyes when he saw a neighbour's aerial occupied by a white-tailed eagle. That's the sea-eagle or erne, you know, and it's a pretty hefty bird. As he watched, the eagle took off with the downward kick that birds give when so doing. That was too much for the aerial, which just bucked and folded up.



London's Radio Tower.—*A model of the revised design for the tower to be erected near Tottenham Court Road, for the Post Office microwave links for television and telecommunications generally. The parabolic and horn radiators will be housed in the section between 350 and 450-ft above ground level. Above this section will be public viewing galleries and restaurants, and the 500-ft tower will be surmounted by a 45-ft lattice tower for more aerials.*

UNBIASED

By "FREE GRID"

Bach and No Bite

SO much has been written in other sections of *W.W.* about the recent Earls Court Exhibition, that I am not going to try to gild the lily. But there was one thing I was sorry not to see included in the specifications of the sound-radio receivers, even the more expensive ones. I refer to the absence of what I would call a senescence adjuster or presbyotic tone control.

It is well known that as we get older, our ears get less sensitive to the upper musical frequencies—or in other words the harmonics—so that eventually we cannot distinguish between a violin and certain of the woodwind instruments. Even in the early stages of senescence, the upper frequencies are weakened to a sufficient extent to cause music to become dull and lifeless; in fact, if I may say so, Bach loses his bite.

This could be simply remedied if set manufacturers would provide, at least in their more expensive receivers, what I would call a treble uplift to compensate for the presbyotia which many people develop a few years after they have started to suffer from presbyopia. To control the degree of treble uplift, the set should have a knob calibrated in years from, say, 60 upwards, or something like that. Can we have it at the next exhibition please?

Fake or Fact?

THE advantage of 625 lines over 405 is so marginal that it is certainly not worth while to make the changeover in this country's system of TV. At the same time in *some* of the demonstrations I have seen, the clearer definition of the 625 transmission is so marked that it is not surprising that many people are influenced in its favour.

In fact, the improvement is so obvious in certain cases that many unkind people might suspect foul play on the part of those members of the radio industry who are 625-line fans. It is so easy, by a little skilful fiddling with the interlacing, to make the lines on any receiver thick and obvious. Could it be that some demonstrators are deliberately trying to panic us into clamouring for the 625-line system? I don't know, and I make no accusations. I am merely asking.

Schismatic Sideshow

AFTER the radio show of last year, I made a few criticisms of the waste of floor space, and I published a photograph of one of the "vast open spaces" which I had noticed.

It was much the same this year but it would seem that my remarks must have been seen and taken to heart by the big white chiefs of the schismatic splinter group who organized an independent exhibition in the New Horticultural Hall, because when I visited it on the Sunday afternoon prior to the opening of the Earls Court Show, I found that not a square yard of floor space had been wasted.

I received my first surprise when I arrived and found a long queue. I could not at first make out why there was such a huge crowd, even though it was Sunday. To some extent colour TV was responsible, I suppose. But the main reason was, as I realized later, the psychological effect of something for nothing. The greater part of the colour TV section of the exhibition was taken up by a see-yourself-on-colour-TV show, to get to which such is the weakness and vanity of human nature, we all fought tooth and nail.

A corpulent cockney expressed the feelings of nearly everybody when she saw herself on the screen. "Blimey, if coloured TV makes me look like that, I don't want none of it."

The trouble was that owing to the squeezing and squelching to which we were subjected in the tightly packed hall, a great deal of heat, both physical and psychological, was engendered with the result that the good lady's face had taken on the deep red colour of a vintage port, and this was faithfully shown on the screen.

Hospital Wireless

RECENTLY (August) I told you how unfavourably impressed I was by the wireless headphones supplied to the patients in a hospital to which Mrs. Free Grid was transported in a sudden emergency.

As a result of what I wrote I received a letter from Mr. John Weir, an engineer whose experience in the maintenance of hospital wireless enables him to look at the matter from quite a different point of view. I quote parts of his letter:—

"Each bed is equipped with a box, usually on the wall, which contains a switch for selecting the required programme. . . . The boxes and 'phones are a serviceman's nightmare, and it would be difficult for me to describe the condition that these items get into, due to misuse by patients. . . . I have concluded after much experience that, being in bed all day with little to do leads patients to fiddle absent-mindedly with 'phones, etc., with the result that leads come off, screws and nuts get loose and pieces break off. . . .

"The various hospital authorities, after much experience of paying for repairs, chose the old-type headsets as the least vulnerable. . . . A damaged headset or wall box . . . can, and in most cases does cause a short circuit on the line and the whole hospital then suffers from programme break-through or loss of volume, or both."

Now I am quite prepared to believe there is a lot in what my correspondent says. In fact Mrs. Free Grid confirms much of it and adds a bit more. She tells me that a lot of the damage is done by the ladies whose duties it is to polish the floors. They have the habit of gliding a bed sideways without first unplugging the headphones. This gives a sideways wrench to the plug in its socket, and usually damages the lead if not the plug or socket.

I think the best solution would be to have one "earphone" only, this being fitted inside the wall-box, the front cover of which would have several perforations at one point to let the sound out. The butt end of an ordinary acoustic stethoscope, such as doctors use, could then be attached to the perforated cover of the wall box by a suction cap.

In this way there would be no delicate electrical leads for the patients to pick at, and it would be virtually impossible for a careless patient or clumsy floor cleaner to short-circuit or otherwise interfere with the electrical apparatus. If the bed were pushed sideways, the tug would be sufficient to release the suction cap without causing damage to anything. Any objections?