DOMESTIC RECEIVER TECHNIQUES

OCTOBER 1967
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Wireless World

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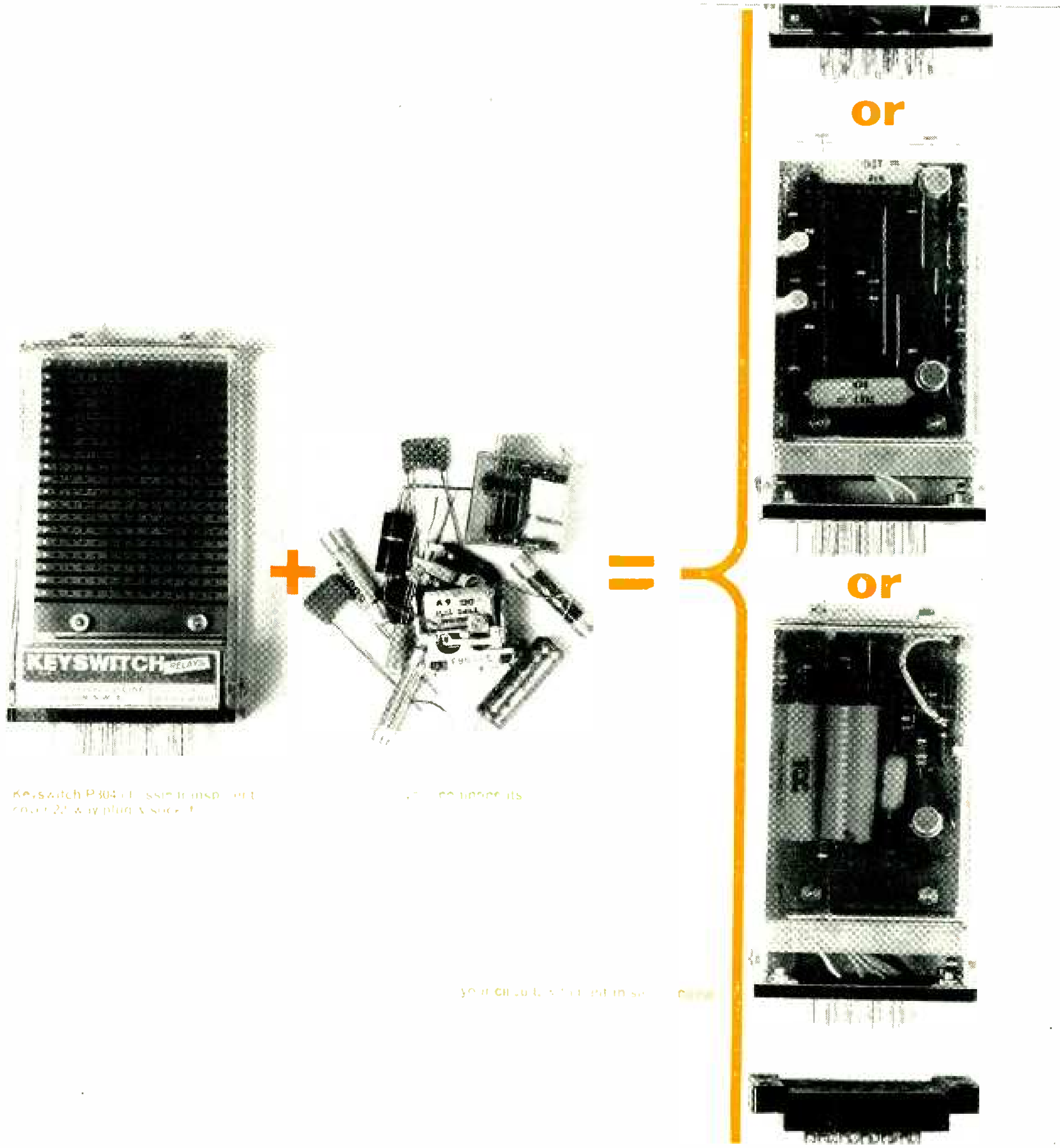
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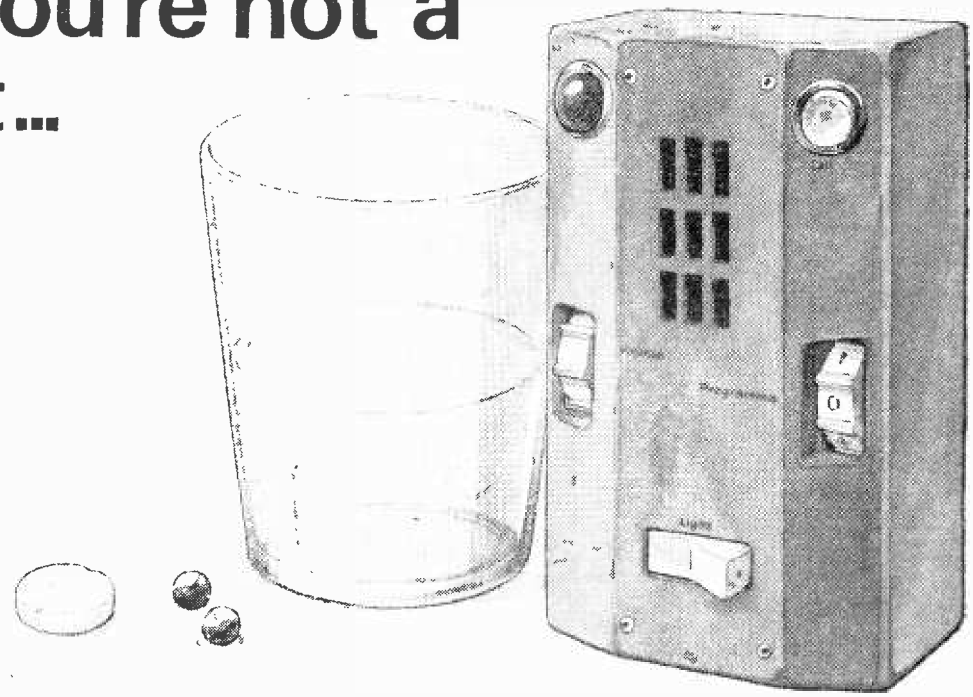

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Wireless World

ELECTRONICS, TELEVISION, RADIO, AUDIO

What is the Electronics Industry?

THIS, strangely enough, is the question posed by the Economic Development Committee for the Electronics Industry, in its recently issued survey of the industry's statistics. This is no new question. Indeed, on more than one occasion during the past fifteen or twenty years we have sought to define "electronics." At one time the generally accepted definition was "radio-like techniques and devices, especially valves, applied to non-communication purposes," but electronics, the child of the radio family, has now grown to maturity and the offspring's name has, by common usage, become the family name.

However, to get back to the E.D.C's question, the definition of an industry is essentially arbitrary. Among the criteria which can be used as the basis of a definition are "the physical nature of the product; the technology used in production; or the need which the product meets." Sometimes these criteria coincide and the defining of the industry is not difficult. However, where, as in electronics, "a technology is advancing rapidly and spreading its influence widely" giving a clear definition of the industry concerned is particularly difficult. The E.D.C. survey points out, that because some car ignition systems use semiconductors no one would suggest that this makes a car an electronic product. Similarly the electronic distributor, probably made by a motor accessory manufacturer, is unlikely to be regarded as an electronic product.

Although, so far as the Government is concerned, any definition is arbitrary, and would appear from the report to be made primarily for the purpose of statistics, "it will tend to change as technology and industrial structure change." The present "minimum list headings" (M.L.H.) of the Government's "standard industrial classification" defining the electronics industry are (a) valves, (b) consumer goods, (c) capital goods, and (d) components.* The E.D.C. also includes telegraph and telephone apparatus in the industry.

According to the latest survey "no precise definition of the electronics industry has ever been accepted by the E.D.C." and it is now proposing a major regrouping. First there would be one M.L.H. for the components sector of the industry with three sub-divisions: active and passive components and microcircuits. It is stated that "the microcircuit sector is included in case by the time of the next census or the one after a substantial number of establishments making these circuits exist independently as off-shoots of both active and passive component (or other) firms." Secondly, there would be one M.L.H. for each of the main product sectors—capital goods, telephone equipment, and consumer goods. Lastly an M.L.H. for "the rather small but mixed sector of firms making audio products and components."

It may well be that integrated circuits (l.s.i. devices particularly, which combine active and passive component manufacture, assembly and testing) will provide a unifying influence on the whole industry. It is blatantly clear that the number of i.c. manufacturers is going to be small but their influence could be very extensive.

One other aspect of the past industrial structure has been a proliferation of trade associations, each one speaking for a particular section without an effective co-ordinating body bringing together the various sectors of the industry.

* (a) valves, c.r.ts. semiconductors and electronic rectifiers; (b) radio and television receivers and sound reproducing and recording equipment including gramophones, gramophone records and tape recordings; (c) capital goods—radio and television transmitters, communication receivers, radar and electronic navigational aids, electronic computers, industrial electronic equipment, electronic medical equipment, high-frequency heating apparatus, electronic testing and measuring equipment, X-ray apparatus, etc.; and (d) components, including resistors, capacitors, inducers, circuit breakers for electronic equipment, sound reproduction components, printed circuits, etc.

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Domestic Receiver Techniques

Developments in circuitry and construction seen at recent trade shows in London

SOUND RECEIVERS

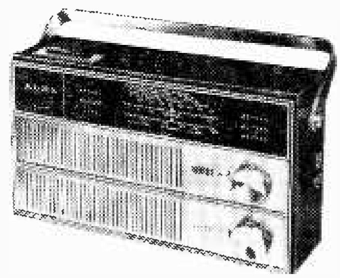
AFTER looking round the trade shows at domestic radio receivers the feeling that one has seen it all before becomes very strong. The development of sound radio in Britain has to a large extent been overshadowed by that of colour television, manufacturers having concentrated the major part of their resources on this. As a result a large number of this year's models consist of last year's printed boards in new cabinets. It could be argued that there is no point in developing the domestic radio further as the public is on the whole satisfied with what it is getting and that this after all is what counts.

However, it is a well-known fact that modern sets last longer and because of this sales are falling as the market approaches saturation. Surely, then, it is up to set designers to produce something sufficiently tempting to encourage the public to consign that old, but still serviceable, receiver to the scrap heap in favour of a new one. People are not going to throw away a three waveband a.m./f.m. receiver for another three waveband a.m./f.m. receiver that has more plastic gold trim and sounds only marginally better. The answer probably does not lie in improved performance, the majority of purchasers caring little for improved selectivity and lower harmonic distortion. An approach should be to make the receiver perform some other useful function in addition to receiving broadcasts. Some examples of this are already to be seen, but additions should lean towards the electronic rather than the mechanical. With a little ingenuity the domestic receiver could be made to perform all manner of extra tasks—burglar alarm, baby alarms, intercom, electronic timers; if a car radio, an anti-theft device, etc.

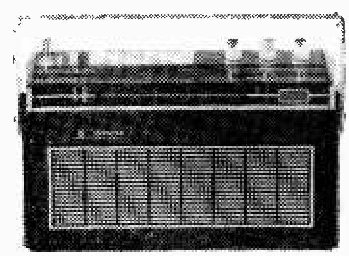
The integrated circuit and the f.e.t. are still not to be seen in domestic receivers and most of the large manufacturers do not seem to be doing much along these lines. The general impression is that everybody is adopting a "we'll wait and see" attitude. However, varicaps are being used in increasing numbers, mostly in f.m./a.f.c. circuits.

For some time now many portable radios have included a switch to cut out the internal ferrite aerial and bring in a separate aerial coupling coil when the receiver is to be used in a car, the idea being to improve the signal/noise ratio. The Pye group have adopted a somewhat different system in one of their models (Pye 1373· Ekco PT305, Ferranti 5503), a medium- and long-wave portable. In this the ferrite rod is left in circuit but when the car aerial is plugged in a single stage wide-band r.f. amplifier is brought into play that gives about an extra 6 dB of gain. The circuit of the r.f. amplifier, shown in Fig. 1, has been designed to operate when coupled to the car aerial via a "standard" length of coaxial cable (32 in). This set's brother (Pye 1372, Ekco PT304, Ferranti 5501) is a v.h.f., medium- and long-wave version that does not include the r.f. amplifier. The sets retail at 16gn and £20 9s, respectively.

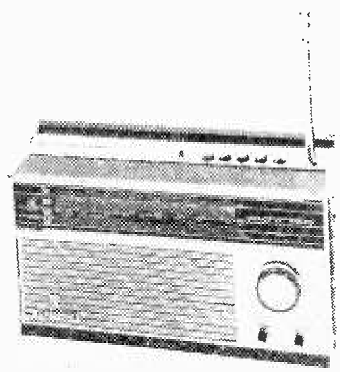
Incorporating one of the features suggested in the introduction and looking most unlike a radio receiver is the Beolit 500 (35gn) from the Bang and Olufsen range —a continental design, of course. This is an eleven transistor v.h.f. receiver that can receive five push-button-selected stations and, if an external loudspeaker is connected, will also function as an intercom. The pre-set tuning system is interesting in that the conventional multi-gang tuning capacitor has been replaced by two



Alba 535 (£14-19-6), a three waveband seven transistor portable using modular circuit techniques.



From Japan an a.m./f.m. five waveband portable using an incandescent lamp tuning indicator, Hitachi KH-1325.



This portable from Grundig (Yacht Boy 208 33.5gn) provides 2 W output to a 5.75 x 3.75 inch loudspeaker, it has three a.m. wavebands plus v.h.f./f.m.

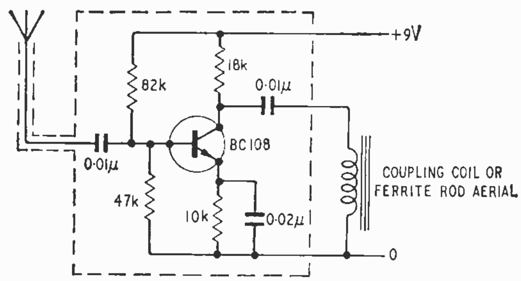
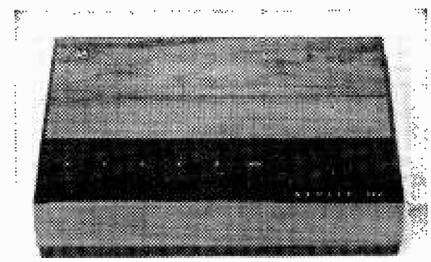


Fig. 1. The r.f. amplifier employed for car aerial coupling in some portables from the Pye Group.



The Beolit 500 from the Bang and Olufsen range is a typical example of continental ' low-line ' styling.

varicap diodes, the actual tuning being carried out by potentiometers (Fig. 2). Only one of the five potentiometers is shown in the drawing. The 22.5 V control voltage for these is obtained from a separate battery, thus avoiding trouble that could be caused by stray coupling with other circuits via the power supply line. It will be noticed that the collectors of both the r.f. amplifier and the oscillator are tuned; the varicaps also provide the means for applying a.f.c. B. & O. have restyled the Beomaster 1000 and the 900. They have respectively become the 1000K (84gn) and the 900K (73gn), and incorporate some improvements. It is interesting to note that these models have a fully stabilized power supply rail, the stabilizer circuits using three transistors.

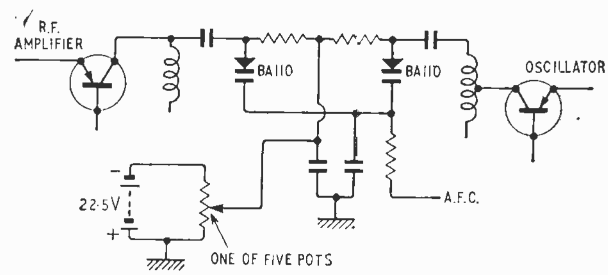
Turning now to a portable from Japan at the higher end of the price range (£57 9s 8d) the FV 1700, from Sharp, has a very full specification. Significant features are f.m. with switchable a.f.c. (varicap), five a.m. wavebands (800-25 m), 17 transistors, b.f.o., fine tuning control, 1 watt output and 11 lb in weight. The tuning indicator on this model is a departure from the norm. Instead of a miniature meter two coloured incandescent bulbs are used. These are focused on a glass honeycomb panel that turns from red to green as a station is tuned in. The circuit to achieve this shown in Fig. 3. Under no-signal conditions Tr1 is off and Tr2 is turned hard on, lighting the red bulb; Tr2 collector is close to OV so the green bulb will be extinguished. On receipt of a signal, taken from the second i.f., Tr1 turns on and the condition of the two bulbs reverse. To conserve battery energy the circuit is only operative when the dial light switch is depressed. Also in the Sharp family is the GS.5500 (£154) a 6 W/channel stereo-gram with separate loudspeaker cabinets.

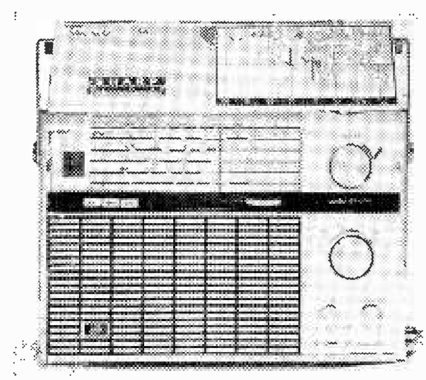
While talking of sets from Japan it is refreshing to note that in spite of all the multi-transistor receivers the humble crystal set still flourishes. They are available ready built or in kit form from Eagle Electronics at about 15s each.

The RP36 (£33) is a new portable from Hacker Radio. It is a five waveband a.m. receiver incorporating 11 transistors and covering 1090-25 metres (152 kc/s-30.64 Mc/s) and has bandspread tuning effective on all wavebands. A separate oscillator is used for each waveband, eliminating the stray capacitance associated with conventional switching and improving performance on the short-wave bands. At the a.f. end a fixed 4 dB of bass lift (at 100 c/s) is provided, the output stage delivers 750 mW at less than 1 % distortion into an 8×5 in speaker.

Changes in the components being used by manufacturers are more or less as would be expected, in-

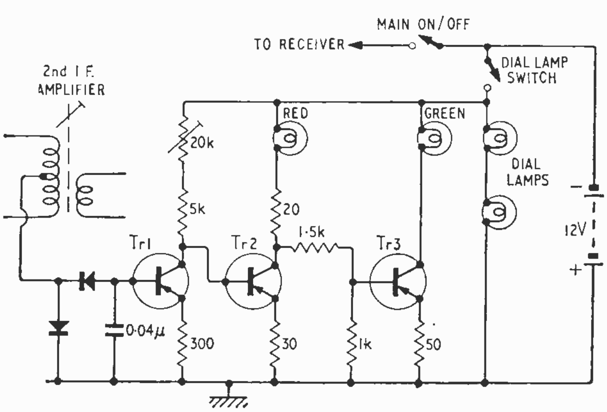
Fig. 2. The tuning and a.f.c. system used in the Beolit 500.

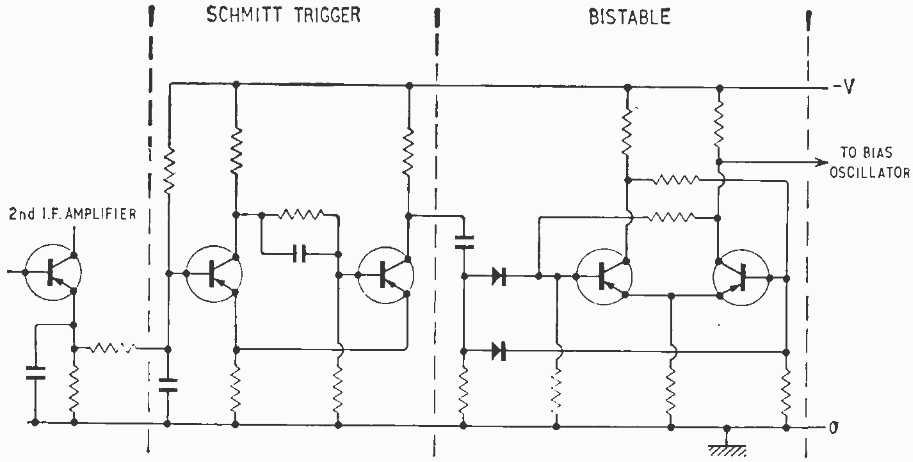


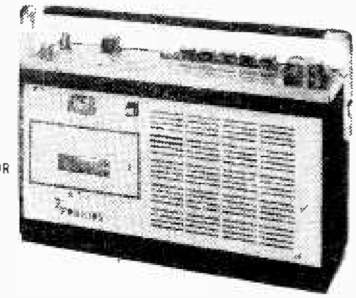


Sharp FV 1700, a 17 transistor multi-waveband portable from Japan.

Fig. 3. The lamp tuning indicator from Sharp, battery power is conserved by coupling this circuit to the dial lamp switch.







The R673, a combined tape recorder/radio receiver from Philips.

Fig. 4. Bias oscillator correction circuit employed by Philips in their combined tape recorder/radio.

creasing use being made of silicon epitaxial transistors. Mullard pre-built modules are also being used to a greater extent and, as pointed out last year, there is a marked swing in favour of modular construction with its attendant advantages. It is surprising to note the preponderance of Japanese components, particularly capacitors, being used in British sets.

National have introduced a portable mains/battery tape recorder with a built-in medium-wave receiver (Model RQ120S—£30 9s). This is a twin-track machine that will accommodate 3-inch spools.

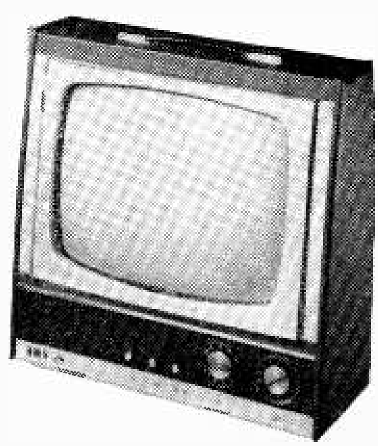
Philips have adopted a different approach in that they have built their cassette recorder into a portable radio (RL673—55 gn). The radio section covers the l.w., m.w., s.w. and v.h.f. bands. Sensitivity on v.h.f. is quoted as being 4 μV for a 26 dB signal-to-noise ratio; non switch-switchable a.f.c. is incorporated. Facilities are available for recording direct from the radio, a microphone or a pickup, and, of course, it is possible to play back standard Musicassette tape records.

With recorder/radio combinations it is possible that harmonics of the bias oscillator will fall in the pass-band of the receiver and cause unwanted beat notes. Philips have overcome this problem in a rather novel way. First the programme to be recorded is tuned in, then a button is fully depressed. This switches the equipment into the recording mode and switches out the ferrite aerial, disconnecting the signal source and a screened aerial coil is connected in place of the ferrite aerial. Now any signals being received will be due to harmonics of the bias oscillator. These are amplified in the i.f. strip and detected, causing a.g.c. action. Any change in a.g.c. voltage is sensed at the 2nd i.f. amplifier emitter and used to operate a Schmitt trigger which in turn complements a bistable (Fig. 4). The bistable is coupled, via a switching transistor, to the bias oscillator in such a way as to effect a change in oscillator frequency, thereby removing the spurious harmonics. When the finger is removed from the button, the ferrite rod aerial is reconnected and the control circuit is switched out, the recorder remaining in the record condition.

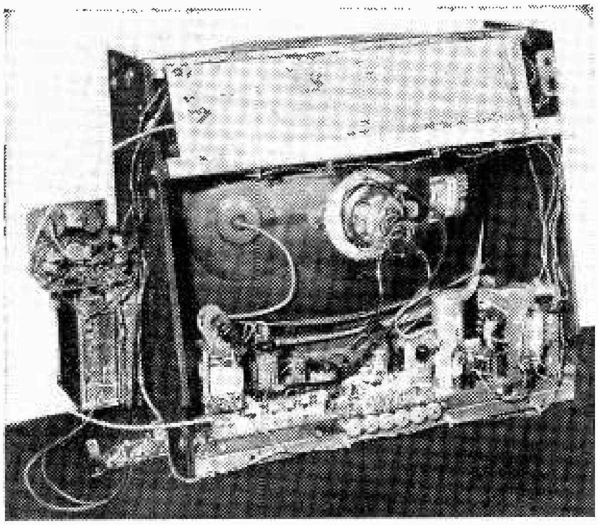
TELEVISION RECEIVERS

IN Britain television receiver design is rather in the doldrums, mainly because of the present and impending broadcasting arrangements. At the end of this decade there will be a major switch-over to a single television standard—625 lines on u.h.f.—and all the manufacturers can be expected to come out then with completely new, all-solid-state single-standard receivers. Meanwhile, with most of their development effort going into these future designs, the manufacturers are virtually marking time with the current hybrid dual-standard sets, which have not changed much since last year and are not likely to change substantially next year. This applies to both monochrome and colour receivers. In monochrome the minor developments that have taken place have been largely aimed at improving the attractiveness and maintaining the sales of black-and-white sets in the face of the coming (at least, hoped-for) colour boom. Means have been found for reducing production costs (for example, using one large printed circuit in place of several small ones) and adding small picture improving features (such as the Bush black-level correction circuit and the K-B "Deep Scene" optical filter in front of the c.r.t.—both of which are in fact revivals of old ideas).

The trade shows did, however, provide one or two



H.M.V. 16-inch portable dual-standard monochrome set, Model 2645, with hybrid circuit on a single printed circuit board. It weighs 27½ lb.



Rear view of self-supporting inner cabinet of Decca "Professional" monochrome set. The circuit panel above the tube is hinged and opens out to give easy access to the components.

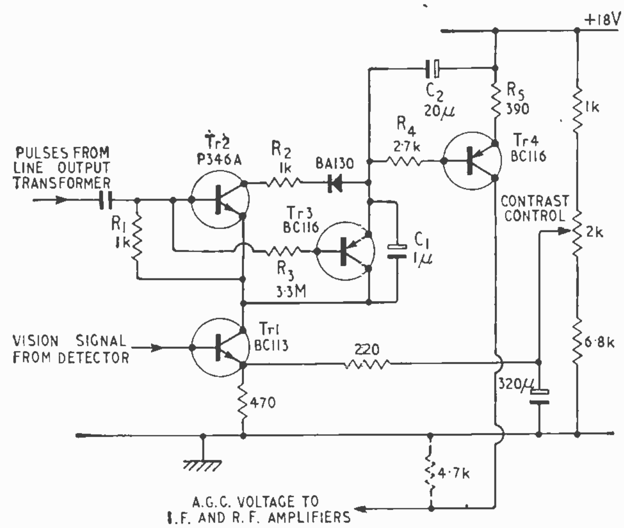


Fig. 5. Gated vision a.g.c. circuit, with anti-blocking modification, used in Decca "Professional" monochrome receiver.

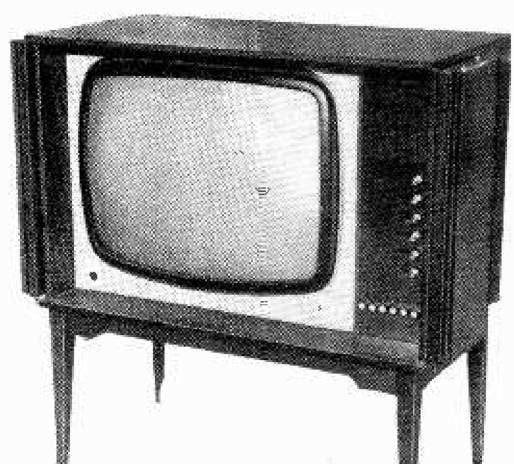
exceptions to this rather dull technical vista. One was the Thorn all-solid-state colour receiver, which has already been dealt with in *Wireless World**. The other was the first full demonstration of the Decca "Professional" receiver, a monochrome set providing superior vision and sound reproduction which was unveiled at the R.T.R.A. conference earlier this year. This 23-inch dual-standard set has been designed to make the best possible use of the signal available within the limitation of a reasonable "quality" price which discerning people can be expected to pay—actually £131 5s. It is not, of course, the ultimate in "hi-fi" television, which would cost many hundreds of pounds (starting with a special £200 c.r.t.).

On the vision side, the set offers clear resolution of 4.5 Mc/s test-pattern bars (625 lines) and 2.5 Mc/s bars (405 lines); a scanning linearity such that no two squares of Test Card D differ by more than 15%; a geometrical distortion such that opposite edges of Test Card D are parallel within $\frac{3}{8}$ inch; interlacing not worse than 45/55 over 50% of the vertical hold range; a picture height and width held constant up to ± 10 V mains variation; elimination of "caption streaking" by d.c. coupling of the transistor video amplifier to the c.r.t. cathode; and, of course, maintenance of correct black level by the use of gated a.g.c. Cross modulation between sound and vision is reduced by using separate sound and vision i.f. amplifiers (the sound take-off being immediately after the tuner), and the noise figures of the transistor integrated tuner are 5.5 dB on Band 1, 7.5 dB on Band 3 and 13.5 dB on Bands 4 and 5.

On the sound side the set is characterized by the separate i.f. already mentioned, a transistor a.f. amplifier with push-pull output giving a maximum of 3 watts, a tone control, and a forward facing 8 in × 5 in elliptical loudspeaker. This audio section, the makers say, is the sort "normally only found in a good record player." For users who require even better sound quality there is a take-off point before the a.f. amplifier providing a connection for external high-quality sound reproducing equipment. (There is also a socket for a tape recorder.) One of the inherent problems in television receiver sound channels is signal pick-up from the vision timebases, and this sets a limit to what can be achieved within the confines of the same cabinet.

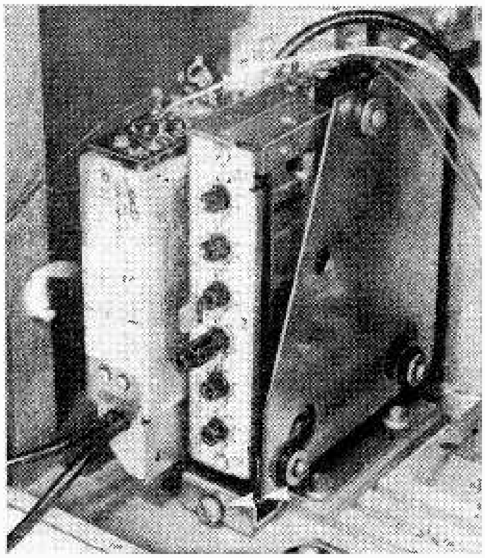
Other unusual features of the set include an electrically isolated chassis (a mains transformer and a bridge rectifier are used); a separate on-off mains switch to allow the volume control to be left set at a required level; facilities for connecting a television camera and a video tape recorder; and a self-supporting inner cabinet assembly, designed for ease of maintenance, which can be supplied as a separate unit for building-in to user's furniture.

The gated vision a.g.c. circuit is interesting because it includes a device to prevent blocking of the system when the line timebase is not working and there are consequently no gating pulses (e.g. during warm-up). Fig. 5 shows the circuit. Tr4 is biased so that it will not conduct unless a video signal is received at the base of Tr1. Transistor Tr2 is a gate which is norm-

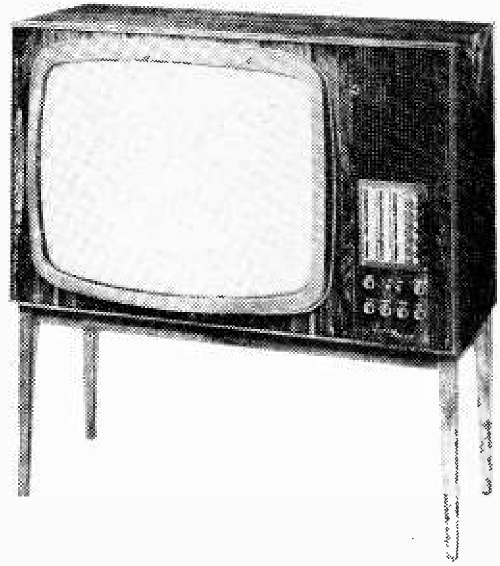


This Pye CT70 25-inch colour receiver is the first model from the re-formed company, Pye Group (Radio Television) Ltd.

* "Transistor Line Output and E.H.T. for Colour TV," August issue, p. 396.



Rear view of Philips six-button integrated tuner. By means of the controls shown any of the six buttons can be tuned to any channel over four bands, so that when BBC-1 or ITV transfer to 625-lines/u.h.f. the viewer can use the same buttons for these programmes as at present.



The first imported colour receiver in the U.K. is this 25-inch Swedish model from Luxor Radio (available from Scandinavian Sound Corporation Ltd.). It is single-standard only (625 lines), has two loudspeakers and uses a hybrid circuit with 14 valves and 88 semiconductor devices.

ally closed (cut-off) but, when opened by positive pulses from the line output transformer during the back porch period, allows the signal from Tr1 to have effect on Tr4. During this period, the effect of Tr1 conducting in proportion to the vision signal amplitude is to produce a negative potential at the base of Tr4 via the diode. This allows Tr4 to conduct, making its collector positive and so applying an a.g.c. voltage to the controlled stages. Capacitor C_2 becomes charged and so maintains the negative base potential on Tr4, while the diode prevents any discharge. If the line timebase is not working and no gate pulses are available at Tr2, transistor Tr3 will conduct and allow a mean-level a.g.c. process to take over, but C_1 prevents it from conducting

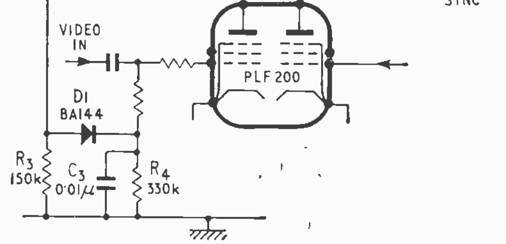


Fig. 6. Black-level correction circuit in Bush and Murphy monochrome 19-inch and 23-inch receivers.

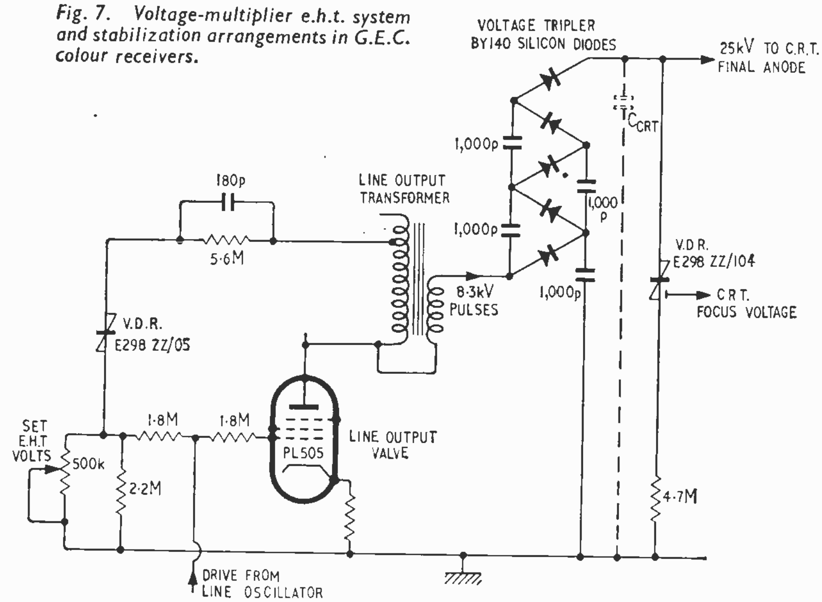
when line scanning is in operation. The contrast potentiometer supplies a positive voltage which, applied to the emitter of Tr1, backs off the effect of vision signal on the base of the transistor, thereby delaying the a.g.c.

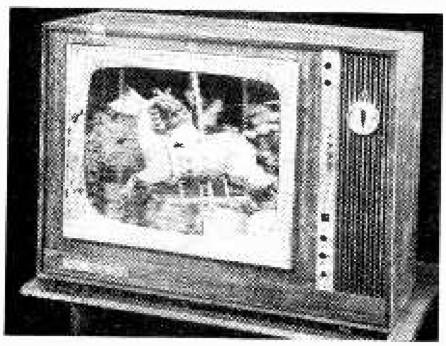
Constant criticism about the failure of television receivers to maintain correct black level seems to be having some effect, for now another manufacturer, Rank Bush Murphy, has done something about it, this time in a normal-price domestic receiver. Misleadingly described as "black level clamp" in the publicity literature, the system is actually a form of automatic correction applied through the video amplifier to the c.r.t. cathode. In Fig. 6, a proportion of the vision signal from the video amplifier valve, tapped off at point P through R_2, has applied to it reverse-polarity sync pulses from the anode of the sync separator. The network is arranged so that the sync pulses in the vision waveform are slightly "over-cancelled," and so changed into small-amplitude reverse-polarity sync pulses. The resulting waveform, in which black level is positive-going, then measures, by its peak value, the variation of black level at the output of the video amplifier. As shown in Fig. 6 the waveform is passed through C_2 to diode D_1, producing across R_1 and C_3 a direct voltage which is applied as a varying positive bias to the grid of the video amplifier.

It can be seen that this bias acts in such a direction as to offset the incorrect voltages applied to the c.r.t. cathode as a result of the a.c. coupling to the video amplifier. With an overall dark picture, for example, the c.r.t. cathode would normally be too negative on black, resulting in too much beam current and making the actual black displayed on the screen too light. Here the reduction of the "black-level" amplitude at P would lower the positive bias on the grid of the video amplifier and so drive the anode and c.r.t. cathode more positive. Thus the beam current would be reduced and the displayed "black" brought nearer to its correct value. The RBM receivers on show incorporating this circuit certainly demonstrated a substantial improvement over uncorrected sets.

In colour television the most obvious trend this year was the appearance of 19-inch receivers. At last year's Earls Court Show everybody seemed to think that there was no future for this size of set and that the 25-inch receiver would be virtually the standard. It now seems that pressure on the manufacturers to reduce prices, plus favourable reaction from the retail trade and public, has encouraged the introduction of the smaller size. Examples were shown by G.E.C. and Sobell, Decca and K-B. This, however, does not result in any significant changes in circuit design, although the tube drive requirements are slightly smaller. In general, colour circuitry follows the techniques described by T. D. Towers in our current "Colour Receiver Techniques," series and variations tend to be small "extras" such as the Philips "Autowhite" switching system which, when the set is displaying monochrome pictures, automatically adjusts the voltages on the three guns of the tri-colour c.r.t. to give the familiar bluish-white picture of monochrome receivers. (If this monochrome "white" were used for the colour programmes the colour pictures would have an incorrect bluish tinge.) Philips, in fact, had two other "extras" in their latest sets. One is a "colour-off" button to assist the user to adjust his brightness and contrast controls correctly (and, perhaps, to allow him to convince himself repeatedly that colour is worth paying all those extra pounds for!). The other is a tuning indicator which shows when the set has been correctly tuned on colour transmissions.

Fig. 7. Voltage-multiplier e.h.t. system and stabilization arrangements in G.E.C. colour receivers.





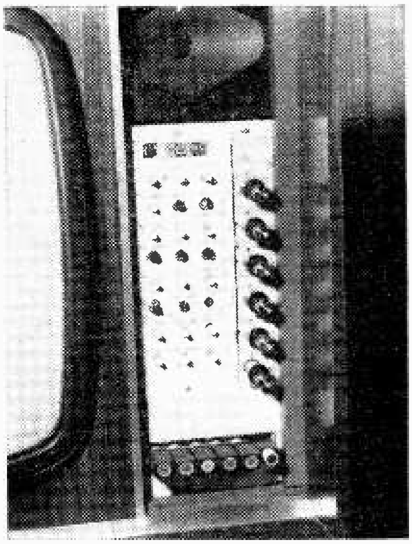
Colour receivers with 19-inch screens are now becoming available. This example is the G.E.C. Model 2028. It has a forward facing loudspeaker and a "colour beacon" which lights up only during transmissions in colour.

The one section of the colour receiver which does show variations in design approach is the e.h.t. generation. Some receivers (e.g. Decca, Murphy) use the conventional overwind on the line output transformer to supply the full voltage which is rectified then stabilized by a shunt regulator valve. Others are using a lower voltage winding giving pulses of 7-8 kV, plus a Cockcroft-Walton voltage multiplier to obtain the 25 kV. This technique avoids the insulation problems resulting from the use of a 25-kV overwind. Here one type of circuit has selenium stick rectifiers for the multiplier and uses a shunt regulator valve. Thorn, in their solid-state receiver, have the selenium rectifiers but dispense with the regulator valve by using a feedback arrangement for stabilization. One gets the impression, in fact, that there is now a general move to drop the regulator—understandably, since it is a large, hot valve which emits X-rays. This has become possible with the availability of high-voltage silicon diodes for the voltage multiplier, which have lower impedance than selenium rectifiers and so give better regulation.

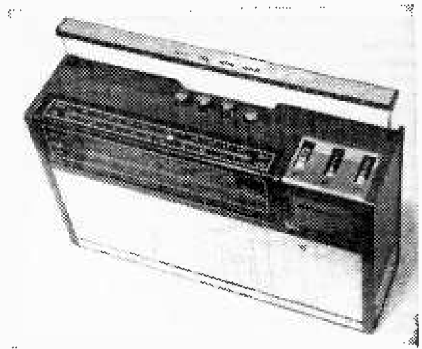
Fig. 7 shows the e.h.t. arrangement in the latest G.E.C. and Sobell colour receivers. Regulation of the e.h.t. derives partly from the low impedance of the silicon diodes in the voltage tripler, partly from the voltage-dependent resistor connected across the 25-kV supply and partly from the v.d.r. used in the line output stage primarily to stabilize the width of the picture. In addition the e.h.t. winding on the transformer is tuned to the 5th harmonic of the output fundamental frequency, so that the waveform from the transformer is made into something more like square pulses and as a result the silicon rectifiers conduct for a longer time in each line-flyback period.

STYLING AND MECHANICAL FEATURES

SIGNIFICANT mechanical developments were not in abundance at the trade shows this year. Most companies were emphasizing styling and cabinet design; for example, the cabinets of the Murphy 19in Painted Range are available in a choice of seven polyester colours, intended to blend in with contemporary colour schemes within the home. Leather type finishes were shown on some of the K-B television sets at the STC show, and one set, named Deep Scene, possesses a dark tinted screen and integral front control panel which, with the set switched off, is intended to become unobtrusive in appearance. Some manufacturers, including Bosch,



Convergence controls on the Pye CT70.



This Ferranti portable has International symbols by the thumbwheel controls.

STC, Rank-Bush-Murphy, and Pye have made serious attempts to improve the acoustics of radiograms by the use of properly designed loudspeaker enclosures, notwithstanding that in most cases the enclosures still remain an integral part of the cabinet work.

Switches and controls for both radio and television sets continue for the most part to remain static in design, but perhaps for colour television sets, the most interesting feature was the disposition of all the convergence controls on the Pye CT70 25 in model (applying also to the comparable Ferranti, Ekco, and Invicta sets). These controls were at the front of the set as shown in the photograph, concealed behind a removable decorative front panel and adjacent to the tuner. This has been done with the service engineer in mind, so that setting up can be carried out easily and directly. Should any of the convergence controls themselves become suspect, the whole panel as a separate unit can be detached from the set via a cable harness and 14-way plug. Although the use of solenoid switching in television chassis is not new, more manufacturers such as Baird, Pye and K-B were showing colour television chassis where solenoids were employed for switching the i.f. strips, timebases, and convergence. On the Pye (Model 60) and Ferranti (Models T1164/1165) monochrome sets, a new rotary multiband tuner employing silicon transistors—known as the Programme Master—is being used. With just this one switch, ITA or BBC 1 or 2 can be obtained without recourse to a separate tuner for BBC 2. Any six channels drawn from any of the bands can be quickly chosen in any order desired, through the six-channel selector mechanism, by pressing and rotating a memory control. Thus any channel combination can be arranged in the sequence desired by the viewer. On some of the K-B television cabinets, the circular v.h.f. and u.h.f. dials are illuminated from the rear by low-voltage torch-type bulbs, indicating which channel has been selected, controls on some of the K-B radiograms were similarly illuminated. Thumbwheel controls on portable radios exhibited by Ferranti have international symbols for tuning, volume and tone adjacent to them, while the volume and tone controls (see photograph) have a broken tapered line marked on them to indicate the relative position of either control. A useful mechanical feature on the Sovereign portable radio by Hacker was that of adjustable station markers providing accurate indication of the local f.m. station, a facility simplifying tuning for the general user. This set also has the new B.B.C. titles for the principal sound services, and is mounted on a small turntable permitting the set to be rotated through 360° to assist in station selection and interference reduction.

The design of the Pye 1373, Ekco PT305 and Ferranti 5503 a.m. portable radio indicates that ease of servicing has been kept well in mind. The printed circuits, tuning gang, controls and loudspeaker are mounted on a wrap round metal tray which can be completely withdrawn from the plastic moulded cabinet. Volume and tone controls are each mounted on separate brackets and can be changed without disturbing other components. Finally, in the direction of stereo signal reception, it was noted that only a few radiogram manufacturers including Bosch and K-B indicated that they were offering a plug-in modular type decoder as an optional extra on some of their sets.

R.S.G.B. SHOW

THE International Radio Engineering and Communications Exhibition is the title of this year's R.S.G.B. show to be held at the Royal Horticultural New Hall, Westminster, London, S.W.1. The central feature will be a radio and space research display by the Science Research Council, and Dr. J. A. Saxton, director of the Radio and Space Research Station will open the exhibition at 12.00 on September 27th, and it will remain open until September 30th from 10.00 to 21.00 each day. On the *Wireless World* stand will be displayed the digital computer being described in our current series of articles, the amateur s.s.b. transmitter described by C. J. Salvage in the March and April issues, the Dinsdale stereo/mono transistor amplifier and D.E.O'N. Waddington's stereo decoder (January). Admission 3s. The exhibitors are:—

Amateur Radio Mobile Society
Baden-Powell House Scout Amateur Radio Group
Brit. Amateur Radio Teleprinter Group
Brit. Amateur Television Club
Daystrom
Electroniques (STC)
Enthoven Solders
G.P.O.
Imhof
International Short Wave League
J. Beam Engineering
K. W. Electronics
Lowe Electronics
L.S.T. Components
Northern Polytechnic
Partridge Electronics
Peter Seymour
P.F. Ralfe Radio
Philadelphian Electronics
Practical Electronics
Radar and Electronics Association
R.S.G.B.
R.A.F.
R. Navy
Royal Signals
Science Research Council
Short Wave Magazine
Swanco Products
T.W. Electronics
Wamrac
Weller Electric Corporation
Wireless World

BBC-2 RECEPTION

Survey in service areas of Crystal Palace, Sutton Coldfield and Winter Hill

AN inadequate or badly installed aerial was found to be the major cause in more than 50% of the households where reception of BBC-2 was unsatisfactory. Of the total sample of over 1,500 households within the 70 dB field strength contours of the Crystal Palace, Sutton Coldfield and Winter Hill u.h.f. transmitters 24% were using aerials which were not designed for u.h.f. reception and only 31% had outdoor aerials. Because of these and other factors, e.g. incorrectly adjusted receivers, only 64% of the householders assessed their reception as satisfactory. However, investigations proved that more than 90% of viewers in the total sample of households, and 98% in the Crystal Palace service area, would be able to receive BBC-2 satisfactorily "provided they have a properly installed [10-element] aerial of the correct type and a correctly adjusted receiver with a reasonable performance." Incidentally, the effect of an inadequate aerial was found to be much more severe on u.h.f. reception than on v.h.f.

These are some of the findings of a survey carried out by the Engineering Division of the B.B.C. in order to obtain reliable information on the standard of BBC-2 reception in viewers' homes, and where possible to compare this with the reception of BBC-1 and ITV.

Some 40 technical staff were employed in this operation; they visited and checked receiver installations at over 1,500 households. The sample of households was provided by the B.B.C's Audience Research Department after a preliminary investigation to find homes where there were BBC-2 receivers. They were selected from areas within the 70 dB (reference 1 μV/m) field-strength contours of the transmitters, avoiding known major pockets of poor reception which will be served by BBC-2 relay stations. The contour corresponding to a median field strength of 70 dB above 1 μV/m represents the approximate limit of the service area of a u.h.f. transmitter.

The grade of reception was assessed by the viewer as well as by the more critical B.B.C. technical staff and the results recorded on detailed questionnaires. These were overall assessments resulting from a combination of all factors which affect the quality of the picture seen on the viewer's receiver.

Unsatisfactory BBC-2 reception resulted in many instances from the failure of viewers to adjust their receivers for best results. This difficulty appeared to be mainly concerned with receivers having continuous tuning over the u.h.f. band but some receivers with push-button pre-set tuning were also giving trouble due to mechanical instability.

Where outside aerials are used BBC-2 reception was technically assessed as being as good as, or better than, BBC-1 and ITV reception at 59% and 60% respectively of the total households investigated. In a further 24% of the households BBC-2 reception was only marginally worse than BBC-1 and ITV. The fact of BBC-2 being worse than BBC-1 and ITV does not necessarily mean it was unsatisfactory. As the survey was carried out during the winter when there is no sporadic E interference from distant co-channel stations in the v.h.f. band, the immunity of u.h.f. reception from this form of interference and the advantage over v.h.f. Band I reception, which would have shown up in summer, was of course not evident.

The survey confirmed that multipath propagation causing "ghosting" which is frequently troublesome in the v.h.f. bands, is not a serious problem with BBC-2 reception on u.h.f.

STROBOSCOPIC HOLOGRAM INTERFEROMETRY FOR TRANSDUCERS

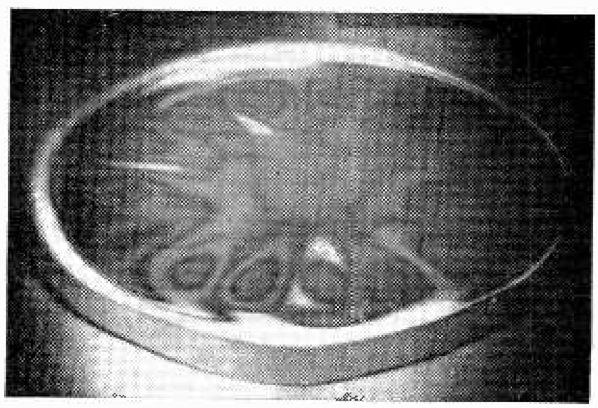
HOLOGRAPHY has made possible the formation of interference patterns of moving objects with rough surfaces; for instance, loudspeaker diaphragms and other electro-acoustic transducers.

One method of recording an interference hologram is to expose two consecutive holograms on the same photographic plate, one before and one after the object has been displaced or distorted. Alternatively, one exposure can be taken with the object in its normal position and the plate replaced in its original position. Viewing the object through this hologram then gives an interference pattern when the object is displaced. The brightness of such fringes, incidentally, is $I = (J_0[4\pi d/\lambda])^2$, where d is the vibration amplitude, and the fringes are spaced at $\lambda 2$ intervals, with nodes showing as the brightest part.) Such patterns can be used to investigate and measure small displacements and modes of vibration.

Potentially greater application is envisaged at the N.P.L. for the technique in which a hologram is recorded with a stationary object, and then the object, now moving, is viewed through the processed hologram. If the laser illumination is interrupted with the same frequency as that of the object a stroboscopic effect is obtained.

The illustration shows a time-averaged hologram reconstruction of an elliptical loudspeaker vibrating at 1 kc/s. The fringe pattern shows contours of equal vibration amplitude spaced at half wavelength intervals on the loudspeaker cone.

Interferometry of this type is of interest because the surfaces investigated need not be smooth and regular, as required for normal interferometry, and even irregular living structures can be investigated.



STEREO SIGNAL SIMULATOR

Silicon transistor design for setting up stereo decoders and tuners

By D. E. O'N. WADDINGTON, A.M.I.E.R.E.

IN an earlier article, [1]the author pointed out the fact that the performance of a stereo decoder could best be optimized using a known multiplex signal. Although the B.B.C. are transmitting regular test signals, they do not provide the entire answer as it is necessary to have a "good" receiver to make use of them. True multiplex signal generators are expensive and, for the amateur, relatively hard to come by. In view of this, the author decided that there could be a use for a circuit which would generate a simulated multiplex signal, i.e. a signal which, although not true multiplex, exhibits multiplex properties.

The first step was to decide what kinds of signal would be most useful. For setting up purposes the signal should consist of an audio frequency (e.g. 1 kHz), 19 kHz pilot tone and $L - R$ information to give either left or right hand channel simulation. In addition to setting up, a distortion check is desirable. In order to do this it is only necessary to provide a low distortion audio frequency signal and the 19 kHz pilot tone. These signals are all that are necessary to set up the decoder but if this source is to be used for setting up f.m. tuners as well, it would be useful to include a frequency modulated r.f. oscillator. From the above signal requirements it was then possible to draw out a block diagram of the complete signal simulator, see Fig. 1.

19 kHz PILOT OSCILLATOR

As low cost, as well as simplicity, was considered to be an essential, the 19 kHz oscillator was designed using a simple *LC* circuit. Ideally, of course, a quartz crystal should be used to control the frequency. However, by using a polystyrene capacitor and a ferrite cored inductor, it is possible to produce a tuned circuit having a low temperature coefficient, of the order of 1 Hz/deg C. Although this would not be good enough for transmission purposes, it is perfectly adequate for setting up decoders, particularly as it is possible to synchronize the frequency with that of a stereo transmission if this is felt to be essential. The oscillator was designed around the basic Colpitts configuration but, in order to ensure that the output waveform was reasonably free from distortion, a simple a.l.c. circuit was included. This was achieved by connecting a diode D1 in series with the feedback path to the emitter of Tr1. When the circuit is first switched on, this diode is forward biased with the result that oscillation starts normally. When, however, the amplitude of oscillation is such that the voltage developed across R_6, due to rectification by D2 and D3, approaches the voltage at the emitter of Tr1, the diode D1 starts to turn off thus limiting the feedback and hence the oscillation amplitude. It is interesting to note that this amplitude limiting action has a further desirable effect in that it helps to ensure that the frequency of oscillation is more or less independent of supply voltage. In the prototype it was found that the frequency only varied 4 Hz for a 20% supply voltage change.

FREQUENCY DOUBLER

The full wave rectifier (D2 and D3) which provides the a.l.c. voltage actually has a more important role to perform, namely, that of frequency doubler. The rectified wave form is taken to the base of Tr2, the collector circuit of which consists of a transformer with a tuned primary. The secondary of this transformer feeds through a phase reversing switch to the mixer. In order to prevent the operation of the switch in the secondary circuit from upsetting the tuning of the transformer and thus the phase relationship between the pilot tone and the sub-carrier, a special winding method was devised (see Fig. 2). The secondary was wound on first in two

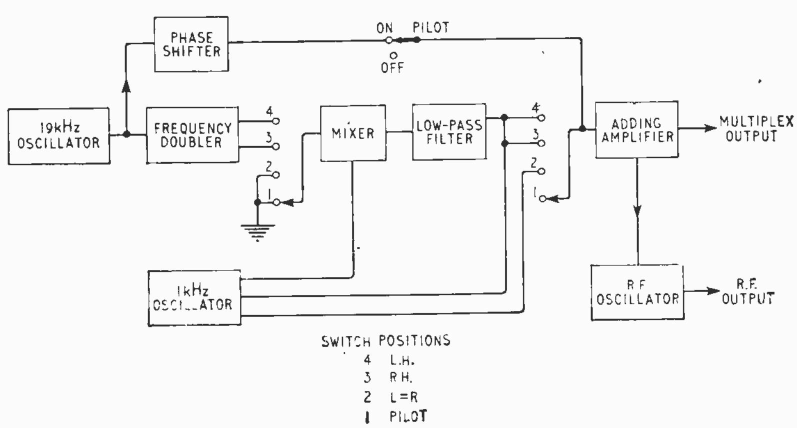
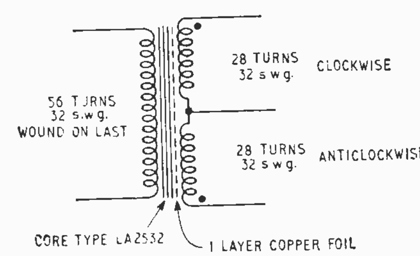


Fig. 1. Block diagram of stereo signal simulator.

Fig. 2. Winding detail for T2.



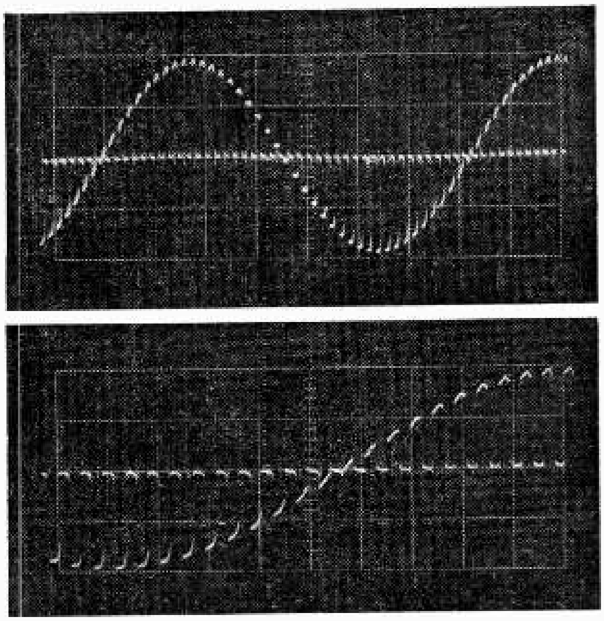


Fig. 3. Top: Waveform at Tr3 collector. Below: Expanded trace of collector waveform.

sections side by side, arranged so that the start of each winding was near the former and the finish on the outside. In order to achieve this and yet to maintain the correct phase relationship, these two halves are in fact wound in opposite directions. Between the secondary and primary is an electrostatic shield consisting of one layer of copper foil. This winding method has the effect of balancing the secondary so that the operation of the phase reversing switch no longer reflects a capacitance change into the primary and the phasing of the pilot tone and sub-carrier is maintained within reasonably close limits.

MIXER AND LOW-PASS FILTER

As a simple suppressed carrier mixer was required, the shunt gate was chosen, its performance being adequate. So that the loading presented to the secondary of T2 should appear more or less constant throughout the cycle the diode D4 in series with a 22 kΩ resistor was included. The output of this mixer is fed to a low pass filter, the function of which is to remove the harmonic components from the switching waveform. As the phase response of this filter is of prime importance it was decided to trade rejection against phase response and to use a slightly higher cut-off frequency than would have been expected. In order to compensate slightly for this a Papoulis class L filter[2] was chosen. While this configuration retains a relatively linear phase and amplitude response in the pass band, the amplitude response falls off more rapidly outside than the conventional Butterworth design. This filtering does not remove all the distortion from the output but, for all practical purposes it is good enough. When the first model was built it was found that although the signal at the shunt gate appeared to be correct (see Fig. 3) the output from the filter had poor channel separation. Naturally enough the filter was blamed, but when the relative amplitudes of the frequency components before and after the filter were examined using a wave analyser, it was found that in point of fact the shunt gate mixer was not providing the required output. A quick examination of the arithmetic of shunt gate mixers showed that the results were as would be expected and that this effect would need to be compensated for. Fortunately no phase complications arise and all that is necessary is to add the requisite amount of unmodulated signal, in phase, to the signal at the output of the filter. This is done *via* R_{20} and RV2.

ADDING AMPLIFIER

The function of this amplifier is to assemble the final output signal. It consists of a three stage amplifier with feedback from the emitter of the output stage directly to the input thus making the input a virtual earth. The interesting feature of the output stage is the level control circuit. By making the collector resistor of Tr6 a 600Ω potentiometer with the collector connected to the wiper, it is possible to vary the output level from zero to maximum while leaving the output impedance fixed at 600Ω. Although this circuit has the disadvantage that there can be no overall negative feedback, the performance is adequate. With an output of 2 V r.m.s. the distortion introduced is less than 0.08% second harmonic and 0.01% third.

PILOT TONE

The pilot tone is taken, *via* a phase shifting network, from the secondary of the 19 kHz oscillator transformer. The range of variation available from this phase shifting network is more than sufficient to compensate for any phase shift in the frequency doubler and mixer circuits. As the correct phasing is most important it should only be set after all other tuning adjustments have been made. The method of setting the phase is as follows:—

1. Set the main selector switch to *L* or *R*, disconnect one end of R_{17} and connect the output to the *x* input of an oscilloscope.
2. Connect the *y* input of the oscilloscope, preferably *via* a high impedance probe, to point A.
3. Adjust RV1 until the waveform is as shown in Fig. 4. It may be necessary to adjust the value of R_{11} in order to obtain the correct proportion of pilot tone. On left or right hand channel, the pk-pk value of the pilot tone should be 10% of the pk-pk value of the waveform.

A.F. SOURCE

This need not be included in the signal simulator as any a.f. source providing up to 0.5 V r.m.s. may be used. However, for the sake of completeness an audio oscillator circuit is included. The circuit is a fairly conventional Wien bridge oscillator. The number of phase shifts within the lop has been reduced to a minimum by permitting both a.c. and d.c. feedback through the thermistor. The d.c. component, however, is so small as to produce negligible additional heating of the thermistor so that the amplitude control characteristic is unimpaired. The frequency of oscillation is approximately 1 kHz.

R.F. OSCILLATOR

The circuit used is a modification of the Clapp oscillator arranged so that the output is 50Ω, and so that the tuned circuit acts as a π section filter thus ensuring that the output wave form is a reasonably good sinusoid. A feature of this design also is the method of confining the radio frequency currents so that there is no necessity for additional decoupling components. Frequency modulation is accomplished by means of a variable capacitance diode connected across the main tuning capacitors. In order that the modulation shall be reasonably linear, a fixed bias is applied to this diode in addition to the modulation voltage. The frequency deviation is set by means of RV3. The easiest way to set this is to use a f.m. receiver with a known discriminator characteristic and to measure the pk-pk voltage output with only the pilot tone as modulation.

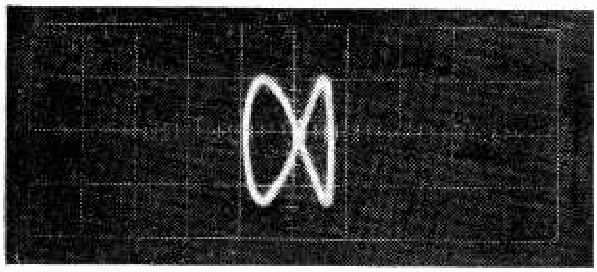


Fig. 4. Lissajus figure showing correct pilot tone phasing.

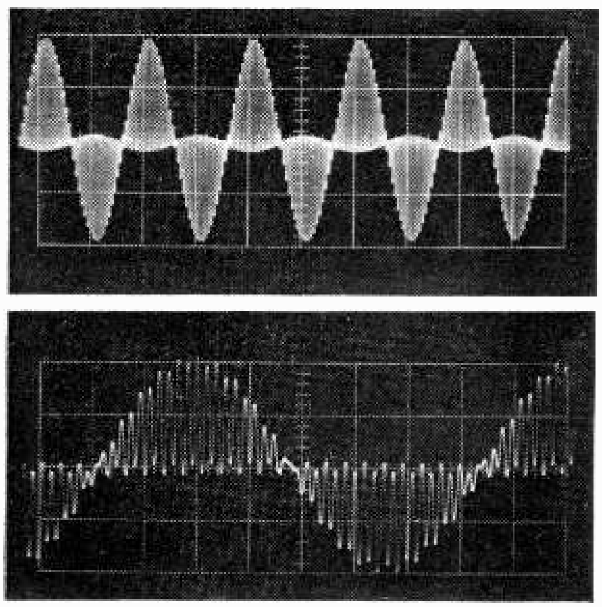


Fig. 5. Upper trace: output signal with incorrect compensation. Lower trace: output signal with correct compensation and 19 kHz pilot tone added.

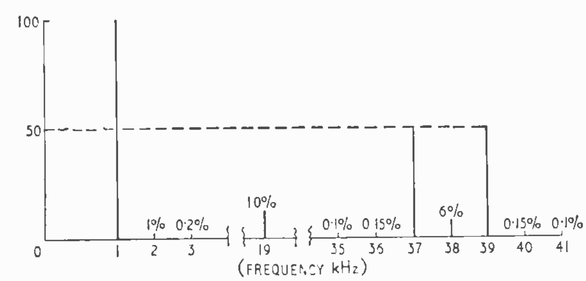


Fig. 6. Spectrum of simulator output with 1 kHz modulation of right-hand channel.

SETTING UP

There are only four adjustments which need to be made: the first is to set the frequency of the 19 kHz oscillator. This should be set as exactly as possible by adjusting the core of T1. If available, a frequency counter is the ideal instrument for the job. In the absence of a counter, however, the best method is to use a Lissajous figure on an oscilloscope. The pilot tone from a stereo broadcast makes the ideal standard if this method is to be used. The next setting is the frequency doubler. The core of T2 should be adjusted to give a maximum output to the mixer.

The channel separation depends on two settings, namely, the pilot tone phasing which has already been described, and the proportions of components in the composite signal. This is set up either on the left or right hand channel with the pilot tone switched off. The method is to apply a modulation of 1 kHz and to view the overall output on an oscilloscope (see Fig. 5). RV2 is then adjusted so that the "base line" of the signal is straight. In order to obtain optimum channel separation, it is necessary to expand the picture in the *y* direction to judge when the best setting has been made.

LIST OF COMPONENTS

Signal Simulator			
R_1	8.2 kΩ	C_1	0·1 μF Mylar
R_2	18 kΩ	C_2	0·01 μF ± 1% polystyrene
R_3	10 kΩ	C_3	2 μF 12 V
R_4	4.7 kΩ	C_4	150 pF polystyrene
R_5	10 kΩ	C_5	2 μF 12 V
R_6	6.8 kΩ	C_6	0.1 μF Mylar
R_7	8.2 kΩ	C_7	As C_2
R_8	68 kΩ	C_8	0.1 μF Mylar
R_9	15 kΩ	C_9	1.6 nF ± 1% polystyrene
R_{10}	1 kΩ	C_{10}	860 pF ± 2% polystyrene
R_{11}	1 MΩ	C_{11}	500 μF 6 V
R_{12}	10 kΩ	C_{12}	500 μF 6 V
R_{13}	10 kΩ	C_{13}	330 pF ± 5% polystyrene
R_{14}	22 kΩ	C_{14}	10 nF
R_{15}	10 kΩ	C_{15}	500 μF 12 V
R_{16}	10 kΩ	Tr1-Tr6	BC 108
R_{17}	2.2 kΩ		
R_{18}	1 kΩ	D1	OA47
R_{19}	3.3 kΩ	D2-D4	1s44
R_{20}	33 kΩ	L1	11.1mH. 141 turns of 36 s.w.g. Core LA2532.
R_{21}	6.8 kΩ		
R_{22}	1 kΩ		
R_{23}	1.8 kΩ	T1	Primary: 112 turns of 36 s.w.g. tapped at 56 turns. Secondary: 112 turns of 36 s.w.g. tapped at 56 turns. Core type LA 2532
R_{24}	10 kΩ		
R_{25}	10 kΩ		
R_{26}	6.8 kΩ		
RV1	250 kΩ		
RV2	47 kΩ		
RV3	250Ω	T2	See Fig. 2.
Audio Frequency Oscillator			
R_{27}	22 kΩ	C_{16}	25 μF 6 V
R_{28}	22 kΩ	C_{17}	33 nF ± 5% polystyrene
R_{29}	4.7 kΩ ± 5%	C_{18}	33 nF ± 5% polystyrene
R_{30}	4.7 kΩ ± 5%	C_{19}	680 pF ± 10%
R_{31}	5.6 kΩ	C_{20}	100 μF 6 V
R_{32}	510 Ω	C_{21}	100 μF 6 V
R_{33}	33 kΩ		
R_{34}	5.6 kΩ		
R_{35}	390 Ω	Tr7	BC108
R_{36}	150 Ω	Tr8	2N3702
R_{37}	10 kΩ		
R_{38}	Thermistor STC type R53	Tr9	BC108
Radio Frequency Oscillator			
R_{39}	15 kΩ	C_{22}	1 μF
R_{40}	4.7 kΩ	C_{23}	8-20 pF
R_{41}	220Ω	C_{24}	150 pF
R_{42}	100 kΩ	C_{25}	3.3 pF
R_{43}	33 kΩ	C_{26}	150 pF
R_{44}	220Ω	C_{27}	100 pF
R_{45}	43Ω	Tr_{10}	2N706
R_{46}	43Ω	D5	BA110
R_{47}	10Ω	L_2	4t 22 s.w.g. enam 0.3in dia. 0.3in long
All resistors 10% ½W types			

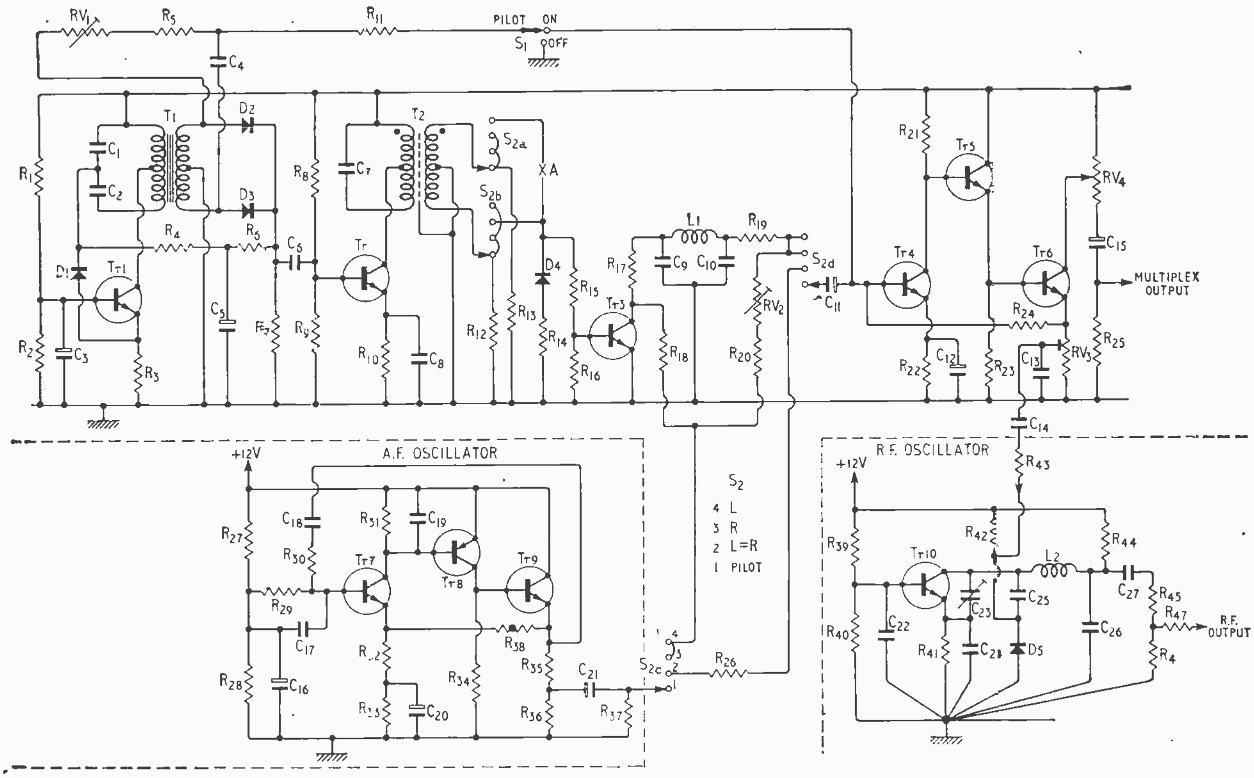


Fig. 7. Complete circuit of simulator showing a.f. and r.f. (carrier) oscillators separately

PERFORMANCE

In the experimental model the following performance figures were measured with a modulation of 1 kHz.

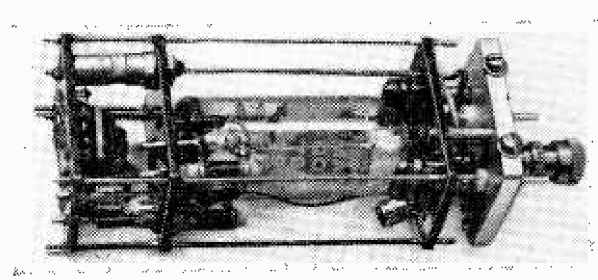
1. Distortion on signal $L=R$: 0.1%.
2. The spectrum of the signal in the right hand channel is shown in Fig. 6.
3. The channel separation was 35 dB.
4. The output of the r.f. section was 10 mV and the channel separation had not deteriorated to any measurable extent.

REFERENCES

1. "A Stereo Decoder," D. E. O'N. Waddington. *Wireless World*, Jan. 1967.
2. "Comparison of Five Methods of Low-pass Filter Design," A. G. J. Holt. *Radio and Electronic Engineer*, March 1964, p. 167.

Temperature Compensation Method for Oscillators

IN some applications frequency stability of crystal oscillators by ovens is not convenient, for instance, where short heating time is required or because of power limitations. Stability in such cases can be had by arranging for a compensating network, incorporating a temperature sensitive element, to provide a control voltage which is applied to a frequency compensating capacitance diode. This method, however, can only be used if the frequency variation is small, as in the case of selected AT-cut crystals. Since this selection is wasteful and expensive a method has been developed at the Marconi Research Laboratories which can be applied to all crystals with a parabolic frequency—temperature law. If two crystals with different turnover frequencies are connected in parallel then the temperature range over which compensation can be obtained is increased. The compensated frequency is, however, higher than the turnover frequency of the parabola. As an example of the technique an oscillator was shown which used two 8 Mc/s crystals with turnover temperatures of −44 and +84°C. With a circuit capacitance adjusted to give maximal flatness to the f-T curve stability was ±1 in 10^6 over a range −26 to +66°C.



Colour TV Standards Converter

Electronic field rate conversion in new B.B.C. equipment for changing North American to European transmission standards

AS a result of a new development in processing complete television fields, it is now possible to convert North American 525-line, 60 fields/second, N.T.S.C. colour television pictures into European 625-line, 50 fields/second PAL colour pictures (or vice versa) by entirely electronic means. This major technical achievement in the transformation of television signal information is the work of the B.B.C. Designs Department—in particular a team led by Peter Rainger—and it makes London a world centre of expertise in the specialized technology of standards conversion. The equipment is installed in a laboratory near Broadcasting House, and at the time of going to press is scheduled to be put into operation on 10th September to convert to European standards live colour pictures relayed from the U.S.A. by the Early Bird satellite—the programme being the World Golf Series finals in Cleveland, Ohio. Meanwhile, *Wireless World* has seen a demonstration of the equipment in which live and recorded colour programme material was sent from the Canadian Broadcasting Corporation's Toronto studio centre to Broadcasting House via Early Bird. The converted colour pictures were astonishingly good, considering the enormous length of the circuit and the complexity of the equipment they had passed through. Comparison with the received 525/60 pictures also displayed during the demonstration showed that any slight defects that could be discerned were those existing in the signals before conversion.

The principal units of the conversion equipment are shown in Fig. 1. It is the first unit on the left, the "field store converter," which is the new development referred to above. This converts the 60 fields/sec incoming picture into a 50 fields/sec picture (without changing the number of lines), and its principle of operation will be described later. The resulting 525/50 signals are fed into an N.T.S.C. decoder, similar in principle to that in an American domestic colour receiver, and here the luminance and chrominance components are separated and the *I* and *Q* chrominance signals obtained by synchronous demodulation. The luminance component is passed into an electronic line store converter—a B.B.C. designed equipment of the type that has been in operation for some years*—which changes the black-and-white picture to the 625-line standard. A second electronic line store converter changes the *I* and *Q* chrominance signals to the 625-line standard. All three components, now on 625-line standards, are fed into a PAL colour encoder, from the output of which is obtained the European 625-line 50 fields/sec PAL colour signal. Alternatively the same three components could be encoded to provide a 625-line SECAM picture for

The complete conversion equipment in a B.B.C. laboratory near Broadcasting House, London

* See "Electronic Standards Conversion," *Wireless World*, October, 1963, p.494.

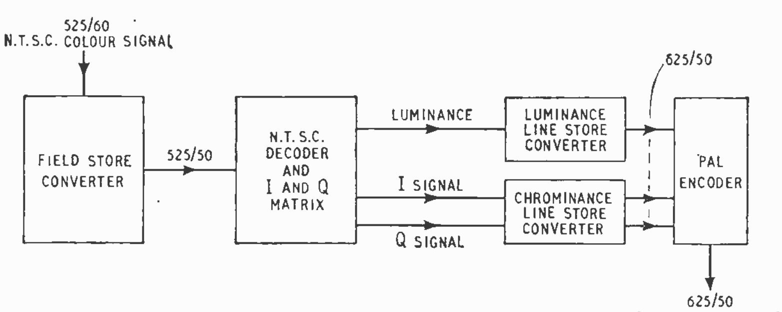


Fig. 1. Schematic of the complete conversion system The new electronic field store converter is the first unit in the chain.

distribution to those countries requiring it. If only black-and-white signals are incoming to the equipment, the luminance line store converter alone provides the 625/50 picture.

Redistributing fields in time

In the field conversion process the basic problem is, of course, that there are 60 American fields to every 50 European fields, or, in a 0.1 sec interval, six American to five European (see Fig. 2). A related problem is that the American field occupies less time than the European field. The field-store converter deals with this situation by redistributing the 525/60 fields in time so that they fit into the time "slots" for fields laid down by the European standard. Since the 525/60 fields are shorter, this means that they must be temporarily stored—hence the name "field store converter"—and read out from the store at the required 50 field/sec rate.

The process can be understood more precisely from Fig. 2, which shows any 0.1 second interval, encompassing six American and five European fields. If the two systems start scanning simultaneously, the first American field will have been completed slightly before the first European field. Consequently the information can be transferred directly without shifting in the time scale. The second American field, however, begins slightly before the second European field, should begin—16.6 ms after the start of the sequence as opposed to 20 ms. A delay of just over 3.3 ms is therefore introduced, as shown, so that the start of American field No. 2 is delayed until just after the correct instant for the start of European field No. 2. This process is continued, the delays increasing with successive fields, until American field No. 5 becomes European field No. 5.

In the explanation of Fig. 2 so far, American field No. 6 in the cycle has not been accounted for. If this were simply discarded the omission of one field in every six would result in a jerky picture, particularly on fast movement. To overcome this difficulty a delay of 16.6 ms is introduced to make American field No. 6 occur at the

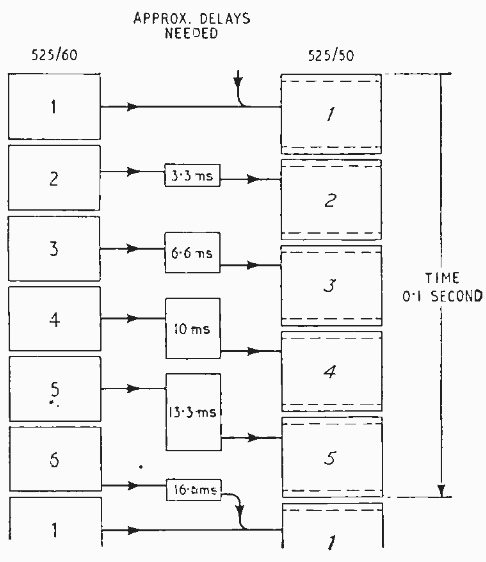


Fig. 2. The sequence of delays necessary to change the timing of the American fields to that of the European fields. (The second stage of interpolation is not shown).

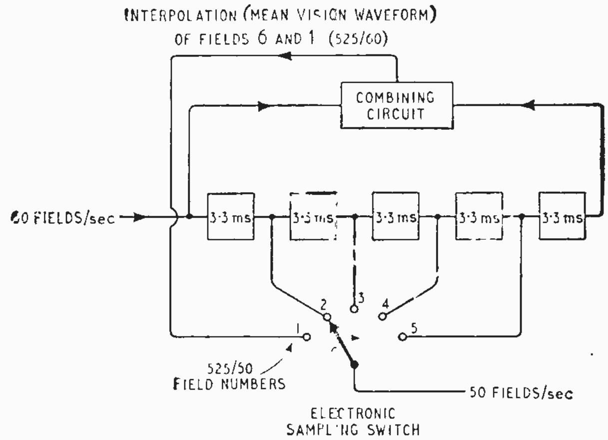


Fig. 3. Principle of the electronic system of the field store converter (not showing second stage of interpolation).

same time as American field No. 1 in the next six-field cycle, then the two fields are combined to form an "interpolated" version (the mean value of the No. 6 and No. 1 waveforms) which becomes the No. 1 field in the next Suropean cycle. This interpolation process is repeated for European field No. 2, and as a result any jerkiness that would otherwise appear is smoothed out in the final picture.

Reduction of picture size

As the number of lines per field is not altered by the introduction of the delays, and the 525 lines occupy less time than the 625 lines in a European field, there will be a space at the top and bottom of the outgoing 525/50 picture, as indicated by the dotted lines. Consequently the height of the outgoing picture is too small for the width, and as a result of this geometrical distortion any circular object would appear oval. This defect, however, is rectified later in the line store converters, which compress the picture in a horizontal direction. The net result, as could be seen at the demonstration, is that the picture geometry is corrected, but there is a black border all round the picture. This is a fundamental limitation of the system which must be accepted but will probably be eliminated in later, more complex, converters.

The basic principle of the electronic system of the field store converter is illustrated in Fig. 3. The incoming signal is passed through a chain of five delay lines of approximately 3.3 ms each, giving a total delay of 16.6 ms or one complete American field. Glass ultrasonic delay lines are used for the 3.3 ms units, and the 525/60 signal is passed through them as amplitude modulation on a 24 MHz carrier. An electronic switch samples the delay-line outputs in turn in such a way that the required delays shown in Fig. 2 for the successive fields are progressively built up. The intervals in which the "wiper" of the electronic switch "moves" from one "stud" to the next are the 1/5-field gaps indicated by the dotted lines in Fig. 2. When a field has passed through the chain it has been delayed by one complete field period, so American field No. 6 emerges from the line at the right time to be combined with American field No. 1 in the next cycle. The two are combined as shown and the interpolated version is picked up by the electronic switch as European field No. 1. By recirculation of the information through the delay chain, the interpolation process is repeated to form European field No. 2.

WORLD OF WIRELESS

Mariner V Communications

MARINER V launched 14th June from Cape Kennedy, Fla., U.S.A., is expected to pass Venus on 19th October after travelling 216 million miles. This 540-lb spacecraft will be about 2,500 miles from the planet's surface on the latter date. Two-way communication with Mariner V is accomplished with a radio link between Earth tracking stations and a dual transmitter, single receiver, radio system in the spacecraft. Communications are transmitted in binary digital form, and radio command pulses to Mariner are decoded in a command sub-system—on board—and routed to their proper destination. The spacecraft is capable of accepting 29 direct commands and a quantitative command (for mid-course trajectory manoeuvre). A 100-channel telemetry sub-system can sample 90 engineering and science measurements; the data gathered, which includes voltages, pressures, currents, temperatures and other values measured by telemetry sensors and scientific instruments, is prepared for transmission by a data encoder also aboard the spacecraft. The tape recorder uses 50 feet of magnetic tape in an endless loop, and science measurements prepared by the data automation system are recorded simultaneously on two tracks at $66\frac{2}{3}$ bits per second. Playback of data will take approximately 36 hours at the rate of $8\frac{1}{3}$ bits per second, playback is from one track at a time at a tape speed of 0.01 in per second. The spacecraft S-band receiver will operate continuously during the mission at 2116 Mc/s. It will receive Earth commands either through the low or high-gain aerial.

Television Teaching Aid

AN audio-visual system called E.V.R. (electronic video recording and reproduction) is to be manufactured and marketed by Ciba Ltd., of Switzerland, Columbia Broadcasting System, Inc., of America, and Imperial Chemical Industries who have formed a partnership in the U.K. This system is so designed that television sets in homes and schools can be used to display recorded programmes from ciné film and video tape at low cost.

The E.V.R. system uses an electron beam recorder which takes off information from a television camera, magnetic tape, or cinema film, and uses this information to generate an E.V.R. master in colour or black-and-white on 8.75 mm unperforated thin film. This film will be produced by Ilford Ltd. (joint subsidiary of I.C.I. and CIBA), and it will be loaded into cartridges seven-inches in diameter and about half an inch thick. The cartridge is inserted into a player attached to the aerial terminals of a television receiver and the information displayed on the screen. The film from the cartridge is automatically threaded, played, rewound, and the cartridge then ejected from the player. The film moves at a speed of five inches per second, can be stopped at will, and a still frame held. It is stated that an E.V.R. cartridge is capable of carrying up to one hour of black-and-white programme or a half hour of colour. Original colour material is recorded in monochrome and reproduced in colour on colour television sets.

For teaching purposes particularly, it is interesting to note that one cartridge player can be used to play back information to a number of television receivers simultaneously. It is also possible to use film strips or ciné film with this machine.

Demonstrations of the system are expected next spring, and cartridges and players (prototype production types to be made by Thorn Electrical Industries) will be available in the spring of 1969.

Colour Television Test Card (F)

FEATURES of the B.B.C. 625-line colour test card include coloured edge castellations to check colour synchronization effects and picture size; a grid with corner diagonals and centre circle enabling picture geometry to be assessed; a "letter box" pattern to test low-frequency effects, and a six-step grey scale, with frequency gratings designed to produce signals of approximately square waveform corresponding to frequencies of 1.5, 2.5, 3.5, 4.0, 4.5, and 5.25 Mc/s. A colour picture is contained in the centre circle to facilitate the assessment of overall picture quality and flesh tones.

In the information sheet 4306(1) July 1967 including a coloured facsimile of the test card (5s for six copies) received from the B.B.C. Engineering Information Dept., the following points are discussed. (1), checking decoder performance, (2) reference generator faults, (3) sync separator performance, (4) resolution, (5) convergence checking, (6) the colour picture, (7) aspect ratio, (8) picture size, (9) contrast, (10) resolution and bandwidth, (11) scanning linearity, (12) line synchronization, (13) low-frequency response, (14) reflections, and (15) uniformity of focus.

Additional comments and information on the use of the test card which may be helpful to service and installation technicians have been issued by the British Radio Equipment Manufacturers' Association, 49 Russell Sq., London, W.C.1. These comments concern colour bars, resolution, convergence, picture size, and contrast.

PAL and SECAM programmes will be **interchangeable,** state AEG-Telefunken, of Frankfurt, Germany, through a specially designed coder-decoder. Dr. Walter Bruch, inventor of the PAL colour system, has developed this device which will transform signals from the French SECAM system, so that they can be received by television receivers working on the PAL system. It will also be possible to exchange programmes in the reverse direction without any degradation. Although the principle of this coder-decoder has already been demonstrated, it would be some time before the unit reaches the manufacturing stage.

The programme for the fourth **Ultrasonics for Industry** conference and exhibition has been compiled by our associate journal *Ultrasonics* in collaboration with the Acoustics Group of the Institute of Physics and the Physical Society. The conference—to be held at St. Ermin's Hotel, London, on October 31st and November 1st—will consist of 16 thirty-minute lectures, ranging from production and industrial uses of ultrasound, through hazards of airborne ultrasound, to animal soner and sub-bottom surveys by acoustic methods. Finally applications such as the ultrasonic interferometer, and medical diagnostic equipment will be discussed. Application forms are available from the organiser, 'Ultrasonics for Industry' Conference and Exhibition, Dorset House, Stamford Street, London, S.E.1.

A satellite **earth station** for Mount Margaret in Kenya is announced by the East Africa Common Services Authority. To be operational by early 1970, the construction and operation of this station will be the responsibility of the East African Telecommunication Company Ltd. Tenders are to be invited from manufacturers for equipment and installation.

Comprehensive performance data, reliably measured under real or simulated operating conditions are essential to using instruments efficiently, or promoting their use without inviting misapplication. S.I.R.A. (British Scientific Instrument Research Association) have provided such an evaluation service for several years, and in view of the internationally expanding interest in this field of applied science, are arranging for a one-day symposium in London on 10th November, the title will be **Progress in Instrument Evaluation.** Six papers will be presented in two sessions, covering topics such as specifying and proving instrument performance, and the importance of environmental testing. Further information from Head of Industrial Communications Group, SIRA, South Hill, Chislehurst, Kent.

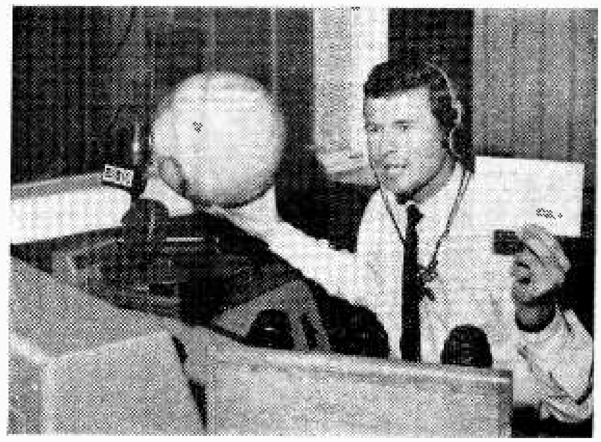
American f.m. Success Story.—Statistics from the American Electronic Industries Association record that in the first six months of the year, the proportion of radio receivers in the U.S. market with f.m. facilities was 39.3%, the highest so far recorded. From 1961 (with 119,000) to 1966 (with 1.29 million), clock radios in the market with f.m. features increased by 984%. Mr. Wayman, spokesman for the E.I.A. Consumer Products Division, said that "we're heading for a 50 million radio sets year," compared with 20 million sets in 1957. He admitted that although technology and styling had a lot to do with this growth, it was also true to say that "a great influence in the return of radio had been the superior sound capabilities of f.m. and stereo transmission."

Colour Television Engineering.—A course of 26 lectures covering the basic engineering requirements for colour television will commence on 9th October at 18.30 at the Northern Polytechnic, Holloway Road, N.7, and on Monday evenings thereafter. Specialist lectures will be given by well-known engineers from industry and broadcasting organizations. The subject matter of these lectures will range from a resumé of black-and-white technique, through a consideration of N.T.S.C. and PAL systems, display systems, receiver design, picture originating equipment, to test equipment, aerial systems, and video-tape recording. A good fundamental knowledge of black-and-white technique is required, and minimum entry requirements are Final R.T.E.B. Certificate or Final C. & G. Telecommunications Technician's Certificate. Fee for the course is £2.

International Conference on Colour Television.—This conference will be held in Paris from April 1st to 5th next year in connection with the International Exhibition of Electronic Components and is sponsored by F.N.I.E. (Electronic Industries Association of France). The scientific and technical aspects of the development of colour television will be considered under three main headings: the reproduction of pictures in colour; television equipment and the exploitation of broadcasting networks; and colour television reception. Information concerning the submission of papers to this conference can be obtained from Colloque International sur la Télévision en Couleur, 16 rue des Presles, 75-Paris 15.

Colour Television Fair.—A two-week colour television exhibition is to be held by Mullard Ltd., at Mullard House from November 17th to December 2nd. This is primarily a show for the public, and set manufacturers will be displaying sets, many of them working in domestic settings. Both the B.B.C.—with an information stand—and the independent television companies are supporting this fair, where there will be continuous shows of colour programmes. Details of ticket distribution will be announced later.

"**Non-Destructive Testing**" was published for the first time in September, by Iliffe Science and Technology Publications Ltd., 32 High Street, Guildford, Surrey. This new quarterly journal will provide full coverage of the techniques, economics, and management of non-destructive testing. Annual subscription rates are: U.K. £6, overseas £10.



Malcolm Nisbet, compère of the B.B.C. World Service's latest programme World Radio Club, indicates the target area of his programme and the club card. He gives DX news as well as tips to newcomers on how to improve shortwave reception.

An exhibition of American **electronic production equipment** opens on November 13th at the Royal Lancaster Hotel, London. About 50 American manufacturers are expected to participate in this exhibition, which covers such items as spray etches, precision etches, screen printers, welding and encapsulating equipment, integrated circuit processing equipment, and other machinery for producing complex circuit boards, miniature transistors, diodes and packaged circuits. Open from 10.00 to 17.00 on the first day, and from 10.00 to 18.30 on November 14th to 18th. Information and tickets may be obtained from the Director, United States Trade Centre, 57 St. James Street, London, S.W.1.

A three-year research programme which will include an investigation into the fundamental physics and properties of materials which limit the **performance of magnetic recording heads,** is to be undertaken at the Welsh College of Advanced Technology, Cardiff. This research is being sponsored by Data Recording Instrument Co. Ltd., manufacturers of recording heads for data processing and general industrial applications.

Hong Kong Colour TV. According to the July issue of *The World of Hong Kong*—the first of a series of monthly newspapers to be published by the Hong Kong Government Information Services—the Colony will be transmitting at least 40 hours of colour television programmes, weekly when a second channel starts up later this year. Of this number of hours, 32 will be filled with original programmes in Chinese.

Redbridge Amateur Radio Society is to be the title of a club being formed in the London borough of this name. Interested readers are invited to write to the Secretary, T. L. Stoakes, 62 Dudley Road, Ilford, Essex.

Standard Frequency Transmission.—We regret the misalignment, relative to the time scale, of the modulation schedules for WWV and WWVH in the diagram on p. 446 of the September issue.

An error occurred in the parts list of the article "**Low Distortion RC Oscillator**" by P. F. Ridler that appeared in the August 1967 issue. VR1 should have been described as a 50 kΩ, 2-gang, matched, curve A, potentiometer, Type CLR/192/17.

PERSONALITIES

W. J. Morcom, B.Sc.(Eng.), F.I.E.E., for the past two years Marconi's chief engineer (telecommunications) has been appointed manager of the company's Radio Communications Division. Mr.

W. J. Morcom

Morcom joined the company as a design engineer on broadcasting transmitters in 1933 after graduating from Imperial College on a Whitworth Scholarship from a Naval Dockyard. During the second world war he was concerned with radio combat and jamming techniques and in 1947 became head of Marconi's transmitter design group. From 1956-1965 he was chief transmitter engineer.

Bernard Marsden, F.I.E.E., M.I.E.R.E., who has been with Associated Television Ltd. since 1955, latterly as group engineering controller, has joined London Weekend Television Ltd. as controller of operations. L.W.T. will, as its title indicates, be providing the weekend programmes for the London I.T.A. station to be relinquished by A.T.V. which will then be concentrated in the Midlands where they have so far operated only on weekdays. Mr.

B. Marsden

Marsden, who spent five years in commercial broadcasting before joining A.T.V., was previously in the domestic radio industry. From 1963 to 1967 he was technical controller of A.T.V.

P. Scargill, A.M.I.E.R.E., who joined Union Carbide Ltd. a year ago as sales manager for the U.K. for capacitors and semiconductors, has been appointed general manager of the company's Electronics Division. Prior to joining Union Carbide he was with Hughes International (U.K.) Ltd. The company also announces that **Dr. J. S. Wagener,** formerly general manager of the Electronics Division, has been appointed director, electronics, in Union Carbide Europe, Inc. in Switzerland.

English Electric Valve Company announces the appointment of **John Montgomery-Smith,** B.Sc., as a sales engineer dealing chiefly with photo-

J. Montgomery-Smith

multipliers and image intensifiers. Mr. Montgomery-Smith, aged 33, graduated in physics from Manchester University in 1956 and then joined the Marconi Company where he spent some time on radar receiver development. In 1961 he went to Mullard Ltd. as a sales engineer responsible for thyristors and special industrial valves and for the past four years has been commercial product manager of the Infra-Red and Special Semiconductors Department.

"In recognition of his devoted and eminent service in the advancement of engineering in motion pictures, television and in the allied arts and sciences," the Society of Motion Picture and Television Engineers has elected **Dr. John G. Frayne,** an honorary member. Dr. Frayne, who was born in 1894 in County Wexford, Ireland, emigrated to the United States in 1914. He received his B.A. degree from Ripon College, Wisconsin in 1917. In 1922 Dr. Frayne received his doctorate in mathematics from the University of Minnesota. He joined the American Telephone and Telegraph Company in 1919, after service in the U.S. Signal Corps. In 1929 he joined Westrex Corporation. In collaboration with Halley Wolfe of Westrex, he wrote "The Elements of Sound Recording." Dr. Frayne, in collaboration with R. R. Scoville, developed the intermodulation technique of distortion measurements.

Arthur C. Clarke, whose original article "Extra-terrestrial relays" outlining the principles of synchronous communication satellites was published in *Wireless World* in 1945, was presented with a certificate of honorary fellowship of the British Interplanetary Society when he addressed members on September 7th on "Voices from the sky; past, present and future of communication satellites."

E. V. D. Glazier, Ph.D., B.Sc., F.I.E.E., head of the Physics & Electronics Department at the Royal Radar Establishment, Malvern, has been appointed director of the Establishment in succession to **G. G. Macfarlane,** C.B., B.Sc., Dr.Ing., F.I.E.E., who has become controller of research. Dr. Glazier, who is 55, entered the Scientific Civil Service in 1935 serving first in the G.P.O. as an executive engineer and was transferred in 1942 to the Signals Research and Development Establishment where he took charge of the research division in 1950. He was director of scientific research (electronics and guided weapons) in the Ministry of Aviation from 1957 until 1959 when he was appointed head of the Ground Radar Department at R.R.E. where in 1963 he became head of military and civil systems.

Dr. E. V. D. Glazier

Alfred R. Laws, who has been manager of Marconi's Radio Communications Division since it was formed two years ago, has joined the board of Racal Communications Ltd. as commercial director. Mr. Laws spent six years in the Post Office Engineering Department before joining the Royal Signals in 1943.

A. R. Laws

In 1960, he retired from the Services with the rank of Major, having been responsible for the design, installation and commissioning of the Commonwealth Communications Army Network (COMCAN)—a world-wide h.f. communications system.

This year's recipient of the David Sarnoff award is **Dr. James Hillier,** vice-president of RCA Laboratories, for his "pioneering research on the electron microscope, including both electron optics and biological microscopy, and for his accomplishments as a research director and his inspiration to scientists young and old." The David Sarnoff Award was established in 1959 between the Radio Corporation of America and what is now the Institute of Electrical and Electronics Engineers. The award consists of a gold medal, a bronze replica of the gold medal, and $1,000.

Captain L. S. Bennett, C.B.E., B.Sc., M.I.E.E., R.N. (Rtd.), education and training officer of the I.E.E. has retired after nine years' service on the staff of the Institution, and is succeeded by **K. C. Jones,** A.M.I.E.E., Grad.I.E.R.E., who has been deputy education officer for the past two years. Before joining the staff of the I.E.E., Mr. Jones spent six years in the radio and electronics industry and seven years as a lecturer in electronics and communications. He is currently engaged in part-time research on semiconductor technology at the University of Surrey.

E. R. Howlett has joined Rola Celestion Ltd., the Thames Ditton, Surrey, loudspeaker manufacturers, as sales manager. Mr. Howlett, who has been more than 20 years in the industry, was recently with R.C.A. (Great Britain) Ltd.

John R. Mills, B.Sc., has become director of the Signals Research and Development Establishment of the Ministry of Technology at Christchurch, Hants, in succession to **Cedric J. Stephens** who has been appointed chief scientific adviser at the Home Office. Mr. Mills, who is 51 and a graduate of King's College, London, entered the Scientific Civil Service in 1939. He was a member of the team set up at the Telecommunications Research Establishment (now R.R.E.) at Malvern to develop electronic systems for civil aviation; his particular interest being D.M.E. From 1954 to 1960 he was superintendent in the airborne radar department at R.R.E. In 1961 he became head of the Radio Department at R.A.E., Farnborough, and since 1965 has been head of the electronics branch of the Electronics and Instrumentation Division, Ministry of Technology, Headquarters.

Dennis H. Noyle, B.Sc., manufacturing manager of International Rectifier Company (G.B.) since 1964 has been appointed production manager. Mr. Noyle, who is 39, spent seven years in the field of geophysical exploration before studying at the Battersea College of Advanced Technology for his degree which he obtained (majoring in electronics) in 1960. He then joined Texas Instruments Ltd. and subsequently took charge of production of all germanium transistors. In 1963 he transferred to industrial engineering and was sent to the parent company in the U.S.A. for training. The following year he joined I.R. at Oxted.

D. H. Noyle

Charles A. Marshall, B.Sc., M.I.E.E., who for the past two years has been editor of *Systems & Communications* (which has now ceased publication) has become editor of *IEE News*. After graduating at Manchester University in 1945 he spent two years with Philips and then joined the staff of the Mullard Research Laboratories. He entered technical journalism in 1954 when he became technical editor and later editor of *British Communications & Electronics* which in 1965 was incorporated in our associate journal *Industrial Electronics*.

H. G. Foster, B.Sc., M.Sc., F.I.E.E., M.I.E.R.E., editor and latterly managing editor of *Electronic Engineering* for the past 18 years, has retired. A graduate of King's College, London, he was senior research engineer with the Dubilier Condenser Company for a short time before going to South Africa in 1936 to become lecturer in communication engineering at Cape Town Technical College. He returned to this country in 1939 to take up a similar position at

H. G. Foster

Birmingham University (from which he received his master's degree) where he stayed until joining *Electronic Engineering*. The new editor is **L. G. Poole,** until recently on the staff of *Control*.

D. M. B. Grubb has become assistant chief engineer, B.B.C. television developments in succession to **G. D. Cook,** who, as announced in the August issue, has been appointed assistant chief engineer, television operations. Mr. Grubb joined the B.B.C. in 1938 and, since December 1965, has been assistant superintendent engineer, television engineering operations.

OBITUARY

Lt. Col. Sir Albert George Lee, O.B.E., B.Sc., F.I.E.E., who died on August 28th, aged 88, was engineer-in-chief of the British Post Office for seven years until the outbreak of the Second World War when he became director of communications (research and development) at the Air Ministry. For several years after the War Sir George, who was knighted in 1939, was a member of the Scientific Advisory Council for the Ministry of Supply and from 1946 to 1955 was a member of the Royal Commission on Awards to Inventors.

Hugo Gernsback, the well-known editor-in-chief and publisher of the American journal *Radio-Electronics*, recently died in New York, aged 83. He has been called the father of science-fiction, and for many years produced an annual supplement to the journal forecasting the applications of electronics in the next century.

Semi-stabilized D.C. Supply

By G. W. SHORT*

THE simple stabilizer illustrated in Fig. 1 uses positive feedback to compensate the effects of load variations. The voltage reference is zener diode D1. This is not used in the usual way to sense variations in output voltage, but merely to enable Tr1 to pass a constant current through R_2 and R_3.

A portion of the resulting stabilized *voltage* across R_2 and R_3 is picked off at the slider of R_2 and applied to the output pair Tr2, Tr3, which form a compound emitter-follower with high input impedance and low output impedance. The regulation of this basic stabilizer is improved by increasing the reference voltage as the load current increases. The load current flows through R_1, and the resulting p.d. across it is added to the zener voltage.

Setting up is very easy. First, R_4 is set to zero, and R_2 to maximum output voltage with no load. A load resistance corresponding to maximum output current is then connected and R_1 adjusted so that the same output voltage is again obtained. The process is then repeated.

If full output voltage is not obtained at maximum current, the explanation is probably that the unstabilized output voltage has fallen so far that there is not enough voltage left to operate the transistors. The circuit should then be set up again, starting with a lower maximum voltage.

The final regulation curve may show a slight rise of output voltage at intermediate current levels. Resistance R_6 draws a few milliamps when there is no external load. This avoids an abrupt fall of voltage which may otherwise occur at the low-current end.

The lamp gives some protection against short-circuited outputs. Diode D2 is necessary to protect the output pair against excessive reverse base-emitter voltages which can occur on switch-off. The output capacitance C_2 was found to be necessary to suppress parasitic h.f. oscillations due to internal feedback in Tr2 and Tr3. Output ripple is very low provided that C_1 is adequately large. It should not be too large, or large pulses of output current may flow if the load is accidentally shorted.

The zener diode may be replaced by a battery or by a string of junction diodes operating in the forward direction. In this way a low reference voltage (say 1.5 V) may be used, to minimise the voltage wasted in operating the stabilizer. A suitable power source is shown in Fig. 2.

*Amatronix Ltd.

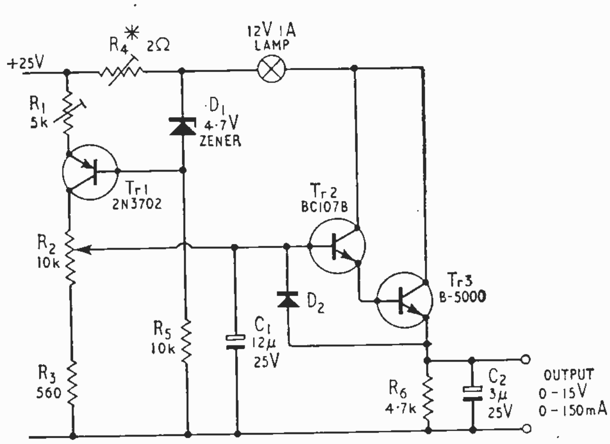


Fig. 1. Supply circuit for 0-15V, 0-150mA. The B-5000 transistor requires a heat sink of 10cm × 10cm × 2mm aluminium.

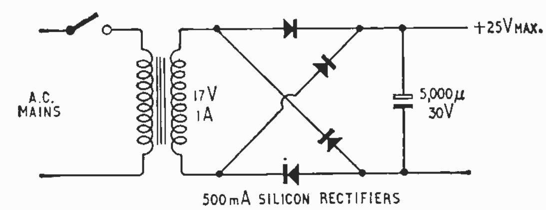


Fig. 2. Mains power unit.

Books Received

Russian Books on Automation and Computers, compiled by E. Gros. This publication provides a comprehensive list of Soviet books and irregular publications (symposia, conference transactions, pamphlets) on the theory and application of automation and computers. Pp. 92. Price 160s. Scientific Information Consultants Ltd., 661, Finchley Road, London, N.W.2.

Basic Electricity for Electrical Engineers by A. W. N. Kerkhofs. This book comes from the Philips Technical Library and is available in German, Dutch and English. It provides a simple explanation of a.c. and d.c. theory starting from fundamental principles as taught in the electrical engineering courses run by the Philips Company. Pp. 212. Price 38s. N.V. Philips Gloeilampenfabrieken, Eindhoven, The Netherlands.

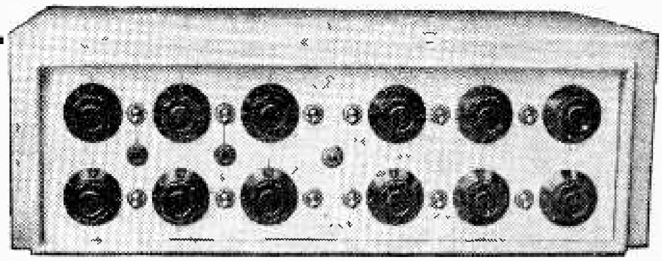
An Introduction to the Electron Theory of Solids by John Stringer. Some fundamental knowledge is assumed in this book. This includes the properties of gases, liquids, insulators, semiconductors and metals; chemical binding; the concepts of macroscopic symmetry and the use of Miller indices and the Bragg law. The reader should also have knowledge of vector algebra, partial differential equations and real and complex variables. The subject matter includes:—the breakdown of the classical theory; atomic spectra and the old quantum theory; the uncertainty principle of Heisenberg; the foundations of quantum mechanics; some problems in wave mechanics; a wave-mechanical treatment of the simple harmonic oscillator and the hydrogen atom; assemblies of atoms; atoms in motion; statistical mechanics. Pp. 246. Price 35s. Pergamon Press Ltd., Headington Hill Hall, Oxford.

Spread-F and its effects upon radiowave propagation and communications. Reviewed last month. The price is 210s and incidentally AGARD was formed in 1951, not 1961 as was stated.

—Vortexion

quality equipment

12-WAY ELECTRONIC MIXER



The 12-way electronic mixer has facilities for mixing 12 balanced line microphones. Each of the 12 lines has its own potted mumetal shielded microphone transformer and input valve, each control is hermetically sealed. Muting switches are normally fitted on each channel and the unit is fed from its own mumetal shielded mains transformer and metal rectifier.

FOUR-WAY ELECTRONIC MIXER

This unit provides for 4 independent channels electronically mixed without " spurious break through," microphony hum and background noise have been reduced to a minimum by careful selection of components. The standard 15-50 ohm shielded transformers on each input are arranged for balanced line, and have screened primaries to prevent H.F. transfer when used on long lines.

The standard 5 valve unit consumes only 18.5 watts, H.T. is provided by a selenium rectifier fed by low loss, low field, transformer in screening box. The ventilated case gives negligible temperature rise with this low consumption assuring continuance of low noise figures.

20,000 ohms is the standard output impedance, but the noise pick-up on the output lines is equivalent to approximately 2,000 ohms due to the large amount of negative feedback used.

For any output impedance between 20,000 ohms and infinity half a volt output is available. Special models can be supplied for 600 ohms at equivalent voltage by an additional transformer or 1 milliwatt 600 ohms by additional transformer and valve.

The white engraved front panel permits of temporary pencil notes being made, and these may be easily erased when required. The standard input is balanced line by means of 3 point jack sockets at the front, or to order at the rear.

Mixer for 200-250V AC Mains	£40 8 6
Extra for 600 ohm output model	£1 18 6
Extra for 600 ohm 1 milliwatt output	£3 0 6

Size 18¾in. wide × 11⅛in. front to back (excluding plugs) × 6¼in. high.
Weight 22lb.

THREE-WAY MIXER and peak programme meter, for recording and large sound installations etc.

This is similar in dimension to the 4-Way Mixer but has an output meter indicating transient peaks by means of a valve voltmeter with a 1 second time constant in its grid circuit.

The meter is calibrated in dBs, zero dB being 1 milliwatt-600 ohm (.775V) and markings are provided for + 10dB and −26 dB. A switch is provided for checking the calibration. A valve is used for stabilising the gain of this unit. The output is 1 milliwatt on 600 ohms for zero level up to +12 dB maximum. An internal switch connects the output for balance, unbalance, or float. This output is given for an input of 40 microvolts on 15 ohms.

An additional input marked " Ext. Mxr." will accept the output of the 4-Way Mixer converting the unit into a 7-Way controlled unit. This input will also accept the output of a crystal pick-up but no control of volume is available. The standard input is balanced line by means of 3 point jack sockets at rear but alternative 2 point connectors may be obtained to order at the front or rear as desired.

The 8 valves and selenium rectifier draw a total of 25 watts.

P.P.M. for 200-250V AC Mains .. .. Price on application
Size 18⅛in. wide × 11¼in. front to back (excluding plugs) × 6¼in. high.
Weight 23lb.

10/15 watt Amplifier with built-in mixers.
30/50 watt Amplifier with built-in mixers.
2 × 5-way stereo mixers with outputs for echo chambers, etc.

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- stable to 2 parts in 10^8 per day
- automatic operation of the convertor
- 1248 B.C.D. output to printer as an option
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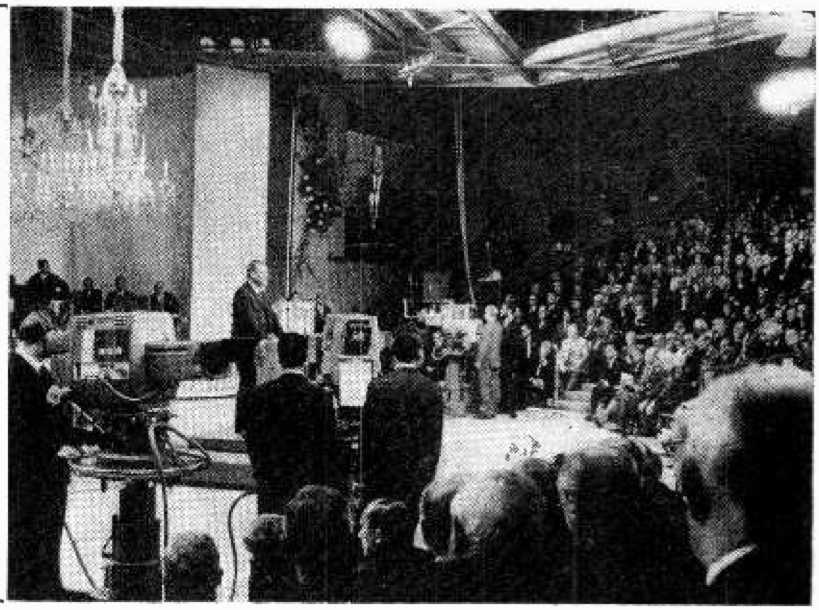
DEVELOPMENTS IN GERMAN DOMESTIC RADIO AND TELEVISION AS SEEN AT THE 25TH GERMAN RADIO EXHIBITION, BERLIN, 25 AUGUST – 3 SEPTEMBER



GERMAN COLOUR TELEVISION STARTS

THE special attraction at the 25 Grosse Deutsche Funkaustellung was, of course, colour television. Nearly 30 years after the demonstration of colour television in Berlin, the city took part in the official opening of German colour broadcasting. Herr Willy Brandt (now Federal Minister of Foreign Affairs and Vice-Chancellor, but previously Mayor of Berlin) inaugurated the service and at switch-on at least a dozen apparently black-and-white monitors (plus, as usual, a large-screen Eidophor projector) could be seen to change simultaneously to colour. A fitting tribute was paid to Dr. Walter Bruch, pioneer of the PAL system, who was present at the opening ceremony along with many dignitaries and 1,200 guests.

Initially the German colour service will be limited—420 hours in the first year from the two German television networks (about four hours each per week by ARD and ZDF), which is less than in the U.K.

Colour receivers

Sales of colour receivers for the second half of 1967 (sets were released in July) are expected to be 80,000 and possibly greater, in 1968 to reach 200,000, in 1969 320,000 and in 1970 450,000, making a total sale of about 1 million by 1970. (It has been reported, incidentally, that one survey in Germany showed that only 8% of householders said they would buy a set for a price over 2,000 DM.) Retail prices of German colour receivers have been subject to some variation recently. They started high at 2,500DM (£230) until mail order houses and large stores announced prices of around 2,000DM (£180) or less. Attempts at price fixing seem to have been circumvented by exporting sets and then buying them back. Most of the large firms now offer sets at around 2,300DM (£210). During the exhibition Grundig announced a 48 cm (19 in) receiver for 1,865DM (about £170). Then there is the Kuba 28 cm (11 in) portable set selling at 1,500 DM, less than £140. (The design of this set does not fit into the normal pattern however—it is a simple PAL receiver, using mainly valves.

All told there are 18 names in colour television (about the same as for black-and-white) producing nearly 50 models, though many have similar chassis of course. The principal makers are A.E.G.-Telefunken, Blaupunkt, Graetz and Schaub-Lorenz (I.T.T.), Grundig and Tonfunk, Imperial and Kuba (G-E), Körting, Loewe-Opta, Metz, Nordmende, Philips, Saba, and Siemens. Other names, involved to a lesser extent, are Braun, Emud, Kaiser and Wega. Practically all the sets have a 63 cm (25 in) diagonal screen and are delay-line PAL receivers (rather than simple PAL sets which rely on the eye to average small phase errors on adjacent lines). Exceptions to the 63 cm screen size have 56 cm (22½ in) screens (Blaupunkt CTV 2006 and Siemens FF11), a 48 cm (19 in) screen (Grundig T800), and a 28 cm (11 in) screen (Kuba CK211P—see illustration on p. 485).

Two important decisions must be taken at the outset in colour receiver design; the question of the h.t. value and the method of picture tube drive. Since the mains supply voltage in the U.S.A. is 117 V, transformers have been used there to provide the h.t. voltage (optimum value around 400 V). But in Europe the higher voltage mains supplies led to the adoption of the transformerless technique using either a half-wave power-supply circuit, with a separate horizontal output stage and e.h.t. generator (lack of availability of valves with a high enough anode dissipation for combined output stage service has led to separate e.h.t. generator and line output stages), or a doubler circuit with electronic regulation to drop the voltage to around the 400 V mark.

Commonly with the doubler-type of circuit a shunt voltage regulator valve with 25 kV across it maintains a low internal resistance of the e.h.t. supply, but this technique is likely to be ousted by using a v.d.r. and voltage multiplier thus avoiding any trouble due to X-rays. Most makers (e.g. Siemens, Grundig, Körting, Loewe, Saba) seem to use the half-wave system, usually with a separate 30 V winding on the c.r.t. transformer to give 36 V *via* a bridge rectifier for the transistor circuitry. (This voltage can be added to the 270 V to give over 300 V for the colour difference, deflection and video output stages.) Telefunken, Blaupunkt and Nordmende are among those using the doubler technique.

Concerning the colour tube drive, the colour difference method, in which $R-Y$, $G-Y$ and $B-Y$ are fed to in the c.r.t. grids and the luminance Y signal fed to the cathodes, effectively giving matrixing in the tube, is used on Grundig and Philips receivers, also Loewe and Metz. (This is the method used in the U.S.A.) The disadvantage of this technique is the high amplitude signals required from the difference amplifiers (around 200 V) and from the luminance amplifier (over 100 V into 25 pF with a bandwidth of over 4 M/cs), making transistorization expensive, if not impossible. With the *RGB* method, however, in which the *R*, *G*, and *B* signals are obtained from a matrix and fed to the tube cathodes, the three colour stages need only be designed for 115 V output into 12 pF at over 4 Mc/s bandwidth, thus making transistorization easier. This method is used in Telefunken, Blaupunkt, Graetz and Schaub-Lorenz, Kuba, Nordmende and Siemens receivers. There are disadvantages though, in that beam-current limiting is more complicated and deviations of black level of 1% are noticeable. These can result in a higher number of active devices (transistors plus valves)—around 50, rather than around 40 for the difference method. It seems that the half-wave power supply (270/300 V) and the colour difference technique offer the most economical solution.

On the question of valve/transistor ratio, economics and other factors dictate the use of transistors in the tuners and sound and vision i.f. stages, and valves in the output stages. In the colour circuits, sound stages, sync-separator, etc., either can be used, and this accounts in part for the varying ratios found. Colour difference stages also vary, and can use either three valves or five transistors. Analysing receivers on this basis of valve/transistor ratio, one finds four main groups. Philips and Saba models employ 27 valves and 13 transistors, whereas the Grundig models have 19 valves and 23 transistors. Both these groups use the colour difference approach. Makers using 14 valves and 33 transistors and the *RGB* approach include Telefunken, Kuba-Imperial, Körting, and Nordmende, while the 14 valve-40 transistor group take in Blaupunkt, Loewe-Opta, Schaub-Lorenz and Graetz and Siemens. The situation is thus quite different from in the U.K. where 11 valves and 33 transistors are common with the colour difference method.

An interesting and unique colour receiver which attracted a great deal of attention was the Nordmende Spectra Colour S. This set is equipped with three 15 cm (6 in) monochrome monitors which can receive different programmes simultaneously (see illustration). The large colour screen can display any of the three monitor pictures or a fourth programme. This rather expensive luxury costs nearly 5,000DM (about £450).

Monochrome receivers

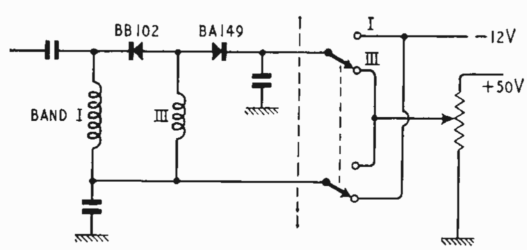
With the current interest in colour television it might be thought black and white receivers had taken a back seat. Market-wise this is in fact so—receiver sales were down 6% last year (1966) to the 1964 level. (Exports were high though, at 20% for 1966.) It is felt, though, following experience in other countries, that the sales of black-and-white receivers will not be affected by colour sales. The degree of market saturation is 60%, so to reach the 85-90% figure thought to be achievable will mean that the number of householders buying a set for the first time will be high over the next few years.

With the new introductions there are now a wide variety of screen sizes in the portable sets—28, 30/31, 36, 41, 44, 47/48 and 51 cm (11 to 20-in). The larger table models have, almost without exception, 59 or 65 cm screens.

More attention seems to be given to sound quality than in the U.K., although many sets do not have negative feedback from the output transformer secondary. Many feature two or more loudspeakers, and in at least one case the maker has thoughtfully provided connections for an external amplifier to be used.

Circuit design changes of late have taken place mostly at the tuner end, notably with the increasing use of variable capacitance or tuning diodes along with a number of pre-set potentiometers for station selection. The latest developments concern the use of diodes for switching—the tuner described on p.400 of the August issue is an example of v.h.f.-u.h.f. switching. More recently Band I-III switching has been achieved, one method using Band I and III inductors in series, with a switching diode across one of the coils (BA143) and a tuning diode (BA142) across both coils. An alternative method, used by Telefunken in the MT500 tuner for both monochrome and colour receivers, is shown in Fig. 1, where the diodes function both as short circuits and variable capacitors, but not, of course, at the same time. Band IV-V switching and tuning arrangements are different, the same inductor being used for both bands. In the Telefunken design, the two diodes (BA149) are in series on Band V while on Band IV one is forward-biased, thus increasing the tuning capacitance. In the u.h.f. region, chokes rather than resistors isolate the diodes from their control circuits—small deviations in capacitance due to the voltage dropped across the resistors now becoming significant.

Two of the designs which came from the S.E.L. applications lab. some time ago were for f.m. discriminators using the diode-transistor pump type of pulse-counting detector. The circuits formed part of direct-coupled i.f. amplifiers operating with low i.f. values (200 k/cs) and without transformers or inductors. One design, for a 5.5 Mc/s inter-



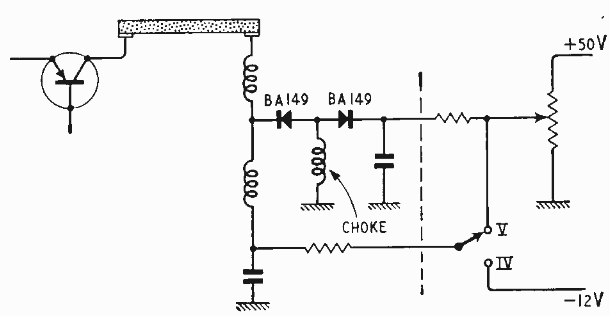
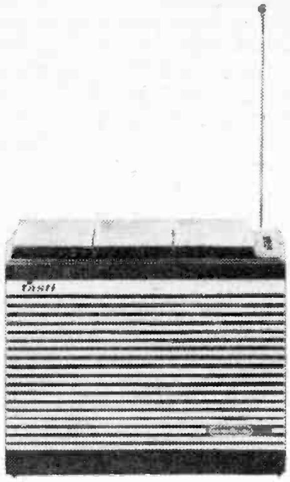
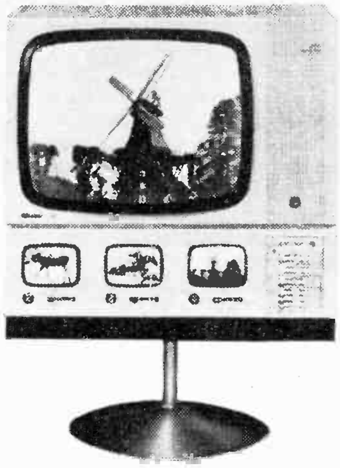


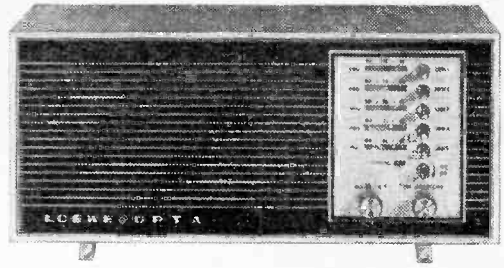
Fig. 1. Use of variable capacitance diodes for band I-III switching (upper diagram) and band IV-V switching (lower diagram) as well as tuning (Telefunken). Given adequate decoupling, controls to right of broken line can be remote from tuned circuits.



Portable v.h.f.-only receiver without tuning scale but with three pre-tuned stations. Cost about £13 (Nordmende "Tasti").



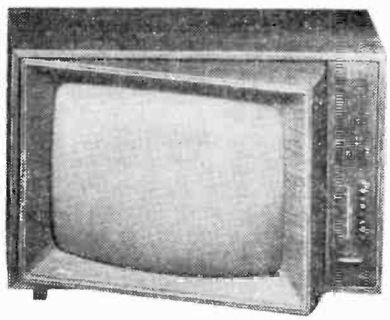
Colour receiver with three monochrome monitors which may be operated simultaneously (Nordmende).



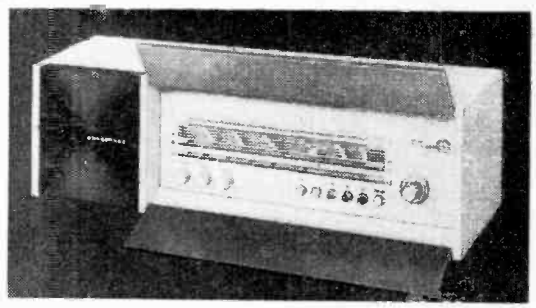
Pre-set tuning by potentiometers and capacitance diodes on a best-selling v.h.f.-only mains receiver (Loewe-Opta " Tempo ").

Latest tape recorder in " Electronic Notebook " series with playing time of 2 x 10 minutes (Grundig EN7).

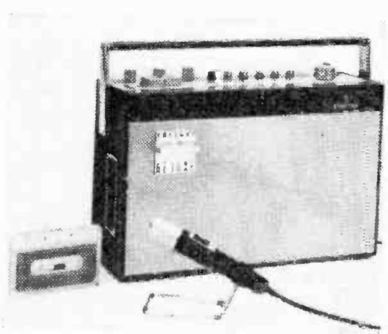
Combined car radio receiver (m.w. and l.w.) with tape cassette player (Philips).



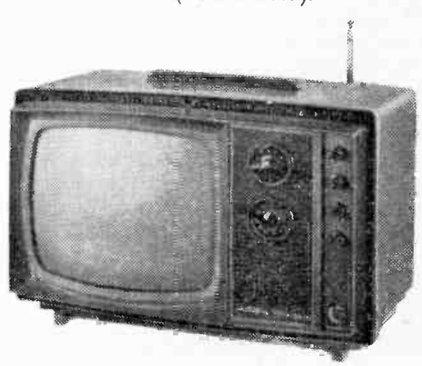
Above:- Novel colour receiver with adjustable screen viewing angle (Metz).



Right: Colour scheme of receiver can be easily varied by changing hinged flaps—orange and red in model illustrated (Nordmende Spectra Futura).



Combined four-band radio and tape recorder for portable or car use—a " Tonstudio im Taschenformat ". When recording from radio, bias frequency is chosen to avoid beating between local and bias oscillators.



Portable colour receiver with 29 cm (11 in) tube. Set uses the simple PAL system and costs about £140 (Kuba CK211P).

carrier sound receiver, is incorporated as part of a television receiver design using only semiconductor active devices. The design, for a 110°, 18 kV e.h.t. set, is developmental but production may be considered in 1968. The power supply circuit for the receiver is transformerless and the supply voltage is dropped, in part, by an s.c.r. (switched at the 50 c/s rate) which forms part of a voltage-stabilized supply. The horizontal timebase uses a 1,000-V thyristor in series with a BD106, permitting operation from a supply voltage of 110 V. The various supply voltages for the receiver are taken from rectified outputs of a winding on the output transformer of this stage—including the e.h.t.

Sound receivers

Cabinet colour seems to play a larger part in the German domestic radio and

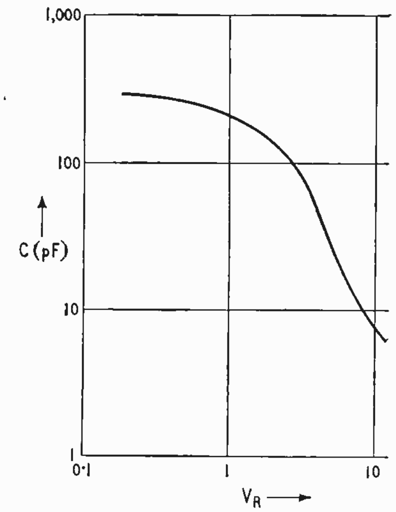


Fig. 2. Capacitance variation with reverse voltage in BA163 tuning diode.

tv market than in Britain—Nordmende, in particular, have bright single and multicoloured receivers in their range. In the Spectra Futura models (illustrated) the hinged flaps which cover the front panel are coloured orange and red, with the pvc-covered cabinet in white and loudspeaker facia in black. The colour scheme can be altered to bright blue and dark blue simply by using different flaps. (In the stereo version, incidentally, the two loudspeaker boxes can be detached and placed apart from the receiver.) In spite of the interest in colour schemes the "technische look" still holds an important place in marketing, as exemplified by Braun equipment. The latest catch-phrase is the "Metall-look," used by Grundig to describe their aluminium-fronted tuner-amplifiers.

The trend in v.h.f. receivers toward diode-tuned front ends with pre-selected stations (usually five) is strong and appears on many tuner-amplifiers *in addition* to the normal continuously-variable tuning arrangement. Usually each pre-set potentiometer is accompanied by a separate scale indicating the channel or frequency selected. This technique has now found its way into some lower-priced receivers, in particular the Loewe-Opta Tempo, a v.h.f.-only mains table radio announced last year, which has turned out to be a best-seller. For the tuning-diode supply a separate transformer winding with rectifier and a 36 V Zener stabilizing diode is usual.

A more recent introduction in the v.h.f.-only class is the Nordmende Tasti, an unusual portable design in that no tuning scale is included. Large push-button switches occupying the whole set-top select one of the three pre-tuned stations (see illustration).

Integrated circuits. Heathkit Geräte GmbH showed an f.m. receiver, the AR-15, which uses integrated circuits in the i.f. stages. (This model was introduced in the U.S.A. early this year.) Two RCA CA3012 circuits, two crystal filters, two discrete transistors and a mixer and discriminator transformer make up the 10.7 Mc/s i.f. section. (The CA3012 i.c. is also used in two Blaupunkt black and white television receivers. It is expected that Blaupunkt will market a car radio with a European i.c.—Philips or Siemens—early in 1968.)

The first European pocket radio using integrated circuits was shown by Philips. This medium-wave only set operates from a 3.6 V Deac cell for two hours on one charge—output power is given as 50 mW. The i.f. amplifier contains one i.c. and another is used in the a.f. pre-amplifier (TAA 263). Additional discrete active devices are a BF195 and AC127/AC132 complementary output stage.

What is probably the first use of thick-film integrated circuits in domestic apparatus—in Europe at any rate—was seen at the Telefunken stand. The nine-component passive circuit with discrete tantalum capacitors and transistors (2N4062 and 2N3704) attached forms the a.f. pre-amplifier section of the Banjo a.m./f.m. portable. Telefunken have in fact produced a range of miniature diodes and transistors, for connection on to thick-film passive circuits, which are electrically equivalent to a transistors, e.g. BA174 ≡ 1N4154; selected range of standard diodes and BC197 ≡ BC107; AF257 ≡ AF106; and BF230 ≡ BF195.

One of the most interesting developments in passive components in recent times is the practicability of variable-capacitance diodes with the right impurity concentration profile for capacitance values extending up to 300 pF or so, making possible the elimination of ganged variable capacitors in m.w. receivers. Devices with capacitance ratios exceeding 20:1 (for voltage ratios of about 10:1) are possible with Qs of over 200, examples being the Intermetall (I.T.T.) BA163 (Fig. 2) and the Siemens BB107 double diode. The two diodes in the BB107 are different, capacitances being 150 pF and 375 pF at 3 V, so that they can be used for a.m. r.f. and oscillator tuned circuits. Experimental a.m. tuners using such diodes have been built in various application laboratories—a Siemens model the writer saw occupied about half the volume of a matchbox! Fig. 3 shows a typical a.m. mixer/oscillator circuit using the BA163 diodes, and which includes potentiometers for pre-selecting a number of stations.

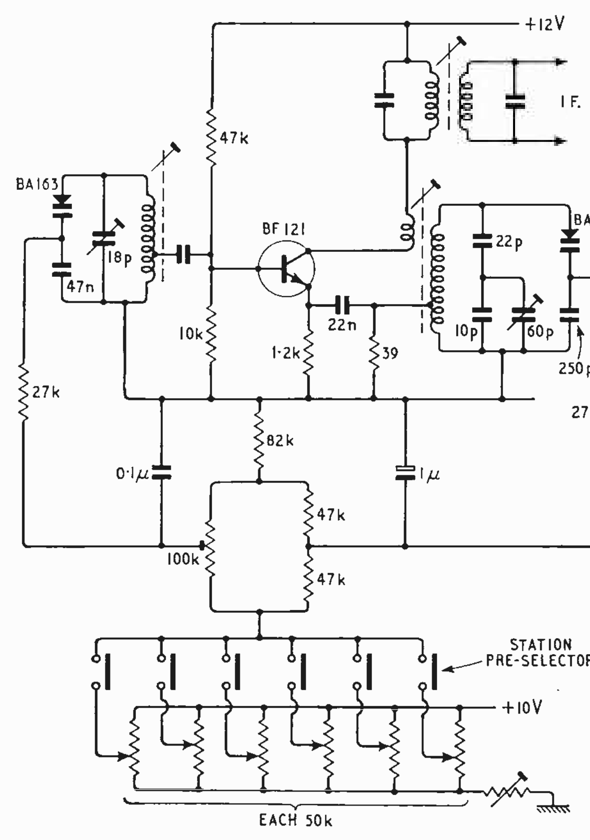


Fig. 3. Application of BA163 tuning diodes to medium wave receiver. Stations are pre-selected by potentiometers (Intermetall)

OCTOBER MEETINGS

Tickets are required for some meetings: readers are advised, therefore, to communicate with the society concerned

LONDON

4th. I.E.R.E.—"Animal sonar" by Dr. D. Pye at 6.0 at the Institution, 8-9 Bedford Square, W.C.1.

4th. S.E.R.T.—"Radiophonic workshop" by F. C. Brooker at 7.0 at London School of Hygiene and Tropical Medicine, Keppel St., W.C.1.

4th. B.K.S.T.S.—"The design of linear audio-frequency amplifiers" by Dr. E. A. Faulkner at 7.30 at the Royal Overseas League, Park Pl., St. James's St., S.W.1.

10th. Soc. Relay Engineers.—"Extending a narrow-band v.h.f. system to 230 Mc/s" by L. Frankham and "U.H.F. distribution at fundamental frequencies for large communial systems" by J. Claydon at 2.30 at the I.T.A., 70 Brompton Rd., S.W.3.

11th. I.E.R.E. & I.E.E.—Symposium on "Ultrasonics and medicine" at 2.30 at Middlesex Hospital Medical School, Cleveland St., W.1.

12th. R.T.S.—"Fully transistorised colour television receiver" by J. W. Bussell, S. C. Jones and R. Gray at 7.0 at the I.T.A., 70 Brompton Rd., S.W.3.

12th. Brit. Acoustical Soc.—Symposium on "Sound propagation in anisotropic solid media" at 2.40 in the Physics Dept., Imperial College, S.W.7.

13th. I.E.R.E. & I.E.E.—Symposium on "Ariel III" at 10.30 a.m. at the Middlesex Hospital Medical School, Cleveland St., W.1.

16th. R.T.S. & I.E.E.T.E.—Lecture by G. E. Mueller, Manned Space Flight Chief of NASA at 6.0 at the I.T.A., 70 Brompton Rd., S.W.3.

17th. I.E.E.E.—"Education for the engineering mission" by Dr. W. G. Shepherd at 6.0 at I.E.E., Savoy Pl., W.C.2.

19th. I.E.R.E. — Symposium on "Management methods and media in electronic training at the School of Electronic Engineering, R.E.M.E., Arborfield" at 8-9 Bedford Sq., W.C.1.

25th. I.E.R.E. & I.E.E.—"A survey of digital data display systems" by Dr. G. Wooldridge and T. J. Stakemire at 6.0 at London School of Hygiene and Tropical Medicine, Keppel St., W.C.1.

25th. B.K.S.T.S.—"High-quality monitoring speakers" by R. E. Cooke at 7.30 at the Royal Overseas League, Park Pl., St. James's St., S.W.1.

27th. R.T.S.—"Television distribution and broadcasting from satellites" by G. K. C. Pardoe at 7.0 at the I.T.A., 70 Brompton Rd., S.W.3.

BATH

19th.—I.E.R.E. & I.E.E.—"Ergonomics in electronic equipment and systems design" by B. Shackell at 6.0 at the Technical College, Avon St.

BIRMINGHAM

12th. I.E.R.E.—"Sound waves in the sea" by Dr. V. G. Welsby at 7.15 at the Dept. of Electronic and Electrical Eng'g., the University.

BRISTOL

11th.—I.E.R.E.—"Some experiments with demountable valves" by Dr. C. R. Burch at 7.0 at the Technical College, Ashley Down.

CARDIFF

4th. R.T.S.—"Further aspects of colour television" by B. J. Rogers at 7.30 at the Angel Hotel.

6th. S.E.R.T.—"A PAL for the service man" by G. D. Barnes at 7.30 at Llandaff Technical College, Western Avenue.

11th. I.E.R.E.—"Design of low distortion transistor amplifiers for audio frequencies" by P. J. Baxandall at 6.30 at the Welsh College of Advanced Technology.

20th. S.E.R.T.—"What is programming?" by D. G. Howells at 7.30 at Llandaff Tech. College, Western Ave.

CHELMSFORD

3rd. I.E.R.E.—"Telemetry and communication systems in the oil industry" by A. C. W. Bedwell at 6.30 at the Technical High School, Patching Hall Lane.

CHELTENHAM

16th. I.E.R.E.—"Development in railway signalling and communication systems" by W. H. Dyer at 7.0 at the North Gloucester Technical College.

COLCHESTER

24th I.E.R.E.—"The future of electronic telephone exchanges" by V. E. Mann at 7.0 at the University of Essex, Wivenhoe Park.

COVENTRY

19th. S.E.R.T.—"Thyristors" at 7.30 at the Herbert Art Gallery and Museum, Earl St.

EDINBURGH

4th. I.E.R.E.—"An integrated circuit reliability study with special reference to plastics encapsulation" by G. R. Latham at 7.0 at the Dept. of Natural Philosophy, the University.

GLASGOW

5th. I.E.R.E.—"An integrated circuit reliability study with special reference to plastics encapsulation" by G. R. Latham at 7.0 at the Inst. of Engineers and Shipbuilders, 39 Elmbank Cresc., C.2.

LINCOLN

5th. I.E.R.E.—"Trens in semiconductor development" by Dr. G. D. Bergman at 6.30 at the East Midlands Electricity Board Showrooms.

LIVERPOOL

18th. Inst. Eng'g Inspection.—Symposium on "A practical approach to reliability engineering" at 9.45 a.m. at the Royal Institution, The University.

18th. I.E.R.E.—"Computer control of air traffic" by D. Halton at 7.0 at the College of Technology, Byrom St.

MANCHESTER

16th. Soc. of Instrument Tech.—"Analytical instruments and their application to automatic control" by G. L. Collier at 6.45 at the Literary and Philosophical Soc., 36 George St.

19th. I.E.R.E.—"Medical electronics" by H. S. Wolff at 7.15 at Renold Building, College of Science and Technology, Altrincham St.

NEWCASTLE-UPON-TYNE

4th. S.E.R.T.—"Colour television" by D. G. Packham at 7.15 at the Charles Trevelyan Technical College, Maple Terrace.

11th. I.E.R.E.—"Domain originated functional integrated circuits" by Dr. M. B. N. Butler at 6.0 at the Inst. of Mining and Mechanical Engrs, Neville Hall, Westgate Rd.

NEWPORT, I.o.W.

20th. I.E.R.E.—"I.L.S. integrity monitoring" by W. F. Winter at 7.0 at the Technical College.

NORTHAMPTON

26th. S.E.R.T.—"Record playing units" by E. Mortimer at 7.0 at the College of Technology, St. George's Ave.

NOTTINGHAM

18th. I.E.R.E. & I.P.P.S.—"Microcircuitry" by Dr. I. C. Walker at 6.30 at the University.

READING

10th. I.E.R.E.—"Integrated circuits" by D. H. Roberts at 7.30 at the J. J. Thomson Physical Lab., the University.

REDRUTH

19th. Soc. of Instrument Tech.—"Computer hardware construction and operation" by W. D. Old and W. C. Hosken at 7.30 at Cornwall Technical College.

SOUTHAMPTON

18th. Soc. of Instrument Tech.—"The design and development of industrial pressure transmitters" by E. C. Buckland and R. W. Penny at 7.30 at the University.

19th. S.E.R.T.—"Some applications of tape recorders" by G. A. Allcock at 7.30 at the College of Technology, East Park Terrace.

24th. I.E.R.E.—"Domain originated functional integrated circuits" by C. P. Sandbank at 6.30 at the Lanchester Theatre, the University.

WIRELESS WORLD DIGITAL COMPUTER

3—More on system design: the order decoder and control unit: how they translate instructions given to the machine into switching signals for operating the various control gates.

LAST month we considered the arithmetic unit and its associated stores, and we ended with a system diagram (Fig. 25, p.422) showing the computer as so far described. The machine could in fact be used in this form if all the control gates shown in Fig. 25 were connected to switches and a means were available for generating batches of eight shift pulses and applying them to the appropriate registers. But such a system would be difficult to handle, as one would have to refer to the circuit diagram to find out which gates to open in order to carry out any particular operation. Also, it would be almost impossible to control the computer from a sequential programming device.

It is the task of the "order decoder" (see Fig. 1 schematic, August issue), on receipt of an instruction from the operator, to open the correct gates and route shift pulses to the required destinations. The shift pulses are applied to this order decoder at low level from the "control unit" (again see Fig. 1 August issue). After the destinations of the pulses have been defined the order decoder amplifies the pulses so that they are capable of driving a shift register.

To enable an operator to convey instructions to the machine a language or machine code "understandable" by both has to be used, and the order decoder is so named because it translates this code into the gate switching signals required by the computer. The basis of the code is a binary word. A five-bit word has 32 possible combinations and in fact would be sufficient to accommodate the 28 control instructions that the computer is designed to handle. The control sequence, however, would not follow any particular pattern and it would be necessary to memorize all 28 instructions, which would make operation of the machine rather difficult.

In view of this it was decided to use an eight-bit control word, split up in such a way as to make memorizing the instructions an easier task. As mentioned in Part 1, the instructions are entered by means of a set of eight switches on the front panel, and there is in fact one switch for each bit of the instruction word. Each switch has two positions, one entering a "0" and the other entering a "1".

The operations that the computer will perform can be divided into four groups: transfer to store; transfer from store; arithmetic; and miscellaneous. The first two bits of the instruction word define which group the order falls in, i.e.

0 0 arithmetic operation
0 1 transfer to store and reset
1 0 transfer from store
1 1 miscellaneous

For transfer instructions the computer is divided into two parts, "arithmetic unit" and "store", and the registers in these parts are given "addresses" within them as follows:—

Arithmetic unit addresses		**Store addresses**	
Register	0 0 1	Store 1	0 0 1
Accumulator	0 1 0	Store 2	0 1 0
Counter	0 1 1	Store 3	0 1 1

During transfer instructions three switches specify the arithmetic unit address and three switches the store address, so a typical instruction would be:—

Nature of order	**Arithmetic unit address**	**Store address**
0 1	0 1 0	0 0 1

In the light of what has been said it can be seen that this encoded instruction means "transfer the contents of the accumulator to store 1". If the code pattern were altered to 1 0 0 1 0 0 0 1 then the instruction would be "transfer the contents of store 1 to the accumulator"—in other words, the nature of the instruction is different but the addresses are the same.

In order to clear a register and "lose" its contents all that is necessary is to specify a transfer either from or to that register, but not specify another address for the contents to come from or go to. For example, either 0 1 0 0 0 0 1 0 or 1 0 0 0 0 0 1 0 would clear the contents of store 2.

Arithmetic instructions (prefix 0 0) do not require that an address be specified, and it is necessary to remember which instruction does what. The left-hand digit in each of the two groups of three digits is used exclusively for arithmetic operations, namely for the formation of the ones complement of a number. The corresponding two switches always have the same effect on the computer regardless of the nature of the order (the prefix). This results in a saving of parts and makes manual operation of the computer easier.

As was mentioned in the binary arithmetic "reminder" section (August issue) the control instructions are converted to the octal number system for ease of handling. All control instructions with the octal equivalent are listed in the table on the next page, which uses the following abbreviations:

A = accumulator	St.2 = store 2
R = register	St.3 = store 3
Cntr. = counter	C = carry store
St.1 = store 1	T = transfer

A transfer between, say, the register and Store 2 will be indicated as follows:—T. R→St.2.

It can be seen that the "complement accumulator" instruction ($045_{(8)}$) is a combination of three instructions, i.e. add, inhibit carry and set 2^0 in register.

The logical circuit of the decoder is shown in Fig. 26. The reader is permitted to shudder at what appears at first sight a very complicated conglomeration of components. However, things are not as bad as they may seem. The single pole switches S_1 through to S_8 provide the means of feeding in control instructions and the electrical signals resulting from closure of the switches are correspondingly labelled A to H. It will be noticed that instructions can be fed in from another source. Consider S_1. When this switch is open the output of NOR 15 is "up" and that of NOR 16 "down." When the switch is closed the output of NOR 15 is down and that of NOR 16 is up; therefore NOR gates 15 and 16 provide the A and $\bar{A}$ inputs to the decoder. This double inversion is carried out for the other input switches by NOR gates 17 through to 30. The signal lettering A to H corresponds to the letters heading the columns of the instructions of the table. Care must be taken not to confuse the As and Bs of the adder/subtracter inputs with them.

During the following explanations of the decoder operation it is necessary to refer to the computer logical diagram of Fig. 25 (September issue) as well as Fig. 26. First, let us see what happens when we close switch S_8. This results in the order to add, 0 0 $1_{(8)}$. The nature of the order is arithmetic, so the switches giving A and B will be open (0 0), NOR gates 15 and 17 will be "up" and 16 and 18 "down." The input to the decoder will therefore be $\bar{A}\bar{B}$ gate AND 46 will open and provide one input for gates 47, 48, 49 and 50. As the input is $\bar{A}\bar{B}$, gates 51 and 52 will be closed and NOR gate 31 will be up. This opens the computer gates 13 and 15, completing the register and accumulator regenerative loops. Switch S_8 is closed, so the input to the decoder, in full, is $\bar{A}\bar{B}\bar{C}\bar{D}\bar{E}\bar{F}\bar{G}H$. Gate 49 will open as it already had one input up, $\bar{A}\bar{B}$ from gate 46, and its other inputs are $\bar{G}H$. The output of gate 49 "tells" the adder/subtracter to add. In going up, gate 49 provides an input for NOR 33 which goes down, and NOT 34 goes up, providing one of the inputs to gate 63. The other input for gate 63 is clock pulses from the control unit. The output of gate 63 goes up and down in sympathy with the clock pulses triggering flip-flops 1 and 2, providing shift pulses for the register and accumulator. In all, eight clock pulses are received from the control unit, and after the last one the contents of the register will have been added to the accumulator.

The conditions for subtracting are very similar except that switch S_7 is closed and S_8 open, and gate 50 opens to tell the adder/subtractor to subtract. The rest of the operation is the same as for adding, the register and accumulator receiving shift pulses.

For multiplication the switches that are closed are S_5 and S_8. As $\bar{A}\bar{B}\bar{G}H$ is still present, the add AND gate 49 opens, with the same results as before; also gate 47 ($\bar{A}\bar{B}\bar{D}E$) opens to inform the control unit that multiplication is to take place. Division is again very similar the input being $\bar{A}\bar{B}D\bar{E}G\bar{H}$. Gate 48 opens to inform the control unit that division is to take place and gate 50 opens with the same results as before, i.e. subtract, shift pulses to R and A.

Switches S_3 and S_6 inhibit the carry store and set the 2° bistable in the register to form the 1s complement. These are "straight through the decoder" instructions and as such are not gated with anything else and can be ignored while considering other aspects of the decoder.

Let us open all the switches except S_2, so that the order's prefix is $\bar{A}B$ or 0 1, signifying that a transfer to store is required. All the arithmetic gates will remain closed as these require a $\bar{A}\bar{B}$ input. Gate 51 will open and the output of NOR 31 will fall, closing the computer gates 13 and 15, breaking the register and the accumulator feedback loops. Gate 51 also supplies one of the inputs for gates 53 and 54. As the output of NOR 31 is now down, the output of NOR 32 is up, providing one input to each of the shift pulse AND gates 58, 59, 60, 61 and 62.

CONTROL ORDERS TABLE

Binary Order A	B	C	D	E	F	G	H	Octal Equiv	Instruction
Arithmetic									
0	0	0	0	0	0	0	1	0 0 1	add
0	0	0	0	0	0	1	0	0 0 2	subtract
0	0	0	0	1	0	0	1	0 1 1	multiply
0	0	0	1	0	0	1	0	0 2 2	divide
0	0	1	0	0	0	0	0	0 4 0	inhibit C
0	0	0	0	0	1	0	0	0 0 4	write 1 in 2° of R
0	0	1	0	0	1	0	1	0 4 5	complement A
Transfer to store									
0	1	0	0	1	0	0	1	1 1 1	T. R→ St. 1
0	1	0	0	1	0	1	0	1 1 2	T. R→ St. 2
0	1	0	0	1	0	1	1	1 1 3	T. R→ St. 3
0	1	0	1	0	0	0	1	1 2 1	T. A→ St. 1
0	1	0	1	0	0	1	0	1 2 2	T. A→ St. 2
0	1	0	1	0	0	1	1	1 2 3	T. A→ St. 3
0	1	0	1	1	0	0	1	1 3 1	T. Cntr→ St. 1
0	1	0	1	1	0	1	0	1 3 2	T. Cntr→ St. 2
0	1	0	1	1	0	1	1	1 3 3	T. Cntr→ St. 3
Transfer from Store									
1	0	0	0	1	0	0	1	2 1 1	T. St. 1→ R.
1	0	0	0	1	0	1	0	2 1 2	T. St. 2→ R.
1	0	0	0	1	0	1	1	2 1 3	T. St. 3→ R.
1	0	0	1	0	0	0	1	2 2 1	T. St. 1→ A.
1	0	0	1	0	0	1	0	2 2 2	T. St. 2→ A.
1	0	0	1	0	0	1	1	2 2 3	T. St. 3→ A.
Reset									
0	1	0	0	1	0	0	0	1 1 0	Clear R.
0	1	0	1	0	0	0	0	1 2 0	Clear A.
0	1	0	0	0	0	0	1	1 0 1	Clear St. 1
0	1	0	0	0	0	1	0	1 0 2	Clear St. 2
0	1	0	0	0	0	1	1	1 0 3	Clear St. 3
Miscellaneous									
1	1	0	1	1	0	0	0	3 3 0	Reset Cntr.

The odd man out is the counter reset instruction. As this is not a shift register it is necessary to apply a negative voltage to its reset d.c. line, this being performed by the $11_{(2)}$ instruction.

The next part of the instruction is the arithmetic unit address. At this stage we will consider only transfers from the register or accumulator and not the counter. Now the address of the register is 0 0 1 ($\bar{C}\bar{D}E$) and that of the accumulator is 0 1 0 ($\bar{C}D\bar{E}$), and, as shown in the table, if the transfer is to come from the register then switch S_5 (giving E) will be closed. The input to the decoder is now 0 1 0 0 1 or $\bar{A}B\bar{C}\bar{D}E$. Gate 53 will therefore open and this in turn will open the computer gate 16, which allows the register access to the store. Also it will be noted that when clock pulses arrive, gate 58 can open and close in sympathy to trigger flip-flop 1 and provide shift pulses to the register as the output of NOR 32 is up. If the transfer had been from the accumulator the order would have been 0 1 0 1 0 or $\bar{A}B$ $\bar{C}D\bar{E}$. In this case AND 54 would have opened to open computer gate 17, allowing the accumulator access to the store, and AND gate 59 would open on receipt of clock pulses to provide accumulator shift pulses.

All that remains to be done is to specify the address in the store. No further control gates have to be opened and all that is required is to ensure that the correct store receives shift pulses. Now the address of store 1 is 0 0 1 ($\bar{F}\bar{G}H$), that of store 2 is 0 1 0 ($\bar{F}G\bar{H}$) and that of store three is 0 1 1 ($\bar{F}GH$), so it can be seen that on the receipt of clock pulses gate 60, 61 or 62 will open to provide the correct store with shift pulses. Note that gates 55, 56 and 57 cannot open as they have a common $A\bar{B}$ or $10_{(2)}$ input.

For transfer from the store, the order prefix is 1 0 or $A\bar{B}$. Gate 52 will open, and this will close computer gates 13 and 15 via NOR 31 and open computer gate 14 to allow the store access to the arithmetic unit. Gates 53 or 54 cannot open to open gates 16 or 17 as a common $\bar{A}B$ input is required for this. Also note that as the output of NOR 31 is down that of 32 will be up, so one input to the shift pulse AND gates will be up (58 to 62). The only effect of setting the arithmetic unit address will be to open either AND 58 or AND 59 on receipt of clock pulses, to provide either the register or the accumulator with shift pulses.

Selecting the store address $\bar{F}\bar{G}H$, $\bar{F}G\bar{H}$ or $\bar{F}GH$ will open one of the gates 60, 61 and 62 on receipt of clock pulses to provide shift pulses for the required store. Also, as gate 52 is up, gates 55, 56 and 57 have a common input line up. One of these will open, depending on the address selected, to open one of computer gates 18, 19 or 20 and therefore open the output line of the selected store.

We have not yet discussed the parallel transfer from the counter. First, this is classed as a "transfer to store" instruction with the prefix $\bar{A}B$. Bearing this in mind, if we now selected the address in the store into which the counter had to be copied, shift pulses would be applied to that store. Now this is a parallel transfer, and if shift pulses were applied to the selected store the information would be destroyed; so shift pulses to the selected address must be inhibited. To transfer from the counter we first select $\bar{A}B$ and the counter address $\bar{C}DE$. Gate AND 51

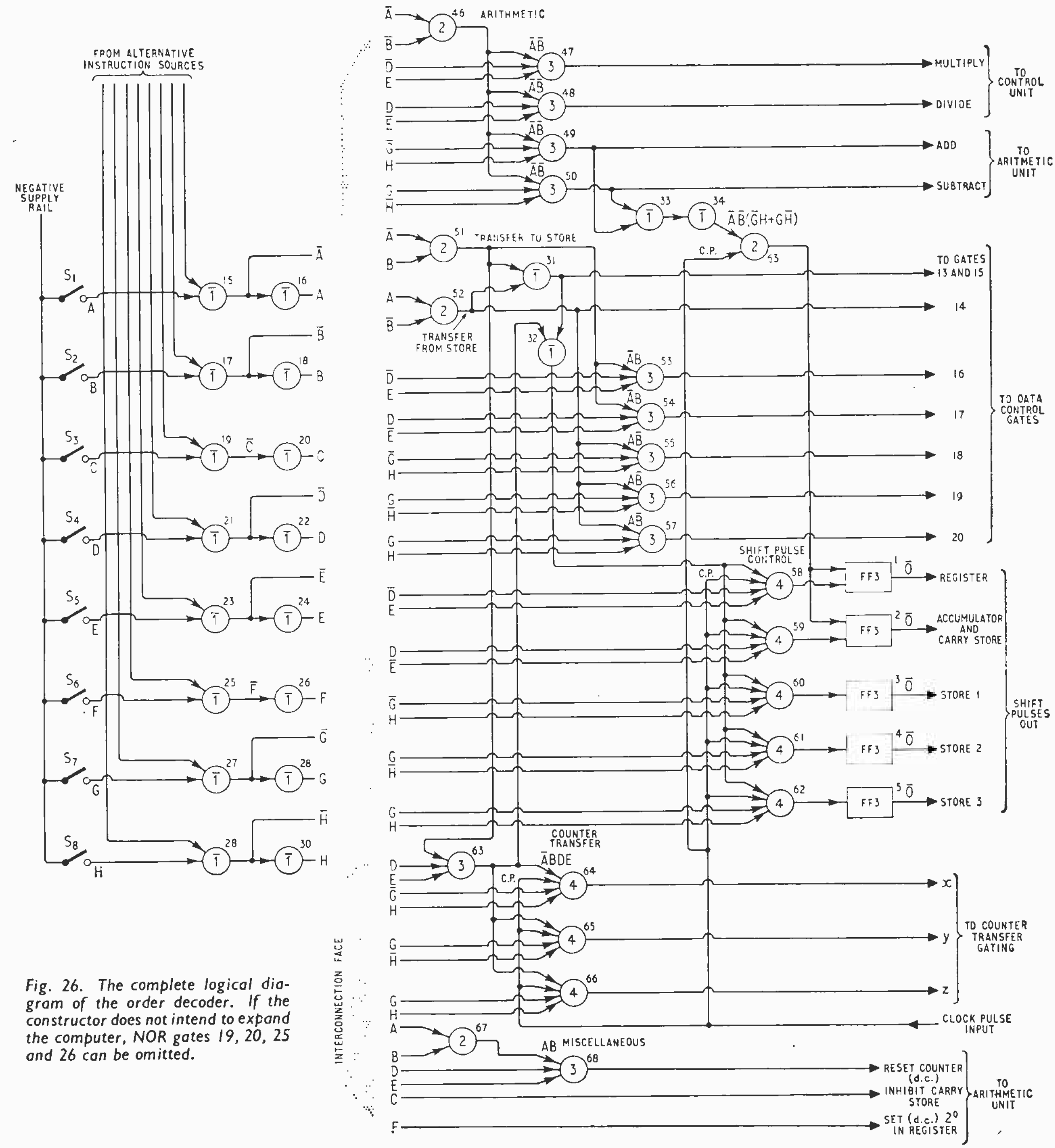


Fig. 26. The complete logical diagram of the order decoder. If the constructor does not intend to expand the computer, NOR gates 19, 20, 25 and 26 can be omitted.

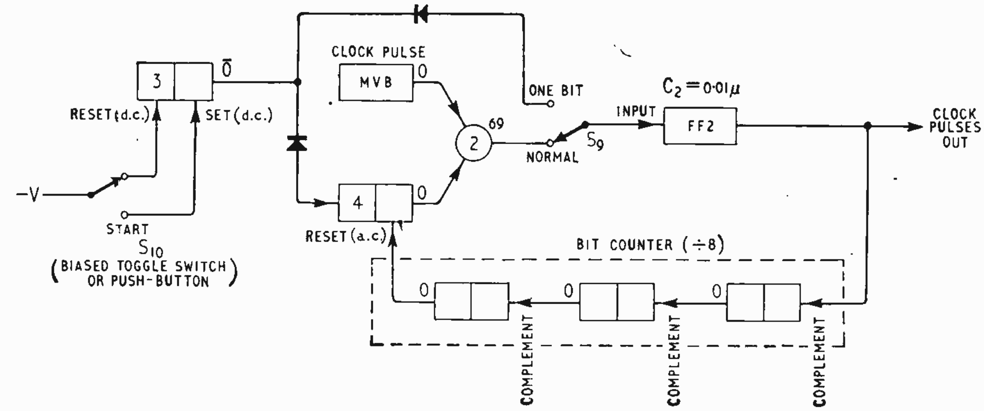


Fig. 27. Simplified diagram of the control unit, illustrating the principles involved.

will open, providing one input for AND 63. The other two inputs are D and E, so AND 63 will open, and this will cause one of the inputs to NOR 32 to go up. NOR 32 output will go down, as will one of the inputs to each of the shift pulse AND gates. These cannot now open and no shift pulses can leave the decoder. In opening, gate 63 provides a common input for gates 64, 65 and 66. The store address selected ($\bar{F}GH$, $F\bar{G}\bar{H}$ or $\bar{F}GH$) opens one of these gates when clock pulses are applied; therefore the X, Y or Z output goes up. These, of course, communicate with the counter transfer gating. The only reason for feeding gates 64, 65 and 66 with clock pulses is to ensure that no inadvertent transfer can take place while moving the control switches until clock pulses are deliberately applied.

The only other function of the decoder is to reset the counter. The control instruction for this is 1 1 0 1 1 or AB $\bar{C}$DE, which opens gates 67 and 68 to drive the counter reset d.c. line up. It will be noted that the shift pulses are taken from the NOT output of the flip-flops. If this was not done the times of the positive edges would not coincide due to component tolerances.

The decoder differs from the control unit in that it does not take into account conditions that exist within the computer. In other words it receives a certain input and gives a fixed output that does not change. The control unit, on the other hand, receives instructions from the decoder and an additional order to start. The output it gives will then depend on these inputs and conditions within the computer.

It would be a good idea before starting to describe the control unit to list all the things that are required of it:—

Add—Subtract and transfer instructions. Deliver eight clock pulses to the decoder.

Multiply. Provide batches of eight clock pulses to the decoder and one pulse for each addition to the counter. When at the end of a word the contents of the counter equal the contents of store 1, no further pulses to be generated. If at the end of a word the carry store is set, indicating that the capacity of the accumulator has been exceeded, stop generating pulses regardless of the state of the counter.

Divide. Generate batches of eight clock pulses and a pulse to the counter for each subtraction minus one until the carry store is set at the end of a word, indicating that the accumulator has gone negative.

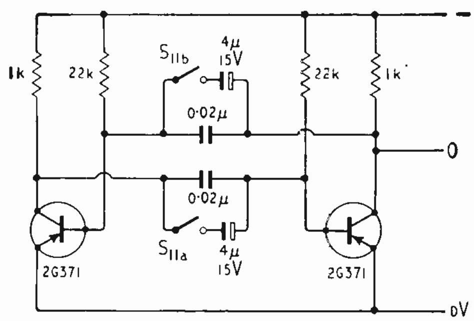


Fig. 28. Circuit of clock-pulse multivibrator. S_{11} allows the frequency to be reduced for slow-motion demonstrations.

General. Provide a facility for operating the computer at slow speed for demonstration purposes. Also, for the same reason, provide a facility for carrying out operations bit by bit instead of a complete operation at a time. Provide an output for a sequential programming device to indicate that an operation is complete and that the computer is ready for a further instruction. Operation of the control switches must not result in spurious pulses being delivered to the computer.

The logical diagram that forms the basis of the control unit is shown in Fig. 27. When the "start" press-switch S_{10} is depressed bistable 3 is set and the positive edge available at its NOT output terminal in turn sets bistable 4, driving one of the inputs to AND gate 69 "up." The other input to gate 69 is provided by the clock-pulse multivibrator, the circuit of which is shown in Fig. 28. As a result AND gate 69 opens and closes in sympathy with the multivibrator output, triggering flip-flop 2. The output of flip-flop 2 is fed to the order decoder and to a bit counter formed by three of the counter type bistables. A counter connected in this fashion will provide one output pulse for every eight input pulses, so after eight pulses have been received by the bit counter its output resets bistable 4, closing AND 69 and preventing any further output pulses. From this it can be seen that every time the "start" switch is pressed eight pulses are delivered to the order decoder. If S_9 is put into the "one bit" position, flip flop 2 is now triggered by bistable 3, so that one pulse will be fed to the decoder for each press of the "start" switch.

The clock pulse multivibrator (Fig. 28) is a conventional astable multivibrator, the speed of which can

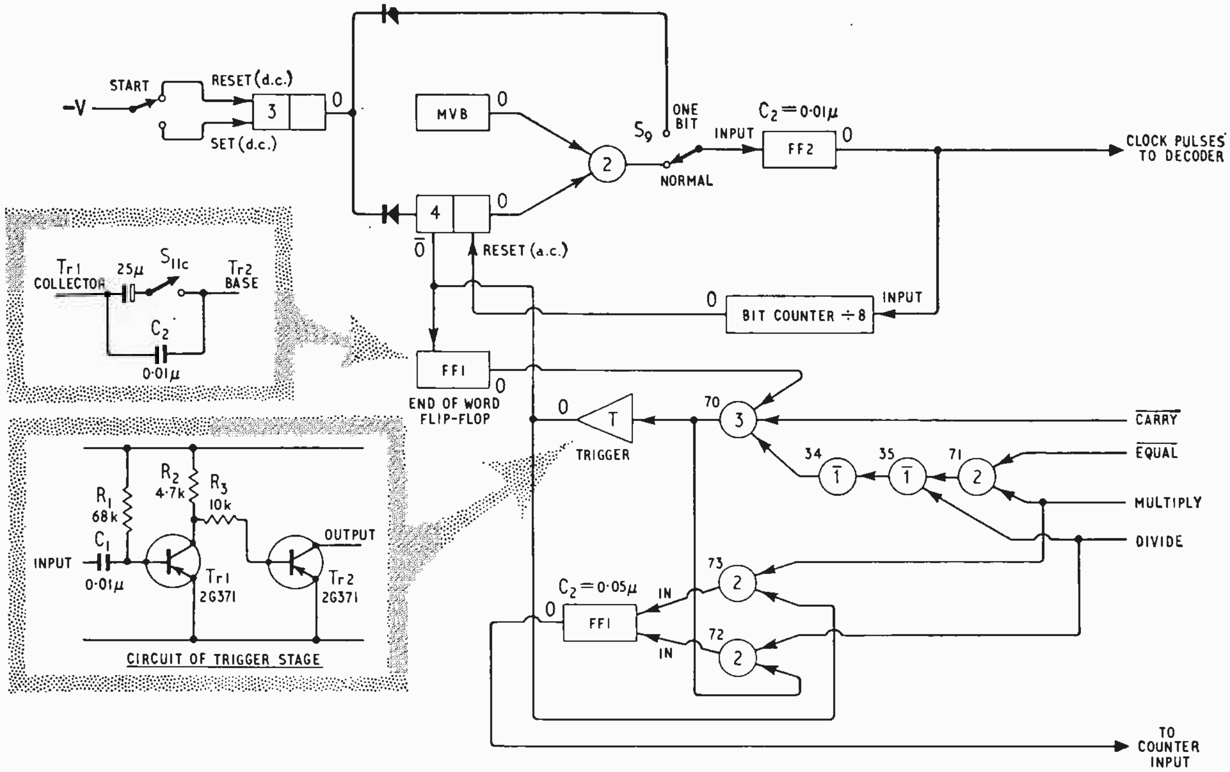


Fig. 29. The complete control unit. Note that the value of C_2 in e.w.t. flip-flop can be altered by S_{11} for demonstration purposes.

be decreased for slow-motion demonstrations by switching in two extra capacitors.

The complete logical diagram of the control unit is shown in Fig. 29. Operation of the basic circuit is much the same as previously described. It will be noticed that after eight pulses have been produced, i.e. one word has been dealt with, the "end-of-word-time-flip-flop" (e.w.t.) is triggered by the negative-going edge available at the NOT output of bistable 4 as it is reset. The output of the e.w.t. flip-flop is fed to gate 70 and has no effect

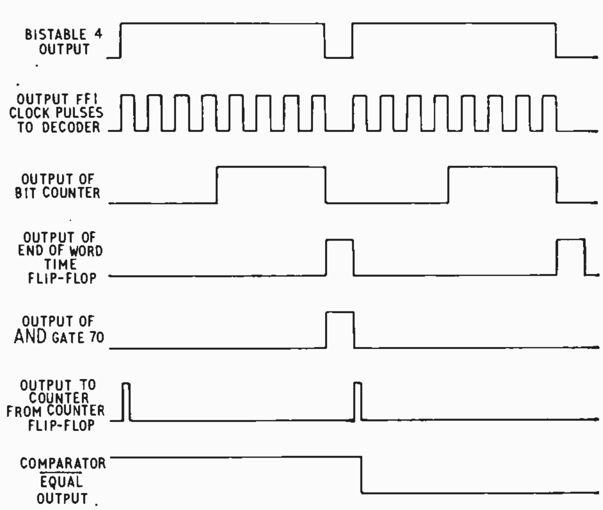


Fig. 30. Pulses present in the control unit when the computer is multiplying by two.

unless "multiply" or "divide" is selected. It will be remembered that during multiplication the multiplier is put into store 1. The computer then adds, each addition being counted until the number of additions equals the multiplier, this being detected by the comparator. When the computer is instructed to multiply, AND gate 47 in the order decoder opens to provide an "up" signal to one of the inputs of gate 71 in the control unit. As the counter is at zero at the start of the operation and as store 1 holds the multiplier, the $\overline{\text{EQUAL}}$ output of the comparator will be "up," opening gate 71, the output of NOR 35 will be "down," and that of NOT 34 "up," providing one input for gate 70. The start switch is pressed, and, as is normal, eight clock pulses are produced. At the end of the word the e.w.t. flip flop triggers to open AND gate 70 which provides an "up" input to the trigger stage (ignore the $\overline{\text{CARRY}}$ input to gate 70 at this stage).

The trigger circuit is one that has not been mentioned previously. Its output transistor collector is coupled to the collector of Tr1 in bistable 4. Under normal conditions Tr1 in the trigger stage is held in a conducting state by R_1 and its collector at 0V. As a result Tr2 is turned off, having no effect on bistable 4. When the e.w.t. flip-flop triggers AND gate 70 opens and the resulting negative-going edge tries to drive Tr1 in the trigger stage further into conduction and has no effect. When C_2 in the e.w.t. flip-flop discharges, the flip-flop returns to its normal condition and closes AND gate 70. A positive-going edge is now applied to the trigger stage, momentarily turning off Tr1. The collector potential of Tr1 rises to − V, turning on Tr2 and "pulling" the collector potential of Tr1 in bistable 4 to 0V, setting bistable 4, to produce another eight clock pulses. Every time

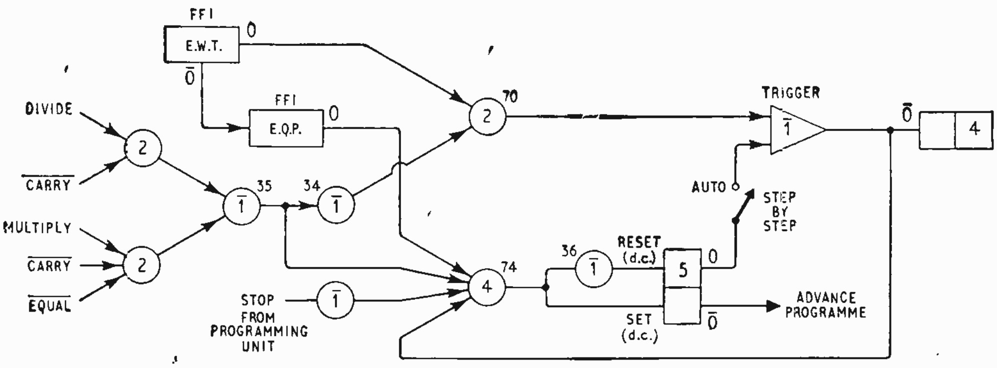


Fig. 31. Modification to the control unit that provides controlling pulses for an external programming device. The numbers of the AND gates on the left of the diagram are: upper 75, lower 71. The unmarked NOR gate is 37.

bistable 4 sets, with "multiply" selected AND gate 73 opens to trigger the counter flip-flop, providing a pulse to advance the counter one position. Sequences of eight pulses are generated, and for each batch of eight pulses a pulse is delivered to the counter until the contents of store 1 equal the contents of the counter. Then the $\overline{\text{EQUAL}}$ output of the comparator goes "down," to close AND 70, preventing any further pulses from being generated.

AND gate 70 is only "interested" in what the conditions are at the end of the word time period, so any carries that are generated during a word do not affect gate 70 as the e.w.t. flip flop is not set. However, if during a multiplication the capacity of the accumulator is exceeded the carry store will be set at the end of a word time, and this causes the $\overline{\text{CARRY}}$ input to gate 70 to go "down," preventing any further additions from taking place. If this did not happen and the computer continued with the computation, the most significant digits would be lost and an end-around-carry would take place, resulting in an incorrect answer.

For example, suppose the arithmetic operation to be carried out is 130 × 3. In binary this is equal to 10000010 × 00000011, so that 10000010 has to be added to itself 00000011 times.

```
                                    1 0 0 0 0 0 1 0
                                  + 0 0 0 0 0 0 0 0
                                    ---------------
                                    1 0 0 0 0 0 1 0 -> 1st addition counter holds
                                                                        00000001
                                                     Store 1 holds      00000011
                                  + 1 0 0 0 0 0 1 0
Carry store set at end of           ---------------
word                         -> 1   0 0 0 0 0 1 0 0 -> 2nd addition counter holds
                                                                        00000010
                                                     Store 1 holds      00000011
                                    1 0 0 0 0 0 1 0
                                                 -> 1
If computer did not stop the        ---------------
third addition would result in ->   1 0 0 0 0 1 1 1 -> 3rd addition counter holds
                                    ---------------                     00000011
                                                     Store 1 holds      00000011
                                                     Comparator stops com-
                                                     puter as counter = St 1.
```

From this it can be seen that if the computer did not stop when the capacity of the accumulator was exceeded the answer to 10000010 × 00000011 would be given as 10000111 or 130 × 3 = 135, which is not a very happy state of affairs. In the completed computer the state of the comparator is indicated on the front panel, as is the state of the carry store, so if the computer halts during a multiplication with the comparator indicating "not equal" and the carry store set, the result contained in the accumulator is unreliable. The operation of the control unit during multiplication is summarized by the waveforms in Fig. 33.

During division it is necessary to count every subtraction minus one and halt the computer when the accumulator goes negative, which is detected by the carry store being set at the end of a word. For example, we will imagine that before the last subtraction the accumulator holds 00000101 and that we are dividing by 00001000. The last subtraction would yield

```
  00000101
  00001000
 ----------
 1 11111101
```

The carry store is set at the end of the word, indicating that the accumulator is negative. It may be interesting to analyse this a little further. What we have done is subtracted 8 from 5; therefore, ignoring the carry, the accumulator must hold the binary equivalent of − 3, but we have already seen that 11111101 is equal to 153. It is clear that if some means were available for indicating the sign of a number, both positive and negative values could be represented. This is dealt with fully in a later section dealing with the operation of the computer.

When the computer is instructed to divide, AND gate 48 in the decoder opens to provide an "up" signal to gate 70 via NOR 35 and NOT 34. Continuous subtractions will now take place as for multiplication, the difference being that the comparator has no effect on the sequence of operations as AND 71 is closed, the condition of the carry store at the end of word time being the sole controlling factor. The counter flip-flop now receives its trigger pulses from AND 70 via AND 72, so now the counter advances one position at the end of the word time period, not at the beginning of a word as with multiplication. Because AND 70 is closed by the carry store at the end of the last subtraction, the last subtraction is not counted, fulfilling the requirement of counting all the subtractions minus one during division. During addition and subtraction the counter is unaffected as AND gates 72 and 73 cannot open. This means that when only addition and subtraction are to take place the counter can be used as a store—but more about this later. The e.w.t. flip-flop time-constant is increased during demonstration functions by a section of switch S_{11}, the switch that controls the clock generator speed, so that the end of each word can be clearly seen as indicated by the long pause.

Modification to allow use of programming facility.—It was mentioned in Part 1 that a stored-programme facility would be a feasible addition to the computer. This could take the form of the matrix programming board already mentioned or could be a uniselector or stepping drum. At each position of such a programme store a particular instruction would be fed to the order decoder, and a complete sequence of instructions would cause the computer to perform a required arithmetical process. If such a device is to be added the computer must be arranged to provide an output pulse to advance the programme one position at the end of each operation.

The additional logic required for such a system is shown in Fig. 31. It provides two possible modes of operation. First, at the end of an operation a pulse is fed to the programming unit which selects the new instruction, then the computer automatically re-starts and goes through the complete programme until a "stop" instruction is received. Second, the " end-of-operation " pulse will advance the programme but will not restart the computer. This means that the " start " switch has to be pressed for each operation but the following instruction is pre-selected. This should be of value when demonstrating the unit to a group of students.

Modifications required to the control unit consist of disconnecting the " divide " control signal from NOR 35 and providing it with an AND gate of its own (75). The $\overline{\text{CARRY}}$ input is disconnected from AND 70 and reconnected to AND 75 and AND 71. The input components to the trigger stage are duplicated and fed from some additional logic. A moment's thought will show that now, when multiplication or division is taking place the output of NOR 35 will be " down " for the duration of the operation and at the completion of the operation the output of NOR 35 will be " up." So at the end of a word when NOR 35 is " up " the programme unit must receive an advance pulse.

At the end of every word the e.w.t. flip-flop triggers as before. If the output of NOR 35 is " down " the computer is restarted in the normal way. Each time the e.w.t. flip-flop resets the end-of-operation (e.o.p.) flip-flop triggers. If NOR 35 is " up," indicating the end of an operation, and if bistable 4 is reset, as it will be at the end-of-word time, AND 74 opens. This sets bistable 5, providing a positive edge to advance the programme. When the e.o.p. flip-flop resets, bistable 5 resets, providing a positive edge for the trigger stage and restarting the computer. This procedure will continue until a " stop " instruction from the programme unit drives the input to NOR 37 " up," preventing AND 74 opening and inhibiting any further restart and advance pulses. The switch in the restart line from bistable 5 enables the programme to be carried out automatically or step-by-step for demonstration purposes. The input to AND 74 from bistable 4 prevents the programme from being advanced in the middle of a word as would happen under certain conditions.

This concludes the description of the functioning of the computer. Readers who have been able to stay with the series thus far can now start to order parts and reach for their soldering irons with confidence.

(Next month: constructional hints.)

LIST OF PARTS

Switches			
8	Single-pole on/off	SM259/DB	A. F. Bulgin & Co. Ltd., Bye Pass Road Barking, Essex
11	Single-pole push-to-make	MP7	
1	Single-pole c/o, biased	SM273/DB	
1	Single-pole c/o	SM265/DB	
1	4-pole 2-way	WS 24	Home Radio (Mitcham) Ltd., 187 London Rd., Mitcham Surrey
Neon Lamps			
48	Clear neon lamps	D795/clear	A. F. Bulgin
5	Red neon lamps	D795/red	

Resistors and semiconductors
LST Components, 23 New Road, Brentwood, Essex

Capacitors
See text, page 367, August issue

Case (used in prototype)
Type 1100A. Alfred Imhof Ltd., Ashley Works, Cowley Mill Road, Uxbridge, Middx.

Corrections. (1) Fig. 2. OR gate, first element of the combined NOR/NOT version should have 1 and not 4 as shown. (2) Equation 3, page 416, should read $A\bar{B}\bar{C}+\bar{A}B\bar{C}+\bar{A}\bar{B}C+ABC=SUM$. (3) Page 422, L.H. column, line 13, change EQUAL to EQUAL. (4) Page 423, L.H. column, line 8, change 20 to 18.

Note: The computer will be on show at the R.S.G.B. exhibition, see page 487.

BOOKS RECEIVED

Basic Algol by W. R. Broderick and P. S. Barker. The material presented in this book first appeared as a series of thirty articles in *Computer Weekly*. Its aim is to provide a means whereby the non-mathematical and the mathematical readers can achieve an understanding as to what Algol is and how it is used. The book starts by outlining the basic principles of computers and binary arithmetic leading up to a description of basic Algol. As each Algol expression is introduced it is included in a programme to illustrate its use and effect. The book includes a question and answer section to enable the reader to try his hand at using his new-found knowledge and ends with a revised report on Algol 60. Pp. 121. Price 15s. Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1.

Instruments Electronics Automation (Third edition) 1967 year book and buyers' guide. This reference work is divided into five sections. The first section contains a Who's Who, Who Buys (a guide to people responsible for the procurement of supplies for Public Services in the U.K.), and British Standard and Defence Specifications. Section two contains manufacturers' addresses, etc. Section three is devoted to an alphabetical buyers' guide; information being presented under more than 4,600 product headings to which section four is an illustrated adjunct. Section five consists of a number of equipment surveys. The book is a mine of information for all who are associated with electronics and automation. Pp. 729. Price 60s. Morgan Brothers (Publishers) Ltd., 28 Essex Street, London, W.C.2.

Computer Technology, proceedings of the conference held in Manchester during July 1967 by the I.E.E. This book presents the papers given at the above conference and covers the latest development in many branches of computer technology. It includes descriptions of sub-systems and complete experimental computers. A number of papers are devoted to storage systems, the plated wire type predominating, although a high-speed read-only store using ferrite rods is described. This store has a capacity of 2,048 words of 50 bits and a random access cycle time of 80 nanoseconds. A paper by members of the Advance Research and Development Department of I.C.T. describes a method of interconnecting unencapsulated integrated circuits on a multilayer thin film conductor structure mounted on a ceramic substrate. Access to the lower conductor layers is made via small windows; interlayer interconnection is carried by the deposition of bridging links. In all, 28 papers are included in this book which should prove to be a valuable acquisition to anyone involved with computers. Pp. 277 (8.25×11.75 inches). Price 75s. I.E.E., Savoy Place, London, W.C.2.

LITERATURE RECEIVED

Electrolube Application Guide has two of its 28 pages devoted to recommended applications within audio and electronics fields. The lubrication of contacts and moving parts are listed under the following headings: tape and disc recorders, radio and television, record players, audio amplifiers, electronic organs/key boards, transmitters, transmitter receivers and radio controlled models. Electrolube Ltd., Slough, Bucks.
WW 337 for further details

English editions of the Agfa-Gevaert **Magneton Magazine** are to be distributed at least once a year. The current edition is available free of charge from radio/photographic dealers or directly from Agfa-Gevaert Ltd., Great West Road, Brentford, Middlesex.
WW 338 for further details

Low inertia motors, tachogenerators and integrators are described in the seven-page catalogue (publication G65) from Ether Ltd., General Products Division, Caxton Way, Stevenage, Herts.
WW 339 for further details

Received from SGS-Fairchild Ltd., Planar House, Walton Street, Aylesbury, Bucks, is the eight-page **Industrial Planar Selector.** Silicon planar devices, such as switching and amplifier transistors, phototransistors, dual transistors, number tube drivers, Zener diodes and s.c.rs, are listed, with primary and secondary selection characteristics.
WW 340 for further details

Quick reference guides 1967/8 for (a) industrial valves and tubes, (b) industrial semiconductors, and (c) industrial components by Mullard Ltd. contain abbreviated product information for performance comparisons. The guides also contain volume numbers of the Mullard Handbook service so that subscribers can obtain detailed data on the products listed. Copies of the three guides can be obtained on application to Mullard Ltd., Industrial Markets Division, Mullard House, Torrington Place, London, W.C.1.
WW 341 for further details

There are 38 pages in the Hird Brown Ltd. brochure J135 **Photo-Electric Cell Operated Relays.** Full information on the 1967 range of photo-electric equipment is given. Diagrams and photographs of ten photo-relays and a selection of time-delay relays. Over 40 types of photo-electric projectors and receivers are described, and an alignment meter for setting up photo-cell beam sources.
WW 342 for further details

A new edition of "**Ignitrons**" by English Electric Valve Co. Ltd., Chelmsford, Essex, is now available. This 114-page publication contains full data on all EEV Ignitrons, an equivalents index, theoretical and practical information for designers and users, quick-reference selection chart of tabulated data, and a list of U.K. stockists and overseas agents.
WW 343 for further details

Three solid-state **power amplifiers** are briefly described in a leaflet from Derritron Electronic Vibrators Ltd., 24, Upper Brook Street, Mayfair, London, W.1. The 25WT, 100WT, and 300WT, produce 25, 100, and 300W respectively to drive small electro-mechanical vibrators.
WW 344 for further details

Radio Frequency Cables is the title of a 43-page B.I.C.C. publication (533). Section one provides physical and electrical characteristics of coaxial cables with polythene and polypropylene insulation. Section two describes Uniring and Hyring insulated and non-insulated terminations for coaxial cables, multiway connectors and installation tools. British Insulated Callender's Cables Ltd., 21, Bloomsbury Street, London, W.C.1.
WW 345 for further details

Shortform catalogue (4 pages) "**Instruments for Industry and Research**" published by Farnell Instruments Ltd., Sandbeck Way, Wetherby, Yorks, describes bench power supply units, sub-unit supplies, sine/square wave oscillators, a solid-state millivoltmeter, and an educational digital logic system.
WW 346 for further details

Manchester Electronics Show

THIS year's Institution of Electronics exhibition to be held in Manchester from September 26th-29th, will be the largest of the series of 22. In all 125 manufacturers are exhibiting—over 50 of them for the first time.

The show, the official title of which is the Electronics, Instruments, Controls and Components Exhibition and Convention, will be held in the Exhibition Halls, Belle Vue Gardens and will open each day at 10.00 and close at 18.00 on the 26th and 28th and at 21.30 on the 27th and 29th. Admission is by complimentary ticket obtainable from exhibitors or the Institution, 78 Shaw Road, Rochdale, Lancs., from which a catalogue of the exhibits (price 5s 6d) is available.

The exhibitors are:—

A.E.P. International
A.P.T. Electronic Industries
Advance Controls
Alma Components
Analog Devices
Arrow Electric Switches
AEI-Thorn Semiconductors
Associated Engineering
Aveley Electric
Avo
Beckman Instruments
Belling & Lee
Benson-Lehner
Bourns (Trimpot)
Bradley, G. & E.
British Electric Resistance Co.
Cambion Electronic Products
Cannon Electric (G.B.)
Cedenco (C. Dénis & Co.)
Celdis
C. P. Clare International N.V.
Coutant
Crouzet England
Croydon Precision Instrument Co.
Dana Laboratories U.K.
Data Acquisition
Datum Metal Products
Dawe Instruments
Diamond H. Controls
Digital Equipment Corp.
E.M.I.
Educational Systems
Electrical Apparatus Co.
Electro Automat
Electro Mechanisms
Electrothermal Engineering
Elliott Automation
Ether Engineering
Ether
Ever Ready Co.
Evershed & Vignoles
Farnell, A. C.
Farnell Instruments
Fenlow Electronics
Flight Refuelling
Foster Instrument Co.
Fylde Electronic Laboratories
G.E. Electronics (London)
Greenpar Engineering
Hallam, Sleigh & Cheston
Hardman & Co.
Hatfield Instruments
Heathkit/Daystrom
Hedin Furnaces
Hellermann Electric
Highland Electronics
Hird-Brown
Holiday Bros.
Honeywell Controls
Howells Radio
Imhof
Insuloid Manufacturing Co.
Intersonde
K.G.M. Electronics
K. & N. Electronics
K.S.M. Electronics
Kent Industrial Instruments
Klippon Electricals
Kolectric
Lambda Electronics
Lectropon
Leeds & Northrup
Lock, A. M. & Co.
Lucas, Joseph (Electrical)
Lyons, Claude
M.E.L. Equipment Co.
Magnetic Devices
Martin-Ivo
Meterflow
Milton Ross Co.
Miniature Electronic Components
Morecambe Electrical Equipt. Co.
Morgan Brothers (Publishers)
Mullard
Newmarket Transistors
Norma
Painton & Co.
Peto Scott
Polaron Equipment
Precision Instruments (U.K.)
Pye, W. G.
Pye-Ling
RCA Great Britain
Racal Instruments
Redifon-Astrodata
Reliance Controls
Research Electronics
Roband Electronics
Royal Navy
S.E. Laboratories (Engineering)
Salford Electrical Instruments
Sasco
Smiths Industries
Staveley-Smith Controls
Stow Electronics
Superior Electric Nederland N V
Symonds, R. H.
Taylor Electrical Instruments
Tectonic
Teddington Aircraft Controls
Telephone Manufacturing Co.
Telford Products
Telonic Industries U.K.
Texas Instruments
Thermionic Products
Thomas & Betts Co. Inc.
Tinsley, H., & Co.
Transradio
Veeco Instruments
Vero Electronics
Watford Electric & Mnfg. Co.
Waycom
Westinghouse Brake & Signal Co.
Whiteley Electrical Radio Co.
Zenith Electric Co.

New Measurement Techniques

From the Fourth International Measurement Congress, IMEKO IV, Warsaw

As was mentioned in our Editorial Comment last month, the Fourth International Measurement Congress at Warsaw encompassed an extremely wide range of engineering techniques.* Electronic methods, however, figured very prominently, because of their ability to provide high sensitivity, accuracy and flexibility in obtaining measurement information, and it is from these that the following examples have been selected. All the papers, with excerpts in three languages and discussion reports, are due to be published in *Acta Imeko* 1967 which will be available from the Imeko Secretariat, P.O.B. 457, Budapest 5, Hungary.

Impulse testing of concert hall acoustics by correlation measurements was a technique suggested by B. P. Veltman of the Technical University of Delft, Netherlands. M. R. Schroeder has proposed a new method of measuring reverberation time which involves calculating the decay in the squared value of the impulse response of the hall, but it is difficult to check this performance criterion for a sufficiently large number of halls because of the complicated procedures necessary with conventional recording techniques. Veltman's solution, in which the impulse response is obtained by cross-correlation between excitation and response, with random signal excitation, is claimed to be relatively simple. This is because his correlation equipment itself is a simple, compact digital system working on signals quantized into two-state form and because it allows the use of "on-off" pseudo-random binary sequences,† known as chain codes, for the acoustic excitation. The testing system is shown in Fig. 1. There are two chain code generators, giving sequences of long repetition period, actuated by a common source of clock pulses. Cross-correlation coefficients between the microphone signal and the loudspeaker signal, which is shifted in time to give a series of delays, are automatically calculated to give the cross-correlation function. This is an amplitude/time curve which is in fact the impulse response, and is obtained in 100 such time-delay points. In the correlator, the different delays between the two signals are obtained by passing the two-state loudspeaker signal through a shift register, and the frequency of the shift pulses applied to this determines the time interval between successive points in the cross-correlation function. Finally, as can be seen from Fig. 1, the successive values representing the impulse response are squared and then integrated to give the required reverberation time curve.

* "Is Measurement a Science?" September issue, p. 415.
† See "Random Signal Testing for Evaluating System Dynamics" by W. D. T. Davies, *Wireless World*, August 1966.

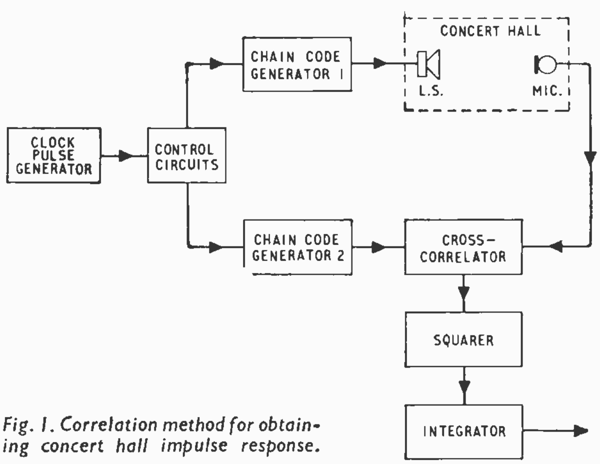


Fig. 1. Correlation method for obtaining concert hall impulse response.

Measuring stored charges in diodes and other semiconductor devices during their recovery periods was the subject of a paper by A. Marek of the Research Institute of Mathematical Machines, Prague, Czechoslovakia. The interest here lies in the ability to measure extremely small charges, of the order of 10^{-13} coulomb, in extremely short intervals of 10^{-9} sec to 10^{-11} sec, during transient conditions after diode activation. In practice the major difficulty is in separating the wanted part of the diode signal (stored charge *vs.* time) for observation from the activation part necessary to produce it. Passive methods of gating (using the signal itself to actuate circuits) were found unsatisfactory because of non-linearity and bandwidth problems, and finally it was decided not to attempt to observe the waveform of the transient quantity (diode current) but merely to obtain its integral over a known time interval. This necessitated the use of an externally timed gate synchronized with the activation system.

A schematic of the measuring apparatus is shown in Fig. 2. The pulse generator determines the instants that the diode activation charge is applied and removed by the measurement control circuits, while the monostable triggered by it determines the precise start and finish of the integrating

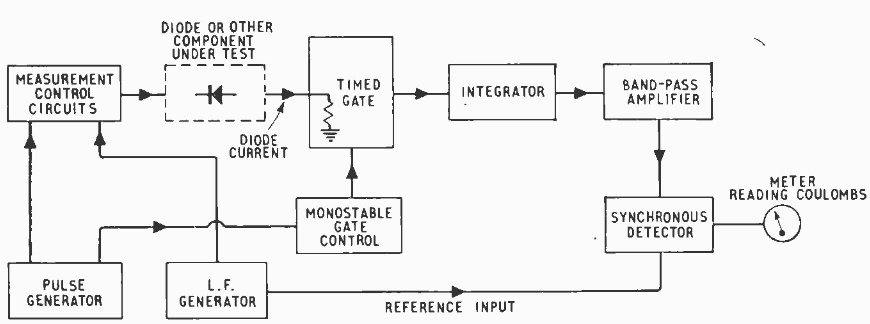


Fig. 2. Schematic of apparatus for measuring stored charges in semiconductor devices.

period. Current through the diode resulting from the activation and subsequent carrier storage is passed through a resistor, and the voltage developed across this is gated during the selected integrating period and passed to the integrator (a low-pass filter circuit). The low-frequency generator, band-pass amplifier and synchronous detector arrangement allow the system to be modulated in order to overcome the zero drift of the timed gate. They also improve the overall sensitivity and allow different activation transients to be applied to the diode under test. In the synchronous detector the integrated signal is converted down to d.c. and this is then displayed on a meter calibrated in coulombs. Dr. Marek reported successful use of the apparatus on point-contact diodes, on bonded, alloyed, diffused, planar epitaxial gold-killed junction diodes and on Schottky-barrier silicon and gallium arsenide diodes.

Calibrating inductive voltage dividers by an apparatus giving extremely high accuracy was described by a speaker from the Laboratory of Electricity and Magnetism, Chinese Institute of Metrology, Peking. The calibration errors at 1,000 c/s were stated to be a voltage ratio error of less than 3×10^{-9} and a phase angle error of less than 3×10^{-8} radian (referred to the voltage divider input signal). The calibration technique is based on the use of a reference voltage and is shown in principle in Fig. 3. The reference voltage is obtained from the secondary of a transformer whose primary is fed from the same a.c. source that energizes the inductive voltage divider. Thus any variations in the energizing source affect the divider voltages and the reference voltage equally, and this effect is cancelled out. Voltages from the various tappings on the divider are balanced against the reference voltage by a compensating circuit to give a null indication on the detector. This compensation is actually provided by a controllable proportion of the signal voltage from the energizing source, obtained through an auxiliary i.v.d. and a transformer. The high accuracy is the result of various precautions for maintaining constant the voltage ratio of the reference transformer. This transformer is constructed in two sections, is extensively screened to reduce magnetic leakage to a minimum, and, during calibration, the transformer screen is maintained at the same potential as the secondary winding. As a result of these measures the relative stability of the reference voltage is said to be better than 1 part in 10^{-6} per hour.

Magnetic-scale displacement measurement system, using a periodic remanence pattern recorded on a coated glass rod as a scale, was the subject of a paper by M. Morimura (Japan). The periodic pattern is recorded by moving the 40-cm magnetically-coated square glass rod at a constant speed past a recording head to which an a.c. signal of constant frequency is applied. This scale is attached to the moving part of the machine in which displacement is to be measured, and a variable-reluctance (flux-sensitive) magnetic pick-up head is attached to the fixed part. At a given phase point in each cycle of the head signal a pulse is generated, and the total displacement of the scale relative to the head is measured by counting the number of pulses produced during movement.

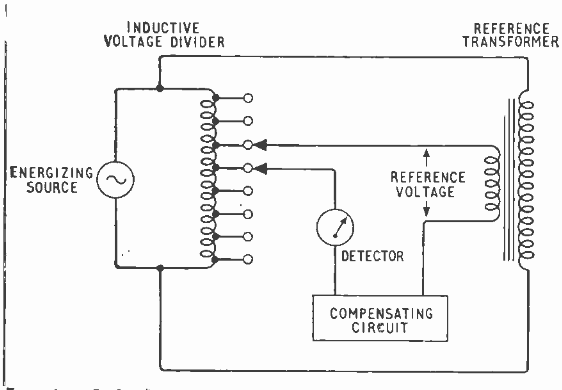


Fig. 3. Reference voltage method for calibrating an inductive voltage divider.

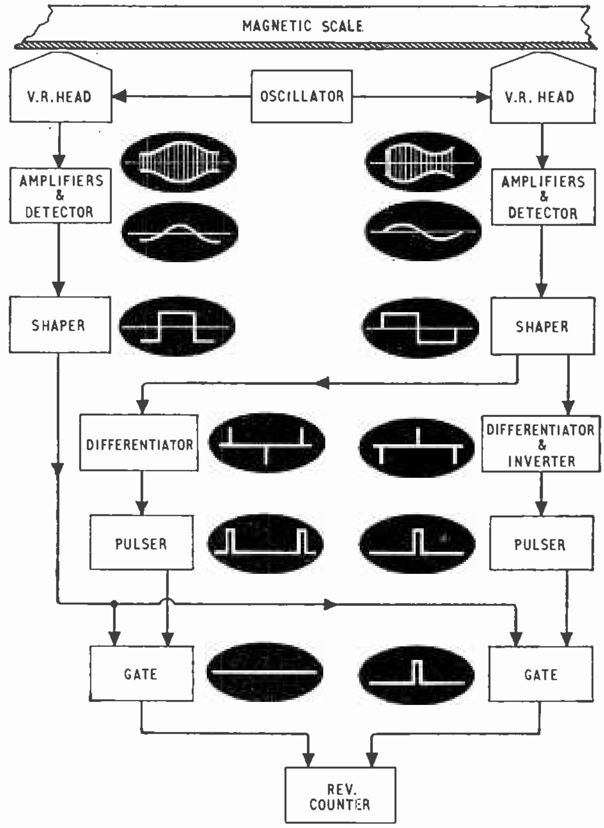


Fig. 4. Simplified schematic of scheme for displacement measurement using a magnetic scale.

The electronic system shown in Fig. 4 is for accommodating two directions of movement—pulses being added to a total count for one direction and subtracted from the count for the other direction. In the right-hand channel pulses are emitted either when the head waveform is rising or when it is falling. The left-hand channel produces a signal which gates the pulses in such a way that one direction of motion results in pulses from one gate and movement in the other direction results in pulses from the other gate. These pulses are then counted in a reversible counter on the principle explained above. Actually the system uses two magnetic scales with their patterns displaced a quarter of a wavelength relative to each other. The purpose of this is to prevent erroneous counts and to provide interpolation to give higher resolution (four pulses now being emitted in a displacement equal to one wavelength). For this interpolation system a more complex logic arrangement than that shown is used, in which each signal channel

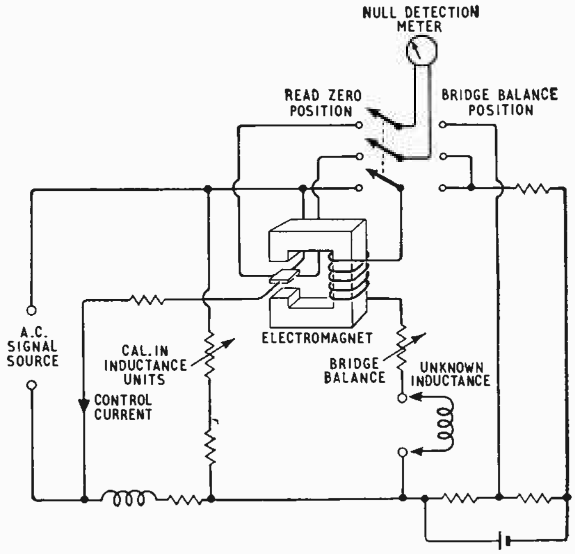


Fig. 5. Hall-effect inductance meter combined with resistance bridge.

controls a gate through which pulses produced by the other channel are transmitted. Measurement of displacement of up to 40-cm in units of 10μ (scale wavelength=40μm) has been achieved, and the accuracy of the unit of measurement has been estimated to be of the order of 0.1μm.

Hall-effect inductance meter, using a Hall element to detect the phase difference between the element control current and the magnetic flux density of the applied field, was described by M. Nalecz, Z. Dunajski, W. Torbicz and H. Ziomecki of the Institute of Automatic Control, Polish Academy of Sciences, Warsaw. In Fig. 5 the energization voltage from the a.c. signal source (which can be 50 c/s mains) is applied across the Hall element, producing a control current in phase with it, and also across a reactive circuit, including the electromagnet and unknown inductance, in which there is a phase difference between the current and the energization voltage. The electromagnet applies a magnetic field to the Hall element which is placed in its air gap. When the unknown L is zero (short circuited terminals), by a suitable choice of circuit components the phase difference between the conrol current I_c and the magnetic flux density B is arranged to be 90°. When an inductance is connected to the terminals the phase shift will differ from 90° causing the Hall element to give a voltage, the d.c. component of which is

$$V_H = \gamma I_c B \cos\phi$$

where γ is the sensitivity of the Hall element and ϕ is the phase angle between B and I_c. Since the phase angle ϕ depends on the value of the unknown inductance and its associated resistance, the Hall element voltage is a function of the inductance and can be measured as such.

Actually, the arrangement in Fig. 5 provides for measurement of the inductor's resistance and for a null-balance measurement of inductance giving greater accuracy and independence of signal source variations. When the switch is thrown to the "bridge balance" position the inductor's resistance can be measured on the resulting d.c. Wheatstone bridge by adjustment of the calibrated "bridge balance" variable resistor. When the switch is thrown to the "read zero" position, the left-hand variable resistor is adjusted until the null detection meter reader reads zero, and in this condition the unknown inductance and other component values are such that $\phi = 90°$. The authors show that the R of the left-hand variable resistor is a linear function of the measured inductance and so this variable control can be directly calibrated in inductance units.

Acknowledgements to the Chairman.—A well-known feature of life in China is that all achievements are attributed to the inspiration of Mao Tse-tung, particularly as received through his "Thoughts." At Warsaw it was interesting to see this influence in the Chinese contribution mentioned above, which began:—

> "Under the leadership of the Chinese Communist Party and the brilliant illumination of Chairman Mao Tse-tung's thought, our national metrological enterprise, just like our other departments, has got a rapid development. Therefore, there is a higher demand in the measurement of a.c. voltage ratio. By promoting the revolutionary spirit of relying on ourselves and to work vigorously, we have carried out our scientific research with the dialectical materialistic point of view and methods explained in 'On Contradiction' and 'On Practice.' We have overcome a series of difficulties with the work-style of 'daring to think and daring to act.' Eventually a method of precise measurement of complex-voltage ratio of i.v.d. at audio frequency has been developed within a short period."

and ended:—

> "That the research can be accomplished within such a short period is the result of the concern of our Party and Government, and also of the constant studying and applying of Chairman Mao Tse-tung's works in a creative way by our comrades in class struggle and the struggle for production and scientific experiment."

Another Chinese paper from the same Institute, on a bridge for measuring the time constant of resistors, contained similar references to and quotations from Mao's philosophical writings.

BISTABLE RESISTORS

THE fact that vanadium oxide (VO_2) exhibits a large discontinuity in resistivity at a temperature of 68°C has been known for some time, but it is only recently that this effect has been utilised to form a bistable element—which may have application as a storage device. The discontinuity is closely associated with a phase transition which occurs at 68°C. Above this temperature VO_2 has a low "metallic" resistivity, while below it, the material is a semiconductor with a resistivity of the order of 10^3 times higher.

To form a bistable element a bias voltage is applied through a series resistor across a VO_2 crystal 100 μm thick. If the energy dissipation below the transition temperature is less than that required to maintain the crystal at 68°C and if the dissipation above the critical temperature is greater than this, then the device will show the bistable property. A positive pulse applied to the device (superimposed on the bias voltage) with sufficient duration to supply energy to raise the temperature above 68°C (or, conversely, a negative pulse to allow temperature to fall below critical) will switch the element from one state to the other. Typical magnitudes of the quantities involved are: bias voltage 17 V, pulse height 16.5 V, duration 10^{-4} s, mean dissipation 150 mW, resistances of 1500 Ω and 100 Ω for the two states, switching time 100 μs. (The switching time of such a device is limited, of course, by the rate of heat transfer.) This work was reported in *Philips Res. Reports*, **21**, 5, p. 387.

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WW—112 FOR FURTHER DETAILS

WORLD OF AMATEUR RADIO

Growth of the Club Movement

GROWING interest in amateur radio is evident from the fact that during the past 12 months the number of radio clubs and societies affiliated to the R.S.G.B. has increased from 270 to 320—an all-time record. The largest sectional increase has been in the number of clubs and societies associated with seats of learning, which now total 55, compared with 42 a year earlier. Universities account for 25, colleges of further education for 11 and schools of all types for 19. Service establishments, headed by the Royal Air Force with clubs at 17 centres at home and abroad, provide another important section of interest, and more than 20 clubs are associated with commercial concerns of all kinds. Just how many individuals are members of the 320 clubs is not known, but if an average of 30 per club is accepted as reasonable the total is approaching 10,000.

British Success in VHF/UHF Contests

AGAINST strong competition from European contestants Jim Foster (G2JF), of Wye College, Kent, took first place in the 1966 I.A.R.U. Region I v.h.f./u.h.f. contest for fixed stations operating on 144 Mc/s, the results of which have just been announced by the organizing society, *Reseau des Emetteurs Francais*. Mr. Foster scored 50,116 points in a field of 375 competitors drawn from 19 countries, with Czechoslovakia, Germany (East and West combined) and Italy providing the highest number of entrants. Second place was taken by a Swedish station (SM7BZX) with 46,059 points, followed by the West German station DLØZW (44,360 points). British stations were also placed first in the contests for fixed stations operating on 1,296 Mc/s and for mobile or portable stations working on the same band, the winners being, respectively, W. R. Hawthorne (G3MCS), of Aylesbury, Bucks., and P. V. Dutfield (G3OBD/P), of Poole, Dorset.

The I.A.R.U. Region I v.h.f./u.h.f. contests take place annually in September and are organized on a rota basis by I.A.R.U. Region I member societies. This year's event, which took place on September 2nd/3rd, was organized by the Danish Amateur Radio Society.

Mr. Foster's success in the 1966 contest followed earlier successes in the 1962 and 1963 events. An idea of the intensity of his activities on 144 Mc/s can be judged from the fact that he has contacted more than 3,200 different stations in 24 European countries. Mr. Foster's station is located 600 ft above sea level, which means that it virtually overlooks the English Channel and has falling countryside in other directions—an ideal site for v.h.f. operation.

December R.A.E.—The winter Radio Amateurs' Examination, organized by the City and Guilds of London Institute, will be held on Tuesday, December 5th, at 18.30 at the College of Preceptors, Bloomsbury Way, London, W.C.1. Applications to sit the examination must reach the Radio Society of Great Britain, 28, Little Russell Street, London, W.C.1, not later than October 31st, accompanied by an entry fee of £2 5s in the case of non-members. The December examination is arranged primarily for the benefit of candidates who fail to pass the examination held during the previous May.

EXPO '67.—Among the thousands of exhibits at EXPO '67, the Canadian Centennial Exhibition in Montreal, is an amateur radio station VE2XPO. Situated on La Ronde, a small island in the centre of the Exhibition the station can be heard most days on 21.3 Mc/s between 14.00 and 15.00 G.M.T. and most evenings on 14.15 Mc/s at about 22.00.

National Field Day Winners.—One of the oldest established radio clubs in the British Isles—the Surrey Radio Contact Club centred on Croydon—was winner for the first time of the National Field Day Shield, most coveted of all the trophies available for competition in R.S.G.B. circles. There were 42 entries. With a score of 2,061 points it was closely followed by the South Birmingham Radio Society (2,032 points) and the Cannock Chase Amateur Radio Society (2,029 points). In the single station section, with 74 entries, Norfolk Amateur Radio Club led the field with a score of 1,208 followed by the Great Yarmouth & District Group (1,023) and Basildon & District Amateur Radio Society (997). National Field Day first took place in 1933 and, except for the war years, has been an annual event since. It is estimated that at least 2,000 people play some part in every N.F.D. This year's event was held on June 3rd/4th.

Beacon News.—Reports on beacon transmitters now operating from Gibraltar and St. Helena will be appreciated by the Scientific Studies Committee of the R.S.G.B., c/o 28 Little Russell Street, London, W.C.1. The Gibraltar station (ZB2VHF) recently provided 64 contacts in two days with 49 different stations in 14 countries on 4 metres with D. Carden (G3RIK) of Rochdale, Lancs., claiming the honour of the first UK-ZB2 contact followed two minutes later by C. Miles (G3TOT), of Knebworth, Herts. The St. Helena station (ZD7WR) is operating in the 2-metre band for the purpose of investigating trans-equatorial scatter on paths to Gibraltar and the United Kingdom, and in view of recent long distance results on this band there seems to be a reasonable chance of contacts being established with stations in the British Isles.

Britain's Lady Radio Amateurs.—Three of Britain's lady radio amateurs have qualified for the exclusive DX-YL Certificate awarded to licensed lady operators who have made contact with 25 or more other YL operators in distant countries. Introduced nine years ago by the Young Ladies' Relay League, the first certificate went to Molly Henderson, ZE1JE, of Salisbury, Rhodesia. Since then 30 of the 8,000 ladies throughout the world that hold a licence, have qualified for the certificate. The United Kingdom holders, all of whom have been licensed for more than 30 years, are Nell Corry (G2YL), of Tadworth, Surrey, Barbara Dunn (G6YL), of Darleston, Cumberland, and Constance Hall (G8LY), of Lee-on-Solent, Hampshire. Although the number of lady operators continues to grow each year the 50 mark has yet to be reached in the United Kingdom.

Amateur Radio on the "Hope."—The hospital ship *Hope*, which is at present in Cartagena, Colombia, as part of the "People to People" programme, will be stationed there until the end of the year when she returns to the United States for refitting prior to leaving for Ceylon for her next mission of mercy. This is the sixth year the ship has carried its programme of teaching service to areas of the world requiring her help. Amateur radio, according to Dr. Harold Morgan, KØTP writing in *QST*, is usually the only means of maintaining contact between those on board the ship and their relations at home. Telephone contacts are expensive and not too dependable from many parts of the world visited by the ship. Crew pay is low and the medical staff (doctors and dentists) donate their services. Mr. Don MacLean, VE3BFA, of Sudbury, Ontario, Canada, is the full-time operator of the amateur radio station on board the ship which is currently operating under the call sign HK1AFG. The station equipment was donated and is maintained by Hallicrafters and a three-element beam is mounted on the starboard mast. Dr. Morgan recently spent two months on board the *Hope* as a radiologist during which time he frequently operated the amateur radio station.

JOHN CLARRICOATS, G6CL

Colour Receiver Techniques—10

Circuit Round-Up

A look at colour television receiver sections which in the main use techniques common to colour and black-and-white practice

By T. D. TOWERS,* M.B.E.

IN articles in this series so far, we have concentrated on the sections of the colour television receiver with features special to colour practice. To complete the picture to some extent, this article surveys most of the remaining sections, including the vision i.f. amplifier, the sound i.f. amplifier, the luminance amplifier, the a.g.c. control section, and the timebases. In addition, we take a brief look at the technique of automatic "degaussing," as colour receiver designs now often include this.

At present colour receivers in this country are dual-standard, but, since colour is on 625 lines only, the circuits used here have been simplified to show only the 625-line portions of them, eliminating the separately switched 405-line portions. Illustrations are from a modern colour receiver design by Mullard Ltd.

VISION I.F. AMPLIFIER STRIP

Fig. 1 shows the circuit of a three-stage vision i.f. amplifier and detector for a 625-line colour television receiver, with a 5 Mc/s 6 dB-bandwidth centred on a 37 Mc/s midband frequency. Bandpass coupling is used on the input from the tuner, but interstage and detector couplings are by single-tuned circuits, stagger tuned. Higher gain could have been achieved by bandpass interstage coupling. However, the extra gain was not necessary in the design and the use of single-tuned circuits led to better production reproducibility.

The i.f. amplifier uses BF167 and BF173 n-p-n silicon v.h.f. transistors which have exceptionally low collector-base feedback capacitance (of the order of a few tenths of a picofarad) making it possible to use them un-neutralised, as here.

Some designs use separate detectors for luminance-chrominance and inter-carrier f.m. to reduce intermodulation beat between the chrominance and sound signals. The design of Fig. 1, however, uses a single detector, and avoids beats by attenuating the sound carrier about 36 dB down on the chrominance carrier in a trap circuit in the front end of the i.f. amplifier.

The amplifier has a total voltage gain of some 70 dB. A 37 Mc/s mid-band signal of about 150 μV at the base of the first transistor produces 1 mV at the base of the second and about 20 mV at the base of the third to give finally 2 V d.c. from the detector (corresponding to 1 V d.c. at the 39·5 Mc/s vision i.f. frequency). These figures imply stage gains of 14 dB, 26 dB and 30 dB approximately.

*Newmarket Transistors Ltd.

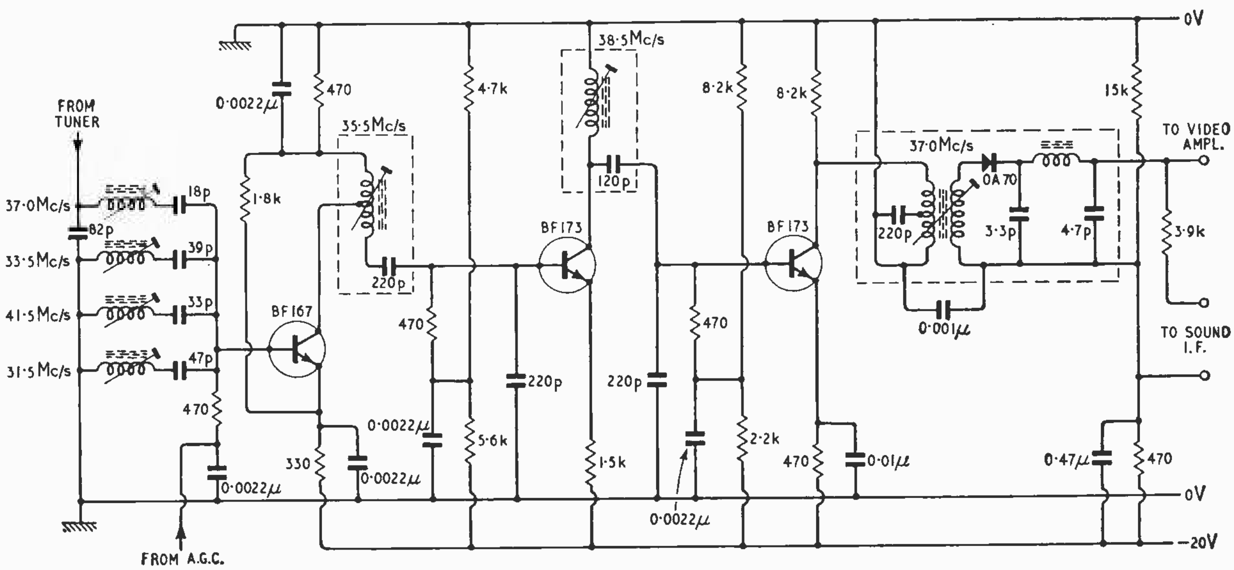


Fig. 1. Vision i.f. strip up to video detector stage.

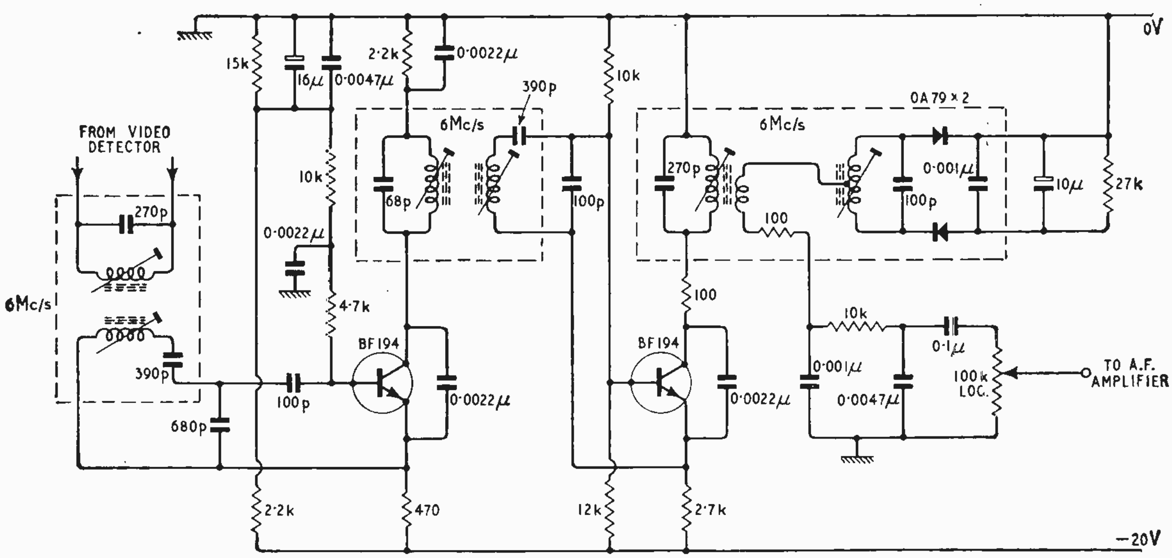


Fig. 2. 6Mc/s intercarrier sound i.f. strip.

A broadband, bottom-capacitance-coupled transformer feeds the tuner output to the input of the i.f. amplifier, the transformer primary being in the tuner itself (not shown). The secondary appears in Fig. 1, with capacitance-tapping into the base of the first-stage transistor to reduce the effects of the variation in the input impedance of the first transistor as its bias conditions are varied by the a.g.c. control voltage. The input stage is shunted by three separate acceptor traps: 33.5 Mc/s sound-carrier attenuation, 31.5 Mc/s adjacent-channel vision, and 41.5 Mc/s adjacent-channel sound.

The first-stage BF167 is a special transistor with a forward-gain-control characteristic. Its gain is maximum at about 4 mA collector current, and reduces by 40 dB at 13 mA. The a.g.c. control signal is derived from a separate section, to be described below, and is applied to the base of the first transistor through a 470-ohm isolating resistor decoupled by a 0.0022μF capacitor. The collector of the transistor is tapped down into the tuned load circuit, so that changes in its output impedance with varying a.g.c. affect the tuned circuit to a minor extent only. The collector circuit is tuned 1.5 Mc/s off the 37 Mc/s midband frequency to 35.5 Mc/s, and has a working Q of about 20. Capacitive-tapping is used here, too, for coupling into the input of the second stage.

The second stage (not a.g.c. controlled) has its collector tuned circuit stagger-tuned 1.5 Mc/s on the other side of 37 Mc/s mid-band to 38.5 Mc/s. It also has an operating Q of about 20 and is capacitive-tapped into the third stage.

In the third stage, the coupling between the transistor and the diode detector is a low-Q, broadband, single-tuned circuit, in which the inductance is tuned by the transistor output capacitance to a midband frequency of approximately 37 Mc/s. The tuned circuit is coupled to the diode detector by a secondary overwind, bifilar wound with the primary. This provides d.c. isolation for the diode and its loads. A pi-type h.f. filter is used after the detector to allow a relatively small filter input capacitance to be used so that changes in reflected tuning capacitance are kept low and phase modulation reduced.

From the detector stage, two outputs are taken off; one carrying luminance, chrominance, and sync to the luminance amplifier, and the other 6 Mc/s inter-carrier sound to the sound i.f. amplifier. You will be able to follow these into the circuit diagrams of the relative sections below.

SOUND I.F. AMPLIFIER

Fig. 2 shows a transistorised 6 Mc/s two-stage sound f.m. i.f. amplifier. It has the input from the video detector fed in through a 6 Mc/s bandpass circuit, capacitive-tapped into the base of the first transistor. A 6 Mc/s bandpass coupling is used also between the first and second stages. In the collector circuit of the second transistor, the 6 Mc/s tuned output circuit is transformer-coupled to a conventional f.m. ratio detector. The detector output is fed into the top end of a 100 kΩ logarithmic volume control, from which the audio signal is led off to a conventional audio amplifier (not shown) employing a PCL86 triode-pentode valve.

It will be noted that no a.g.c. is applied to the inter-carrier sound i.f. strip. The amplifier operates at maximum gain, and has a limiting action on the 6 Mc/s sound signals.

LUMINANCE AMPLIFIER

Fig. 3 gives the circuit of a luminance amplifier design for colour television. The basic function of the amplifier is to amplify the video signal from the detector sufficiently to drive the red, green and blue cathodes of the picture tube. The voltage gain of the amplifier overall is approximately 35 times to allow the full tube cathode drive of 100 V black-white with a 3dB bandwidth of about 5 Mc/s to be obtained from a 3 V black-white detector output.

Besides amplifying this luminance signal, the amplifier also provides drives from separate take-off points to the chrominance amplifier, the a.g.c. control, the sync separator circuit and the saturation preset circuit in the chrominance amplifier.

The BF194 first stage transistor in Fig. 3 acts as a phase splitter. The luminance signals are derived from its collector and the chrominance and a.g.c. drives from its

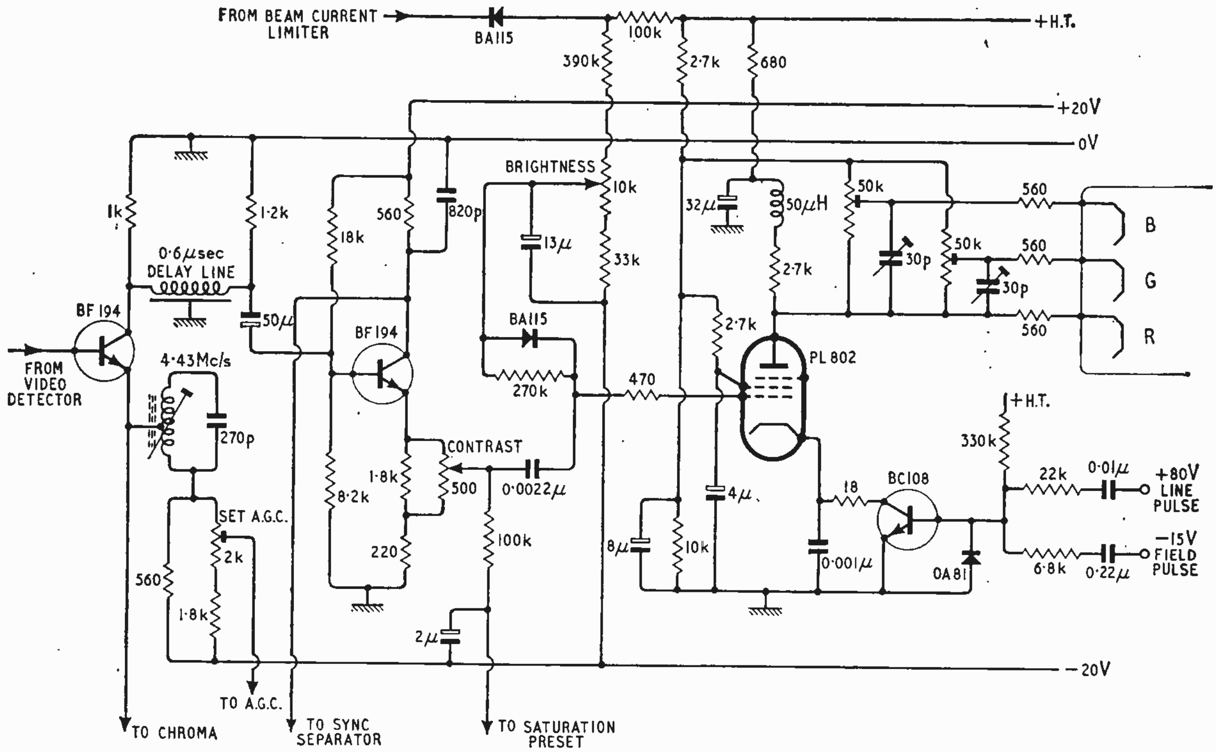


Fig. 3. Luminance (video) amplifier.

emitter. The resistances in the emitter circuit give the stage a high input impedance, designed to provide a light loading on the detector circuit. The emitter circuit includes a rejector trap tuned to the 4.43 Mc/s colour subcarrier frequency. The negative feedback caused by this emitter trap reduces the amplitude of the luminance signal output at the collector by about 3-4dB at the subcarrier frequency. This reduction of the luminance amplifier response at 4.43 Mc/s reduces the radiation of subcarrier from the amplifier and the visibility of the subcarrier pattern on the picture.

Drive from the first to second stages of the luminance amplifier is via a 0.6 μs delay line, for delay equalization of the picture tube drive signals. It will no doubt be remembered that the signals through the luminance amplifier have to be delayed with reference to the signals through the chrominance amplifier because of the narrower bandwidth of the latter. This ensures that the chrominance and luminance signals arrive together at the picture tube. Various forms of delay lines can be used but this design uses an air-cored, distributed-element unit, which is now being commonly adopted because it is cheap and gives a good performance over the required video bandwidth. Such a delay line has an average insertion loss of only about 1.5dB.

The second BF194 transistor in Fig. 3 also operates as a phase splitter, with the luminance signal taken from its emitter and the sync separator pulse drive from its collector. The 500-ohm potentiometer in the emitter circuit provides manual control of the overall gain of the amplifier and thus control of contrast.

From the slider of this potentiometer a signal proportional to the contrast level is taken off by a smoothing, 100kΩ-2μF, filter network as a d.c. saturation tracking control voltage for the chrominance amplifier. This control voltage is applied to the junction of the two current-biased diodes used in the manual gain ("saturation") control of the chrominance amplifier. (This was shown in detail in Fig. 8 of the article in this series in the July, 1967, *Wireless World.*) This arrangement of coupling the luminance contrast control electrically with the chrominance saturation control ensures that the colour saturation tracks automatically with variations in contrast. This means that, once the saturation level has been manually set in the chrominance amplifier, you can operate the manual contrast control on its own without having to constantly adjust the saturation control in step with it.

The luminance output from the contrast control is capacitance-coupled to the grid of the PL802 luminance output pentode valve, via a 470-ohm grid-stopper resistor. The d.c. bias on the grid of the PL802 is varied by a manual 10 kΩ potentiometer "brightness" control across the h.t. rail. The BA115 diode between the control slider and the valve grid acts as a d.c. restoration diode operating on sync pulse tips.

In the cathode circuit of the PL802, in Fig. 3, you will note a BC108 transistor used for blanking insertion. This transistor is normally bottomed by the current through the 330 kΩ resistor from +h.t. into its base. In the bottomed condition, its collector-emitter provides an effectual short circuit, and the PL802 cathode sees only the 18-ohm cathode resistor with a 0.001 μF capacitor shunting it for h.f. compensation. On line and field flyback, negative pulses are fed in to the BC108 base to cut off the transistor, and thus provide line and field blanking by inserting an effective high resistance in the PL802 cathode circuit. The OA81 diode is included to protect the emitter junction of the BC108 from high voltage reverse spikes which might lead to its breakdown.

In the anode circuit of the PL802, a 2·7 kΩ load resistor with an associated 50 μH peaking coil provides direct drive via a 560-ohm stopper resistor to the red cathode of the picture tube. Appropriately scaled down drives are provided to the green and blue cathodes by 50 kΩ preset potentiometers with smaller trimmer capacitors connected across them to compensate for the loss of drive at the higher luminance frequencies.

The BA115 diode at the top of Fig. 3 is connected to the control grid circuit of the e.h.t. shunt stabiliser triode valve. (Shunt stabilised e.h.t. circuits were discussed in the July, 1967, article in this series.) If the picture tube beam current increases excessively, as for example by someone turning up the brightness unduly, the shunt stabiliser cuts off and its control goes negative, causing the BA115 diode to conduct. This causes the d.c. voltage at the top of the brightness control 10 kΩ potentiometer to fall. This in turn reduces the picture tube brightness and the arrangement thus limits the mean current of the picture tube to a safe value.

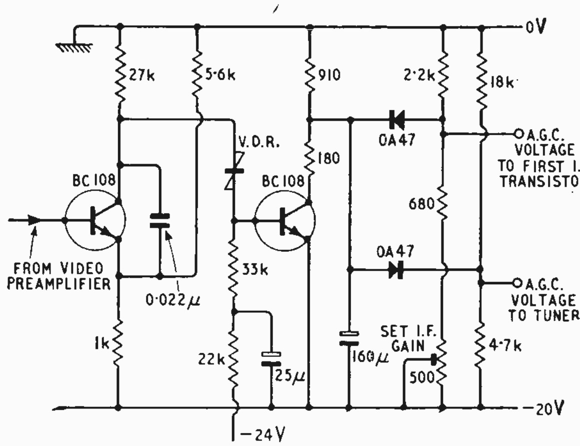


Fig. 4. A.g.c. control circuit.

A.G.C. CONTROL CIRCUITS

In colour television receivers, a.g.c. is conventionally applied both to the tuner and to the first vision i.f. transistor. The a.g.c. control voltages are produced in some circuit such as Fig. 4. The input to this circuit is derived from the emitter circuit of the first luminance stage, as shown in Fig. 3 above. The input level is set by a preset potentiometer take-off in the luminance amplifier. Thus a preset-adjustable proportion of the video signal is fed into the base of the first transistor in Fig. 4. The 5·6 kΩ, 1 kΩ potentiometer network across the supply applies a reference bias voltage to the emitter of the first transistor. When the input from luminance amplifier exceeds this bias by the 0·6 V base-emitter threshhold, control begins and the transistor draws pulses of current proportional to the height of the sync. pulse peaks above the threshhold voltage. These current pulses are smoothed and fed to the second BC108 transistor via a voltage-dependent-resistor.

When the signal level is low, the first BC108 transistor is cut off and the second one bottomed, so that the junction of the 910-Ω and 180-Ω resistors in its collector circuit is at a substantial negative voltage. As signals increase and the a.g.c. comes into operation, the current in the second BC108 begins to fall and the voltage in the collector circuit rises towards zero volts. This voltage is connected as a control to the bias circuits of the first vision i.f. transistor and the tuner r.f. transistor through the OA47 " delay " diodes. As the voltage on the left of the diode rises towards zero with increasing signals, first of all the top diode conducts and forward biases the first i.f. transistor to reduce its gain as explained earlier. When the i.f. gain has been reduced as far as possible, the lower diode comes into operation and applies progressive gain reduction to the tuner transistor.

As the a.g.c. action is controlled by the sync. pulse peaks, it is independent of the vision modulation on the received signal.

SYNC PULSE SEPARATION

In a colour receiver, the sync pulse separator circuits are very similar to those of a black-and-white one. Fig. 5 shows a typical circuit using a single-transistor pulse separator controlling a line timebase oscillator via a double-diode phase detector and providing a separate field sync pulse drive to the field timebase.

Sync pulse signals (derived from the collector circuit of the second stage of the luminance amplifier in Fig. 3.)

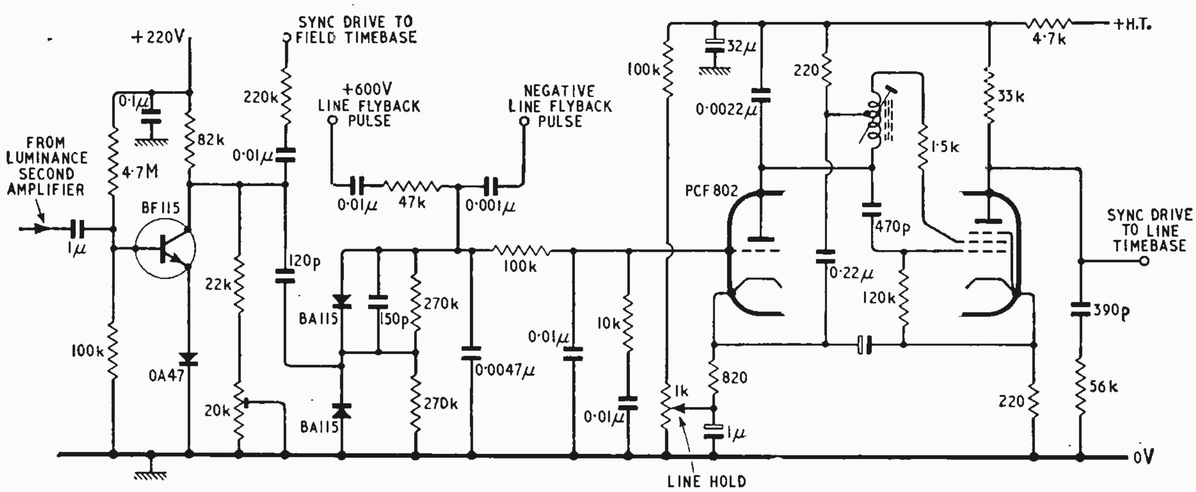


Fig. 5. Sync pulse separator (and line timebase oscillator) circuit.

are fed via a long time-constant $1\,\mu$F-100 kΩ to the base of the sync pulse separator transistor BF115 in Fig. 5. The 4·7-megohm resistor associated with this network ensures that the sync separator transistor bottoms satisfactorily during sync pulse tips, even with low-average video signals. The OA47 diode in the emitter circuit is a protection against the breakdown of the emitter junction of the BF115.

The collector output of the BF115 is fed via a 120-pF capacitor to the double-diode phase detector using a pair of B115 diodes. The sawtooth phase-reference waveform for the detector is derived from a positive, 600 V, line-flyback pulse, integrated by a 0·01 μF-47 kΩ network. A correcting, negative, line flyback pulse is also applied through a 0·001 μF capacitor to enable the phase detector to operate with an output potential of nominal zero volts at phase centre. A small 150 pF capacitor across the upper diode is included to keep the "pull-in" symmetrical about the centre frequency.

The PCF802 triode-pentode valve serves two purposes. Its pentode section operates as a screen-coupled Hartley oscillator with the line drive developed at its anode. Its triode section functions as a variable reactance valve controlling the frequency of the pentode output oscillator by means of the d.c. output from the phase detector circuit. Manual line hold control is effected by varying the cathode voltage of the triode by a 1 kΩ potentiometer fed through 100 kΩ from the h.t. rail.

The output from the pentode line drive valve is fed off to the grid of the line output valve, the circuitry of which will be found displayed in Fig. 3(b) of the April, 1967, article in this series. The field sync output from the collector of the BF115 in Fig. 5 is taken off to control the field timebase, whose circuit was given in Fig. 4 of the same article.

Typical performance figures for the 15,625 c/s line timebase oscillator, controlled by the sync separator as in Fig. 5, are: oscillator control sensitivity 400 c/s per V, pull-in range 800 c/s and mains stability ±5 c/s for ±10% mains voltage variation.

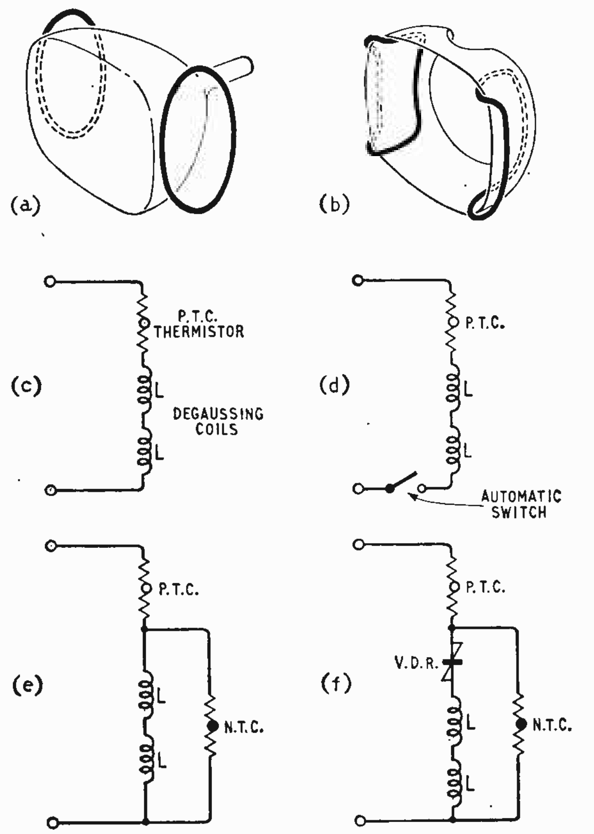


Fig. 6. Automatic degaussing arrangements: (a) location of degaussing coils relative to picture tube; (b) practical dressing of coils inside tube shield; (b) use of p.t.c. thermistor to reduce coil current to negligible proportions after initial high current surge; (d) automatic switch-off after initial degaussing; (e) shunt n.t.c. thermistor used with series p.t.c. one to reduce residual current in coil; (f) voltage-dependent-resistor in series with coil to further reduce residual current of (e).

AUTOMATIC DEGAUSSING ARRANGEMENTS

Automatic "degaussing" is becoming standard in colour television receivers. In this arrangement, the colour tube and related magnetic components are demagnetized automatically each time the receiver is switched on. This ensures consistent colour purity, and eliminates the problems of picture tube beam misregistration that may be caused by changes in the position of the receiver or by accidental magnetization.

A number of methods have been used from time to time for automatic demagnetization. The present trend appears to be to use two coils sited symmetrically around the picture tube and, by means of control circuits, to feed these from 50 c/s mains in such a way that on receiver switch-on a very high a.c. current is passed through the coils initially. The control circuit then reduces the coil current steadily to negligible proportions.

The ferrous components which require demagnetizing are mainly the tube shadow mask, the "trim" band round the screen and the magnetic shield round the cone. For effective degaussing, the magnetic field applied by the coils must initially be large enough to produce saturation of the ferrous material. A field of the order of 500 At is normally sufficient.

Fig. 6 (a) shows diagrammatically a pair of degaussing coils located on either side of the picture tube. In practice these are shaped to fit partly inside and partly outside the magnetic screening shield round the cone as shown in Fig. 6 (b). Because they are in contact with the shield, the coils are insulated sufficiently for operation from the mains with the shield earthed.

The coil specifications depend a great deal on the control circuit used to feed them with gradually reducing current from the 50 c/s mains. Apart from the initial 500 At field required to saturate the ferrous components, it has been established that the residual field should not exceed about 0.3 At, if no measurable effects on beam registration are to be observed.

As to the control circuit for the degaussing coils, British practice seems to be tending towards the use of a p.t.c. (positive-temperature coefficient) thermistor in series with the coils across the mains, the coils being connected series-aiding to produce the required magnetic field around the tube and ferrous components. This is shown in basic form in Fig. 6 (c). The p.t.c. thermistor starts with a very low resistance, so that the current through the coil is high on switch-on. As the thermistor heats up with the current passing through it, its resistance rises rapidly and in a very short time the total current through the thermistor and the degaussing coils reduces to a low value.

In this simple form the residual coil current (and thus magnetic field) may be unacceptably high. One way of eliminating this is to include an automatic switch as in Fig. 6 (d). This switch closes when the receiver is switched on and automatically opens itself after a short period. It may be either a special arrangement on the mains on/off switch or it may be controlled by a bi-metal strip.

An alternative arrangement to minimize the residual current through the degaussing coils is shown in Fig. 6 (e) which uses an additional n.t.c. (negative-temperature-coefficient) thermistor shunting the degaussing coils. The p.t.c. thermistor operates as before. The added n.t.c. thermistor, with an originally high resistance, bleeds off only a small portion of the initial high surge current through the coils, but, as it heats up, its resistance falls and progressively shunts the coils. This finally reduces the residual current in them to an acceptably low level.

A refinement of the combination of p.t.c. and n.t.c. thermistors that has been tried is shown in Fig. 6 (f) where a voltage dependent resistor, v.d.r., is placed in series with the degaussing coils. Initially, when the p.t.c. thermistor has a low resistance, and the n.t.c. a high resistance, the voltage drop across the v.d.r. is low. As the voltage across the coils falls with the rise in resistance of the p.t.c. and the fall in resistance of the n.t.c. thermistors, the resistance of the v.d.r. rises sharply and reduces to a very low level the residual current in the degaussing coils.

The use of a voltage dependent resistor can introduce harmonics of the 50 c/s mains frequency, and, in more refined versions of the automatic degaussing circuit, you may find various arrangements to cancel excessive residual current in the coils by means of anti-phase 50 c/s transformer-driven circuits.

CONCLUSION

In this article we have covered all the sections of the colour television receiver not dealt with in previous articles, except for the tuner, which is a highly specialized part of the receiver. At present only dual-standard 625/405 line u.h.f./v.h.f. tuners are fitted to British colour receivers. The circuit complexity of such dual-standard tuners rules out their discussion in an article of this length.

COMPONENT SPECIFICATIONS

Prague Meeting of the International Electrotechnical Commission

MORE than a thousand delegates from 31 countries were present at the 32nd general meeting of the International Electrotechnical Commission recently held in Prague.

The technical committee (TC 40) concerned with capacitors and resistors continued its trend in reshaping the basic specifications. It is hoped that by the next meeting, probably in 1968, the test and terminology documents for fixed capacitors, potentiometers and fixed resistors will have successfully completed their voting stages and may even be ready for publication. The way is now clear for the preparation of detail specifications and it was agreed that proposals should be examined by the national committees prior to the next meeting. The specification structure proposed is: —

(a) Test and terminology
(b) Standard values and procedures
(c) Detail specifications.

Another step forward by TC40 was the decision to circulate the proposals of its working group on acceptance and assurance testing. Acceptance testing, being carried out on a lot-by-lot basis, would be divided into two groups. *Group A* includes those tests after which the specimens may be returned to bulk supply, e.g., visual examination and measurement of primary characteristics. *Group B* includes those tests after which the specimens must be discarded, e.g., solderability, robustness of terminations, and short-term humidity tests.

Assurance testing will be carried out at less frequent intervals and TC40 have suggested three months and one year as being appropriate intervals. The tests to be performed at three-monthly intervals are: long-term damp heat, electrical endurance at rating conditions, and reliability assessment. Annual tests are of a design proving nature, e.g., resistance to mould growth, flammability, and electrical endurance at extreme ambient conditions.

The committee also continued its efforts to rationalize the sizes of capacitors and resistors. The first steps were taken some time ago to produce overall sizes acceptable to the majority of countries and attempts are now being made to produce more practical sizes so that for example, the long thin resistor can be identified separately from a short fat one having the same rated dissipation. Agreement was also reached that the draft giving definitions, test methods and requirements for thermistors with negative temperature coefficients should be circulated for approval by individual countries. The draft covers thermistors having power ratings from 50 microwatts to 2.5 watts and capable of use in a wide range of applications such as medical electronics television receivers and industrial process control equipment.

The sub-commmittee (SC 40A) concerned with variable capacitors is circulating for approval documents on air dielectric rotary variable capacitors and a guide on the use and testing of variable capacitors. It is also preparing a general document on terms and methods of test for variable capacitors.

The intention of the United Kingdom to "go metric" was apparent during a discussion on the dimensions of spindles and bushes by members of sub-committee SC 48C (switches) when the delegation stated that they would no longer be putting forward proposals for inch sizes. The discussion revealed that there was little disagreement on basic dimensions (eg., 4, 6 and 10mm diameter spindles) and a Working Group has been set up to make proposals for the shapes of spindle ends with their dimensions and associated tolerances. The sub-committee also agreed that in future its specifications should cover three applications, special purpose, general and commercial, in a manner similar to that used in the United Kingdom Common Standards.

Technical committee 56 (reliability) made some progress in extending the lists of terms and definitions, presentation of reliability data and collection of data from the field. However, an impasse was reached on the inclusion of reliability requirements into specifications. Agreement could not be obtained on the alternative U.K. and U.S.A. approaches. It was therefore agreed that a working group be set up to examine the differing views and to try and reach a solution acceptable to the committee. A report was received from the working group which had been studying acceptance and assurance testing. The report is being circulated to National Committees and it will be noted that the principles evolved by the U.K. Committee of Common Standards for Electronic Parts would need little modification to fit the proposals being put forward.

LETTERS TO THE EDITOR

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

Electronics and Vehicle Automatic Control

MAY I congratulate "Vector" on his "Thoughts from a Lay-by" in your September issue, in which he pointed out the deficiencies of the human being as a vehicle control system and suggested that electronics should be used instead.

Considerable work has, in fact, been done on automatic cars both in this country and abroad, e.g., America and Japan. As "Vector" said, the feasibility of using buried cable for vehicle guidance was demonstrated several years ago, for instance during the Road Research Laboratory's Open Days in 1961. However, as far as we know accurate high-speed vehicle guidance has only been achieved using cars fitted with very expensive electro-hydraulic steering systems. It is now necessary to develop a steering actuator which can be mass produced cheaply enough for public acceptance.

Cost is also the chief problem with anti-collision systems. Various technically feasible proposals have been made, such as use of inductive loop vehicle detectors buried every few feet along the road, or fitting all vehicles with radar sets and perhaps transponders. However, consideration of present car insurance premiums suggests that the maximum price worth paying for an anti-collision system is about £10 per year per vehicle, and it has not yet been possible to make an effective system as cheaply as this. We hope that advances in solid-state microwave sources and microcircuits will overcome this problem in a few years time, but until then vehicle anti-collision systems seem likely to be restricted to applications where higher costs are acceptable, for example buses using reserved tracks.

The choice of a country's automated road transport system will be as important and as difficult as selecting its railway gauge or television standard, since it will be extremely expensive to change to a different system later. Thus it is essential for all possible systems to be considered and thoroughly assessed before a choice is made. We therefore welcome discussion of the subject and look with interest at new ideas.

S. PENOYRE

Road User Section,
Road Research Laboratory,
Crowthorne,
Berks.

Noise Figure Measurement

A SIMPLE method of measuring noise figure using a c.w. source was outlined by Mr. C. N. G. Matthews in the August issue. The writers wonder whether the claim that the inaccuracies are not glaring is not justified by the results he quotes. He does not mention that the noise figure is dependent upon source impedance and his method implies using an attenuator whose characteristic resistance equals the required source impedance. An accurate measurement of noise figure using a c.w. method can be made but requires a knowledge of the integrated bandwidth of the measuring system (not just the 3 dB bandwidth). This may be obtained by direct measurement or by measuring the frequency response and integrating graphically.

The noise level with S1 closed (Fig. 1) is noted, the attenuator is then set to 3 dB, S1 opened, the c.w. source increased to give the same reading on the voltmeter and the r.m.s. source voltage is noted. The attenuator is then set to 4.8 dB and the c.w. source voltage further increased to give the original reading once more. This process may be repeated for attenuator settings of 6, 7, 7.8, 8.5 dB, etc., corresponding to an output power multiplication of two, three, four, five, six and seven times the original output noise power.

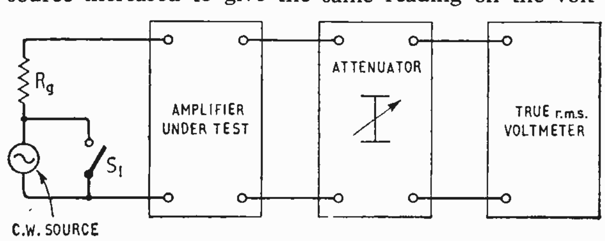


Fig. 1.

All measurements may be referred to the amplifier input terminals merely by dividing by the system power gain. This has been done in Fig. 2.

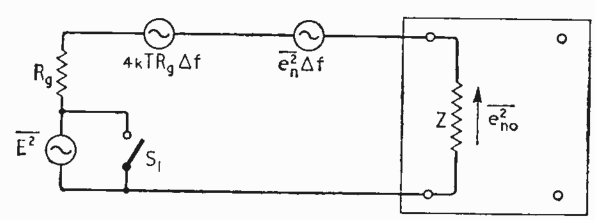


Fig. 2.

Δf is the system integrated bandwidth in hertz.
k is Boltzmann's constant $= 1.38 \times 10^{-23}$ joule/°K.
T is the temperature °K.
$\underline{Z}$ is the amplifier input impedance.
$\overline{e^2_n}$ is the mean-square noise voltage per unit

bandwidth, produced within the amplifier and referred to its input.

$$\overline{e^2}_{no} = (4kTR_g\triangle f + \overline{e^2}_n\triangle f)\frac{Z^2}{(R_g + Z)^2} \quad (1)$$

With S1 open, let $\overline{E^2}$ be the mean-square c.w. voltage to increase the amplifier input power n times

$$n\overline{e^2}_{no} = (4kTR_g\triangle f + \overline{e^2}_n\triangle f + \overline{E^2})\frac{Z^2}{(R_g + Z)^2}$$

Subtract (1) from (2)

$$(n-1)\overline{e^2}_{no} = \overline{E^2}\frac{Z^2}{(R_g + Z)^2} \quad (3)$$

$$\text{Noise Factor} = \frac{\text{Total noise at the output}}{\text{Noise at output due to } R_g \text{ alone}}$$

(which amounts to the same as Mr. Matthews' definition) giving:

$$F = \frac{\overline{e^2}_{no}\,.\,(Z + R_g)^2}{4kTR_g\triangle f\,.\,Z^2}$$

$$= \frac{\overline{E^2}}{(n-1)\,4kTR_g\triangle f} \text{ subst. for } \overline{e^2}_{no} \text{ from (3)}$$

$$\therefore\ \overline{E^2} = (n.4kTR_g\triangle f.F) - (4kTR_g\triangle f.F)$$

Hence a plot of $\overline{E^2}$ versus n yields a straight line of slope $4kTR_g\triangle f.F$ and an intercept on the negative $\overline{E^2}$ axis of $4kTR_g\triangle f.F$. At room temperature 17°C, $4kT = 1.61 \times 10^{-19}$ joule.

Noise figure is $10 \log_{10} F$.

The measurement of noise factor is much simplified if a simple diode noise generator is constructed using a diode such as the G.E.C. A2087. This eliminates the necessity of knowing the system bandwidth and the requirement for a true r.m.s. meter.

R. M. ALLEN & J. MAVOR

Woolwich Polytechnic,
London, S.E.18.

WE would like to take up Mr. Matthews on his reply in the September issue (p. 451) to our criticisms of his original article ("Noise Figure Measurement," August). We assert that the method is fallacious, and to support this contention we present two out of several possible arguments:—

(1) It is true that the noise figure can be defined as the ratio of input to output signal-to-noise ratios, and Mr. Matthews' proposed technique seems to be an attempt to measure this quantity as the difference between two attentuator settings. He presents an argument to justify his conclusion that the difference in attentuator settings (in dB) is equal, or approximately equal, to the noise figure. For reasons which we explained in detail in our earlier letter we think that this argument contains an important oversight, which nullifies the conclusion. Mr. Matthews has so far not answered these detailed criticisms.

(2) As a matter of principle, all methods of noise figure measurement require a noise (or signal) source of calibrated strength. The source is used to add noise (or signal) power to the device until the output meter indication (which initially registers the noise power generated by the device alone) is exactly doubled. The added noise is then equated with the internally generated noise. This technique, with variations, is the basis of all accepted methods. It is not true, as Mr. Matthews asserts, that "all we need is the dB change in noise input to the device under test." What we need is the value of the actual noise power added by the source. Mr. Matthews' attempt to avoid the need for a calibrated source is attractive, but cannot work *in principle*.

F. V. BALE & M. J. S. QUIGLEY

Radio & Space Research Station,
Slough, Bucks.

The author replies:—

I of course agree with Messrs. Allen and Mavor that a signal generator and attenuator will not give a precision noise figure measurement. It is not intended to. It does however give a reasonable indication. Its usefulness is that it requires no specialized equipment.

Without quarrelling with either of the other suggestions I should perhaps mention that for practical purposes we define noise figure as the deterioration in signal-to-noise figure from input to output, normally making the measurement as I described it but using a gas tube or temperature limited diode noise source. Bandwidth does not come into the calculation because we are not concerned with noise in microvolts per root cycle as we would be with, say transistor noise figure measurement. A true r.m.s. meter or a square law detector is as necessary with a noise source as it is with a signal generator.

Turning now to Messrs. Bale & Quigley I would very much like to know who supplies a noise source of "calibrated strength." The gas tube and the temperature limited diode do *not* provide noise of known absolute value, but the excess of "hot" over "cold" noise is accurately known when the source is used under controlled conditions. The value of the noise power added, expressed in dB over cold noise, *is* the dB change in noise input to the device under test. Are we really at odds?

C. N. G. MATTHEWS

Feltham, Middx.

Using Integrated Circuits—Cost and Performance

THE cost of a piece of equipment may be a minor point to Mr. McEvoy ("Letters," September, p. 453), but I doubt whether most readers will see it that way. Since making my original cost comparison I find that the retail price of good silicon a.f. transistors (h_{fe}=250, N.F.=2 dB) has fallen to 2s 6d, and that good resistors can be had for 3d each. This brings the price of my suggested circuit down to 21s 6d, which is less than half the price of the integrated circuit. Adding half a dozen emitter resistors to increase the input impedance if required does not radically change the picture.

It was not my original intention, in making a comparison between the discrete-component and integrated-circuit versions of the stereo mixer unit, to go into the finer points of circuitry. However, since sweeping claims have been made for the i.c. version it is now perhaps in order to look more closely at its circuitry and likely performance. This cannot be done quantitatively from the information in the article, since, apart from figures for gain and bandwidth, no performance data are given, nor are the parameters of the transistors in the i.c., or even the resistance values. Nevertheless, consideration of the circuitry reveals one feature which is likely to produce a poor performance, and perhaps render the circuit unsuitable for use as a stereo mixer. This is the use of a common load resistance for all the emitters of the input transistors. The results of this arrangement are:—

1, reduction of input impedance;

2, deterioration of signal-to-noise ratio;

3, increased distortion; and

4, interaction between volume controls.

The mechanism which produces these defects is quite simple. Consider one of the three emitter-followers at the input as the active input transistor and the other two as passive. The 'gain' of the active emitter-follower can be anything between 0 and 1, depending on its load. In the present case the load is not just the physical load resistance but this resistance shunted by the output impedances of the two passive emitter followers. This is what causes the trouble. If all three transistors are identical, and the bases of the passive transistors are earthed to a.c., then the gain of the active transistor cannot exceed 0.33. This is because the active transistor, in looking into the outputs of the two passive ones, sees a load equal to half its own output impedance.

The immediate result of this low gain is that the input impedance of the active transistor is much lower than might be expected. Again assuming identical transistors, it is only 1.5 times the input impedance of the same transistor in the common-emitter connection.

An indirect effect of the low gain of the input stages is a deterioration of the overall signal-to-noise ratio. The input signal suffers an attenuation of 9.5 dB before it is applied to the gain-producing part of the amplifier. Thus the S/N ratio at the input to the gain-producing part is degraded. The "heavy negative feedback" referred to in Mr. McEvoy's letter does nothing to alter this, since it reduces signal and noise equally.

Another indirect effect is increased distortion. Under the conditions described above, the load of the active emitter-follower is, as we have seen, the impedance looking into the emitters of the other two input transistors. This load is non-linear, and the non-linerarity is in the direction which produces distortion. The half-cycle of input signal which makes the active transistor take more current makes the passive transistors take less. This increases their impedance and raises the gain. On the other half cycle the reverse occurs. Thus one half cycle is peaked and the other flattened.

Now consider what happens if the bases of the passive transistors are not earthed to a.c., but returned to earth through a finite impedance. In practice, this impedance is the source impedance of the input signal, as seen from the base of the passive transistors. Call it r_s. The effect of r_s is to add to the output impedance of the passive transistors a resistance r_s/h_{fe}. Thus, as r_s is increased, the gain of the active transistor moves nearer to 1. In the i.c. mixer circuit, the largest increase in gain occurs when the active transistor is the one with the 5-kΩ volume control VR$_1$, and when the other two inputs are either driven from high impedance sources and volume control VR$_3$ turned right up and VR$_2$ right down. As the volume control at any one input is varied, so the gain experienced by a signal applied to another input also varies. The theoretical maximum variation, with infinite source resistance, is 9.5 dB. A stereo mixer with anything approaching this degree of interaction between volume controls would be very difficult to use. The effect is worst when h_{fe} is low, and the values of base bias resistances specified in the i.c. circuit suggest that the transistors in it do have low h_{fe}.

There is also a crosstalk effect, some of the input signal at one input terminal appearing at the other two. This could make monitoring of the unmixed inputs difficult.

None of the ill-effects mentioned above occurs in the discrete-component circuit. Of course, the relative importance of the various defects in practice will depend on what precisely is inside the i.c. and also on the nature of the signal sources. What is now required is information, in the form of actual measurements of interaction, signal-to-noise ratio, and distortion of the i.c. mixer. One would then be in a position to say whether the millennium has really arrived.

G. W. SHORT

Croydon.

Binary Arithmetic

A CONVERSION from decimal to binary is given in the August issue, page 367. There is a very easy method which can be done mentally. It is to divide the decimal by 2, or halve it, and record the remainders from right to left which will then give the binary. To convert decimal 163 to binary:—

163÷2=81	R.1	1
81÷2=40	R.1	11
40÷2=20	R.0	011
20÷2=10	R.0	0011
10÷2= 5	R.0	00011
5÷2= 2	R.1	100011
2÷2= 1	R.0	0100011
1÷2= 0	R.1	10100011

As the conversion is done mentally, the binary figure is written direct, without any workings shown, being built up from right to left, so—

1023=1111111111; 682=1010101010

E. L. JENKINS

Cheltenham, Glos.

Manx Radio

IN reference to the note on Manx Radio in the September issue of *Wireless World* (page 428), I feel that I should point out that the Isle of Man is *not* part of the United Kingdom.

As far as I know it is a condition of Manx Radio's licence that it should not transmit to the U.K. (this fact has figured in the recent radio controversy in the Isle of Man).

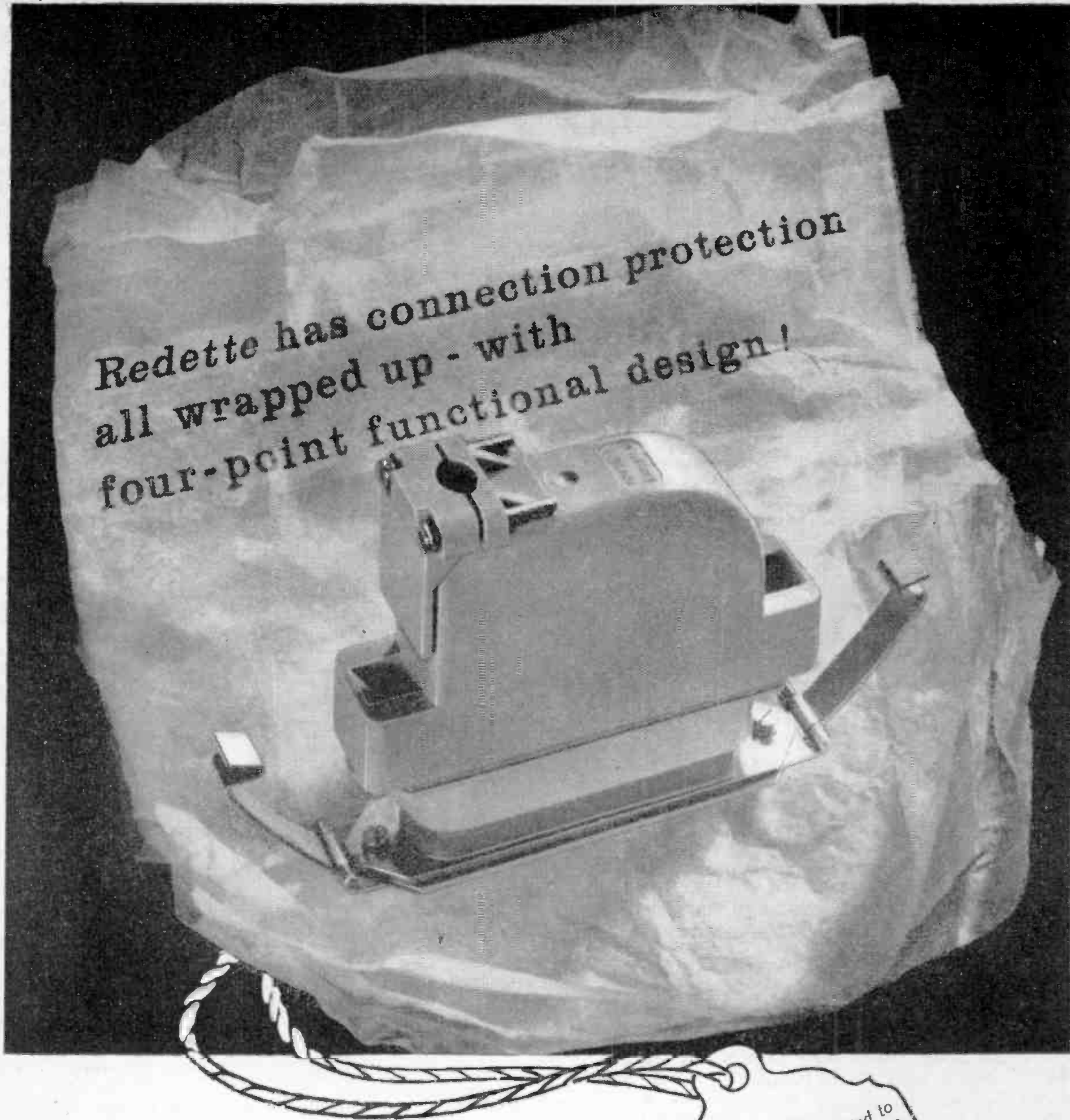
Thus it is hardly correct to state that "Manx Radio is the only local commercial radio station in the United Kingdom."

J. F. CRAINE

Ramsey,
Isle of Man.

OUR COVER

The main theme of this issue—television and sound broadcasting—is typified by our cover illustration specially photographed for us in the latest of the studios at the B.B.C. Television Centre to be equipped for colour. The cameras shown are the Marconi Mk VII which employs a fourth Plumbicon tube to provide a separate luminance signal.



The new Redette range by McMurdo is wrapped in the protection of a specially designed plastic cover – with four big features to give you greater working efficiency, longer life, simpler use and better all-round value! *Point one* is the cover itself – smoothly styled in rugged ABS plastic to keep out dust and moisture and fend off bumps and knocks. *Second point* is the cable clamp. Choice of two positions for top or end cable entry for extra versatility! *Point three* is the flexible ABS plastic shroud that protects chassis-mounted plug-pins and assists polarization and the *fourth point* is strong, secure latching, with nickel plated phosphor bronze retaining clips. With a choice of four ways too (16, 26, 38 and 52) no wonder the well-protected Redette range has big-value connector efficiency all wrapped up! Write or 'phone for facts now.

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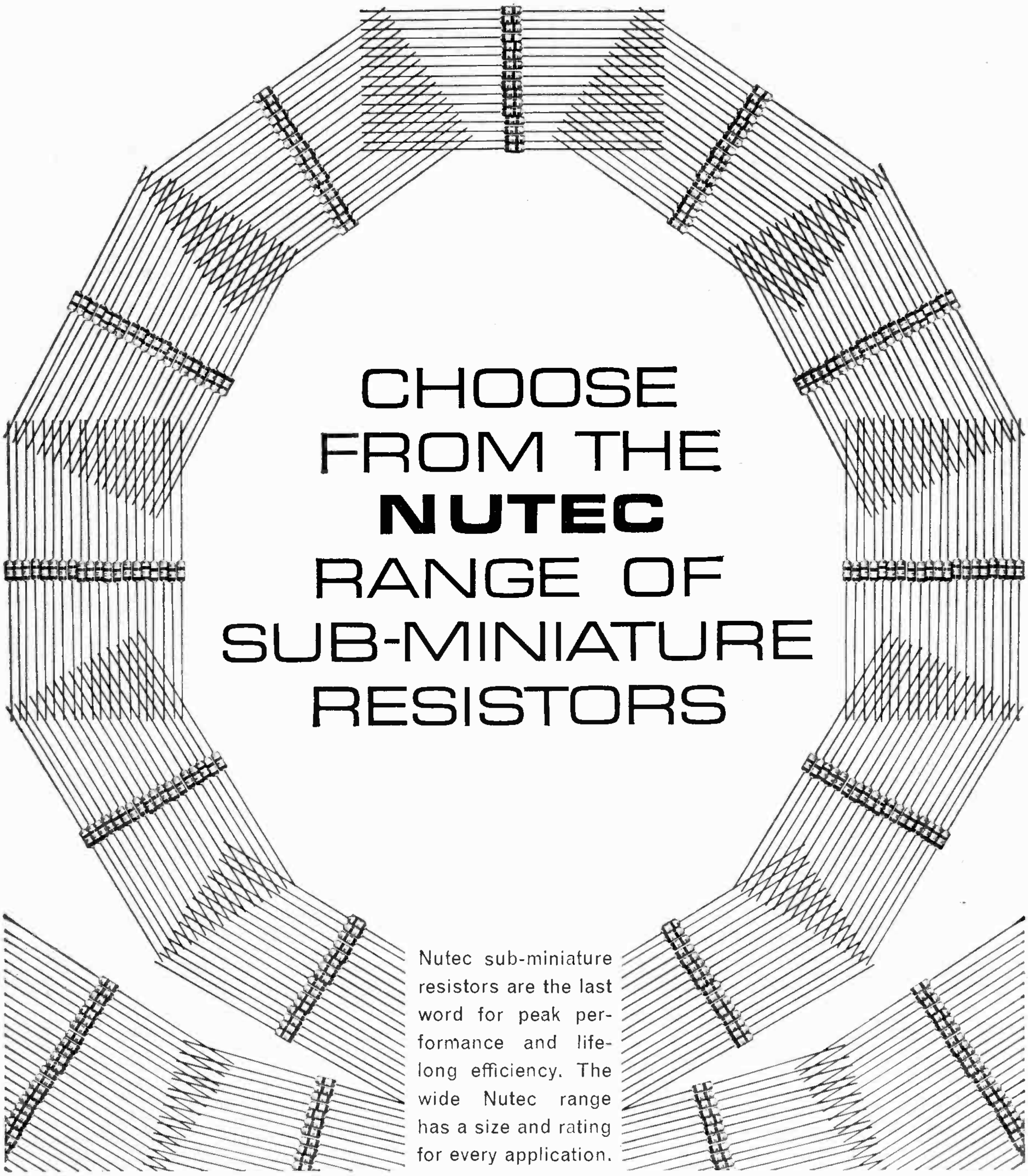
SASCO, P.O. Box No. 20, Gatwick Road, Crawley. Sussex. Telephone: Crawley 28700. Chipping Sodbury 2641. Cumbernauld 25601. Hitchin 2242
PORTUGAL: Agencia Anglo Portugesa, Avenida Fontes Pereira de Meno 15-40 LISBON 1. **SINGAPORE**: Nanyang Radio Co., 213 Victoria St., SINGAPORE 7.
SOUTH AFRICA: Joseph Teer & Son (pty) Ltd., 40 Clommel Chambers, Cr. Eloff & Market Streets, JOHANNERBURG. (Box 1630).

WW—113 FOR FURTHER DETAILS



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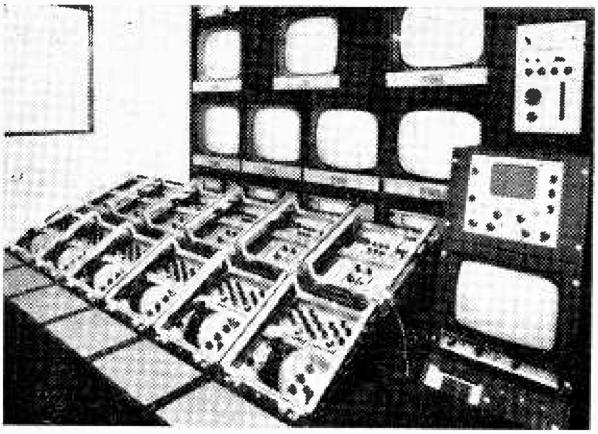
NEWS FROM INDUSTRY



Our photograph shows the camera control position as fitted in outside broadcast vehicles supplied by Pye TVT Ltd. The equipment is from the new system 70 range recently shown at the Design Centre.

Pye TVT Ltd. have won a contract whereby they will supply 50 television transmitters, worth over £2M, to the Independent Television Authority to implement the Authority's forthcoming duplicated 625-line u.h.f. service. The transmitters will be fully automatically controlled and will be unmanned. They will be installed in pairs connected in parallel, at 25 separate sites. Power output varies from 6.25 kW to 25 kW depending upon the site. The first three stations will start monochrome transmissions in the late summer of 1969, going over to colour as soon as possible. The remaining 22 stations will be brought into service successively up to the end of 1971. Incidentally, the I.T.A. colour service is planned to commence in early 1970.

Yorkshire Television Ltd., one of the new programme contractors created in the Independent Television Authority's reshuffle earlier this year, have awarded Marconi a £650,000 contract for the supply of colour television cameras, telecine equipment and outside broadcasting units. Deliveries of the equipment will start in February and the bulk of the order will have been completed in the summer when this new contractor is due to go on the air from a new studio centre at Kirkstall Rd., Leeds.

The Integrated Electronics Division of Standard Telephones and Cables Ltd. have received an order worth over £250,000 for modulator and demodulator equipment to be used on the new **G.P.O. DATEL service** to be inaugurated next year. The equipment is designed to meet a G.P.O. specification enabling data to be transmitted at 2,400 bits/sec over private circuits with standby facilities for alternative transmission over the public network at 1,200 or 600 bits/sec. An optional supervisory return channel with a speed of 75 bits/sec is also available.

Dynamco Ltd., Chertsey, have been appointed exclusive agents in the U.K., West Germany and Eastern Europe for the **Systron-Donner Corp.**, California. Systron-Donner's range of products includes digital counters, analogue computers, pulse generators and transducers.

Decca Ltd. have received a £350,000 contract from the Inner London Education Authority for television receivers for use in schools. The receivers are to be used with a new distribution system devised for schools in conjunction with the G.P.O. which allows flexibility in teaching. The programme can be obtained from a centrally owned studio or from the broadcasting networks.

The Component Marketing Division of Standard Telephones and Cables Ltd. have been appointed sole representatives in the U.K. for the full range of vacuum electronic components produced by **ITT Jennings** of San Jose, California. The range of products include passive devices, capacitors, switches and relays that achieve compactness by virtue of the vacuum in which they operate. The components are suitable for use in extreme environmental conditions.

The Scientific Instrument Control Department of Ferranti has been purchased, together with relevant patents, equipment, stock and work in progress, by Hilger and Watts. The Scientific Instrument Control Department, which has been concerned with the automation of scientific measurements and positional control, has worked closely for a number of years with Hilger and Watts on the control of X-ray diffractometers.

U.K. exports of electronic equipment for the first six months of this year were worth £51.3M compared to £43.9M for the same period last year, according to the figures given by B.E.A.M.A. The increases in the various categories are computers—£2.4M; electronic control equipment—£1.6M; nav. aids and radio communications—over £2M; and telegraph and telephone equipment—£1.3M.

The recent merger between **English Electric** and **Elliott Automation** brings into being one of the largest computer and electronic concerns in Europe, with an annual turnover of approximately £150M. The share capital of English Electric has been increased from £65M to £100M, as agreed by shareholders at the anual general meeting, to enable the merger to proceed. The takeover means that electronics will account for about 40% of the English Electric's turnover.

A contract of some £250,000 has been awarded to Marconi Ltd. by Cable and Wireless (West Indies) Ltd. to provide a 900-Mc/s **tropospheric scatter link** between Guyana and Trinidad, a distance of some 350 miles. Initially 32 voice channels will be accommodated with the facilities to extend this to 48 4-kc/s or 64 3-kc/s channels to C.C.I.R. standards. This new route will improve communications in the area in which Cable and Wireless has recently spent about £5M on radio and telephone cable systems. The two aerials, 60-ft diameter dishes, will be erected at Thomas Lands (Guyana) and Morne Bleu (Trinidad).

Amphenol Ltd have announced price cuts of between 25% and 50% on their 990GB range of trimmer potentiometers.

Ferranti-designed audio equipment, as shown at the Audio Fair, is now available in kit form as pre-assembled modules from Welbrook Engineering and Electronics Ltd., Brooks Street, Stockport, Cheshire.

B.E.A. are to equip their fleet of BAC one-eleven aircraft, due to come into service in August, 1968, with the **Decca Navigator** equipment. The order is worth in the region of £300,000.

Price reductions of up to 50% for Standard Telephones and Cables' range of flatpack d.t.l. integrated logic circuits have come into operation. For example, an MIC 946 Quad 2-input gate which was 37s (100 up quantities) is now 15s 9d, representing a price of less than 4s a gate.

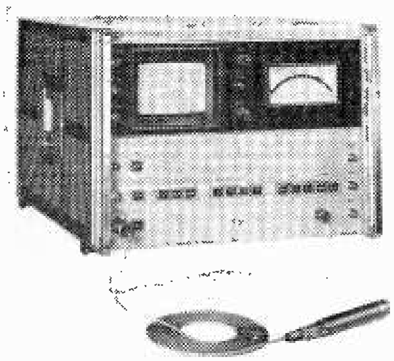
B & K Laboratories Ltd have transferred their sales and service facilities from their headquarters at Tilney St., Park Lane, London, W.1, to new premises at Cross Lances Road, Hounslow, Middlesex. (01-570 7774).

NEW PRODUCTS

equipment systems components

LOUDNESS ANALYSER

AN instrument giving an instantaneous indication of loudness which corresponds to subjective loudness without bandwidth and time duration restrictions has been developed by the German Hewlett-Packard company. The analyser makes a 1/3 octave noise



analysis which is repeated at the rate of 40 c/s and presented on a c.r.t. screen. Total loudness, evaluated by the Zwicker method, is presented on a moving coil meter in sones*. The instantaneous or maximum value of a transient can be stored on the c.r.t. for several minutes to permit the spectrum to be photographed. [Conventional sound level meters measure sound pressure level and not loudness. The indicated value corresponds to subjective loudness only over a narrow bandwidth, and for large bandwidth or impulsive noise the meter readings can be up to a factor of 4 lower than the subjective loudness.] The sound spectrum for 45 c/s to 14 kc/s is split into 20 channels, each containing 3rd-order active bandpass filters allowing ear's frequency characteristic to be simulated either in a diffuse or directional sound field. D.C. signals proportional to the r.m.s. value of the filter outputs are then obtained for shape factors of up to 7 and over a 60 dB dynamic range. Non-linear amplifiers then convert the signals to loudness values from sound pressure values and the outputs are fed to storage circuits. Each of the 20 storage multivibrators is sequentially sampled (at the 40 c/s rate) and displayed on the c.r.t. For the total loudness indicator the resulting pulse sequence is integrated, giving an indication equal of the area under the loudness spectrum curve but expressed in sones.

*Sone: unit of loudness on a scale designed to give scale numbers proportional to loudness.

WW 301 for further details

OPTICAL SHAFT ENCODERS

ROTARY and linear motion encoders in the Optisyn range from Walmore Electronics Ltd., are intended to meet requirements in high grade industrial, military, and aerospace position and rate digitizing applications. Model 29 encoder offers a resolution of up to 6000 counts/rev; accuracy of ±1·8 arc minutes; low starting torque 1·0 oz. in and high pulse rates up to 160 kc/s. Signal levels can be 200 mV peak sinusoidal outputs or 6 V pulses. The diameter of this model is 2·8 in and it has an aluminium alloy case which permits operation in environments where vibration, shock, oil spray and dust are prevalent. A shaft seal can be fitted if required. Walmore Electronics Ltd., 11-15 Betterton Street, Drury Lane, London, W.C.2.

WW 302 for further details

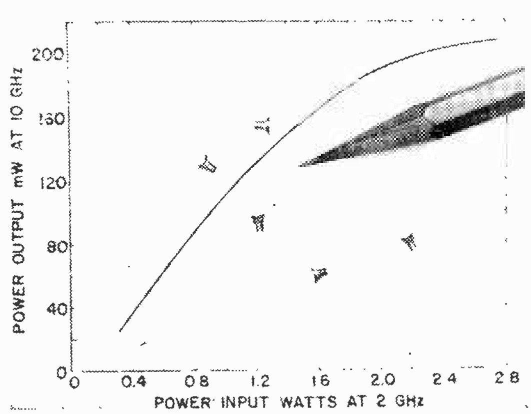
Rescue Beacon

A SPECIAL feature of the Sarbe Compact 355 air/sea rescue beacon is the fact that its transmitted distress signals can be received by aircraft. Operating on 121.5 Mc/s, the international aviation distress frequency for civil aircraft, the survivor's call for help can be picked up 45 miles away by an aircraft flying at 10,000ft and 100 miles away by an aircraft at 30,000ft. It is intended for use by private and business flyers and for yachtsmen. Completely waterproof, and small enough to be carried in a life-jacket pocket, the Compact automatically switches on when the aerial is extended. The beacon will sell for £45 and is battery operated continuously for either 30 hours or 48 hours, dependent upon the type of battery employed. Burndept Electronics, St. Fidelis Road, Erith, Kent.

WW 303 for further details

Step Recovery Diode

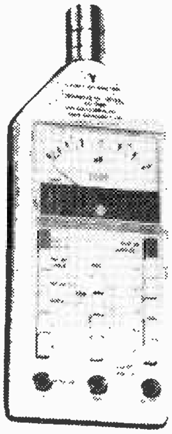
THE HPA 0320 step recovery diode is an epitaxial surface-passivated silicon device from Hewlett-Packard Ltd., 224 Bath Road, Slough, Bucks. For use as a high-order multiplier at microwave frequencies, this device when driven at 2 Gc/s with 2 W of power in a single stage X5 multiplier will yield a minimum of 150 mW at 10 Gc/s. Minimum minority carrier lifetime is 10 ns ensuring sufficient charge storage for high power output. The single stud ceramic package has low inductance with a reverse bias capacitance of only 0.7 to 1.3 pF. Reverse current in these diodes ceases abruptly, generating sharp transients, rich in harmonics, used for frequency multiplication.



WW 304 for further details

Sound Level Meter

TYPE 1400G portable sound level meter from Dawe Instruments Ltd., is intended for measuring levels from 24 to 140 dB (up to 200 dB with special microphone) over the range 31·5 c/s to 8 kc/s. As well as incorporating A, B, and C weighting networks which correspond closely to the 40, 70 and 100 phon equal loudness contours, the circuitry of this instrument complies with "Recommendations for Sound Level Meters" IEC publication 123, and "Specification for Sound Level Meters" BS 3489. The ceramic microphone is non-directional and can be used up to 20 feet away from the instrument; it does not require a polarizing voltage. Jacks permit a.f. analysers, variable or octave-band filters and statistical analysers to be used with the meter.



WW 305 for further details

TAPPED DELAY LINES

SILVER Star tapped delay lines by Johnson Matthey Metals Ltd. are for use in computer circuits and other electronic applications. They are lumped constant *L-C* delay line units constructed from a number of interconnected delay lines. A typical unit has an overall delay time of 100 ns having ten equal taps yielding incremental delay times of 10 ns ± 3 ns. Overall rise time is less than 20 ns. The maximum working voltage is 125 V d.c. Characteristic impedances are 100 Ω ± 5% or 500 Ω ± 5%.

WW 306 for further details

Transducer Amplifier

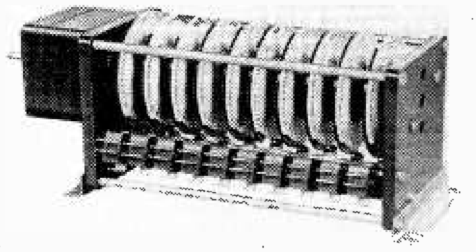
AS an aid in the measurement of load, displacement, torque, pressure and vibration, Vibro-Meter SA, of Switzerland, have produced an 8 kc/s carrier frequency amplifier 8-CFA-1/A. Wire, foil, and semiconductor strain gauges, resistive and inductive transducers may be used with this amplifier. The amplification factor is 8000 and the sensitivity is 0.1% f.s.d. per day.

WW 307 for further details

Cam Timers

EACH of the cam timers in the ACT series by Crater Controls Ltd. is driven by a synchronous motor and gear box. Over 420 timings are available, from 1 r.p.m. to 1 r.p. week (168 hours) and this standard range includes shaft speeds from 1 r.p.m. to 1 r.p.h. Each cam consists of two halves, one half keyed to the shaft and the second half rotatable relative to the first half through 180°. The complete cam unit can be adjusted on the shaft, thus permitting settings through 360°. Fixed cam profiles can be provided to specification. One to fifteen complete cam units can be supplied on varying frame lengths according to the number required. Switching is by micro-switches, each of which is a single pole changeover unit operated (through a lever arm) by the cam profile. The standard rating is 250/440 V, 50 c/s, 15 A. Ratings up to 30 A can be supplied. Crater Controls Ltd., Lower Guildford Road, Knaphill, Surrey.

WW 308 for further details



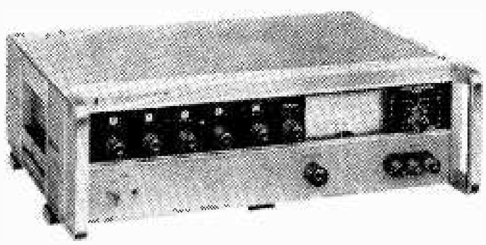
DECADE COUNTER

DECADE counter 550 is a ten-position unidirectional ring counter with n-p-n and p-n-p bistable transistor pairs driving an integral neon number tube. Produced by Weir Electronics Ltd., Durban Road, Bognor Regis, Sussex, it is intended for use where high-speed numerical readout is required. It will operate at frequencies up to 10 kc/s at an amplitude of +2 V to +5 V. The rise time of the trigger pulse is less than half a microsecond. Using a Hivac number tube XN3, or equivalent, this decade counter can be used independently or in cascade. The power requirements for this plug-in printed circuit board are +257 V −10%, −12%, +75 V ±7%, +4.7 V ±5%, or −4.7 V ±5%. At these voltages the current requirements will be 2 mA, 2 mA, 10 mA and 6 mA respectively.

WW 309 for further details

4-Digit Oscillator

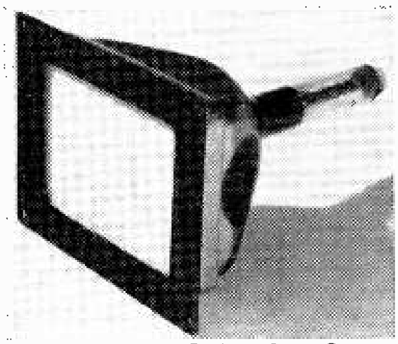
FREQUENCIES between 10 c/s and 1 Mc/s can be selected with four-place digital resolution on the Hewlett-Packard oscillator 4204A. Overall frequency accuracy is 0.2% and this combined with the four-place readout means that in many instances, an electronic counter will no longer be needed. Since the oscillator also has a built-in wide-range voltmeter, the amplitude of the oscillator's output can also be determined. Distortion for this solid-state instrument is said to be less than 0.3% from 30 to 100 c/s, and less than 1% down to 10 c/s and up to 1 Mc/s. Hum and noise content is less than 0.05% of output. The oscillator supplies up to 10 V into 600 ohms, and 20 V into an open circuit. The output attenuator has an 80 dB range in 10 dB steps with less than ±0.5 dB error; a vernier control provides 20 dB of continuously variable attenuation. Oscillator stability is presented at less than a ±0.01% change in output frequency for a ±10% variation in line voltage. The price is £264. Hewlett-Packard Ltd., 224 Bath Road, Slough, Bucks.



WW 310 for further details

CAMERA VIEWFINDER

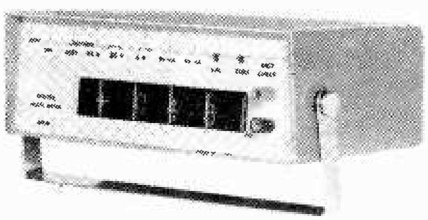
THE Brimar M17-15W is a seven-inch flat-faced rectangular tube, for small monitor and viewfinder applications. This tube has a 70° deflection angle, electrostatic focus and magnetic deflection. A clear glass face is employed and the aluminized screen yields the high brightness of 850 cd/m² for a final anode voltage of 14 kV at 170 μA. The standard phosphor is white W(T4) but others can be supplied. Implosion and flashover protection are provided, and tracking is minimized by the use of moisture repellent lacquer round the e.h.t. contact on the tube cone. A metal mounting frame is associated with the bonded faceplate assembly of this tube. Thorn-AEI Radio Valves and Tubes Ltd., 7 Soho Square, London, W.1.



WW 311 for further details

Digital Multimeter

WITH four-digit readout the digital multimeter DMM-1 measures from 1.999 to 1999 mA a.c. and d.c.; 1.999 to 1000 V a.c. and d.c., and resistance from 1.999 to 1999 kΩ. Manufactured by Microwave and Electronic Systems Ltd., Lochend Industrial Estate, Newbridge, Midlothian, Scotland, it is provided with an accuracy on all d.c. ranges of 0.1% of reading ±1 bit. On a.c. ranges accuracy is determined by the frequency at which the readings are made up to 10 kc/s. On all d.c. functions polarity of input is indicated and on a.c. ranges an a.c. sign is provided. Ni-Cd batteries are built-in with charger for true portability. Calibration is effected by use of an internal reference Zener diode and range selection is by push buttons. This instrument is of solid state construction and includes i.c.s.



WW 312 for further details

TRANSVERTERS

SPECIFICALLY designed for waveform and frequency sensitive equipment such as video-tape recorders, and sound recorders, the series "B" sinewave transverters are manufactured by Valradio Ltd., Browells Lane, Feltham, Middlesex. An *RC* type oscillator with temperature stable components drives heavy duty transistors; the resultant output is fed to a ferro-resonant type of transformer which produces a sinewave output. A high degree of voltage regulation against changes of input voltage and load is also maintained by this transformer. Frequency output is 50 c/s ±0·25 c/s, or better than 0·005% when using a "resonator" frequency synthesizer. Two outputs are provided 115 V and 230 V. The 12V unit will operate over 11 to 15 V and the 24 V unit will operate over 22 to 30 V.

WW 313 for further details

Schmitt Trigger

THE range of discrete component, germanium, digital modules (series 40) manufactured by S.T.C. now includes a Schmitt trigger type 443E. As with the other members of this family the fan-out capability is three when used with other 40 series modules. Backlash is 0.05 V, the upper and lower trigger levels being 0.4 V and 0.35 V respectively. The device will convert a slowly changing voltage into two-state form with short rise and fall times. S.T.C. Comp. Group, Footscray, Sidcup, Kent.

WW 331 for further details

Capacitance Diode

THE high-capacitance change ratio (5 : 1) of the PHV series Varicap permits a greater than normal tuning range. Manufactured by TRW Semiconductors Inc., Laundale, California, U.S.A., this device is offered initially in 3 pF and 20 pF values at typical operating voltages of 2 to 15 V. V_{BR} (breakdown voltage) at 100 μA is 25 V minimum. It has been designed for wideband tuning applications requiring maximum capacitance/voltage change ratios and is encased in a low inductance DO-19 package. Marketed in the U.K. by M.C.P Electronics, Ltd., Station Wharf Works, Alperton, Wembley, Middlesex.

WW 314 for further details

HIGH FREQUENCY FET

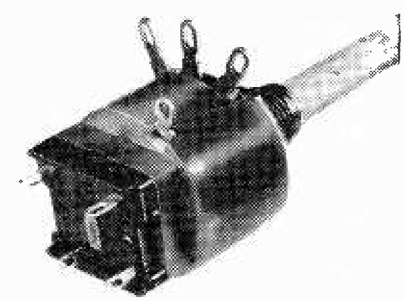
A HIGH frequency 'N' channel f.e.t. by Amelco Semiconductors has a typical power gain of 16dB at 400 Mc/s with a noise figure of 4dB. It also has a 30 V breakdown voltage and a G_m of 4.5 to 10 mA/V at 1 kc/s and 3.5 mA/V at 200 Mc/s. Agents:—Lectropon Ltd., Kinbex House, Wellington Street, Slough, Bucks.

WW 315 for further details

MOULDED TRACK POTENTIOMETER

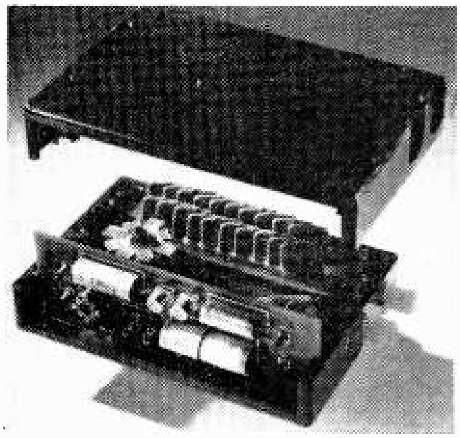
INTENDED for high surge current application, including transistor television equipment, the type 51 moulded track potentiometer by Davall Electronics Ltd., Rothersthorpe Avenue, Northampton, is fitted with a double-pole switch. A screening plate can also be fitted between track and switch if required for mains applications. Resistance range available is 50Ω to 2 MΩ (linear) and 1 kΩ to 1 MΩ (non-linear) with a tolerance of ±20%. The power ratings at 70°C are 1 W and 0.5 W respectively. Insulation resistance is greater than 5000 MΩ at the maximum working voltage of 500 V d.c. Switch actions available are off-on, on-off and change-over.

WW 316 for further details



E.H.T. UNIT

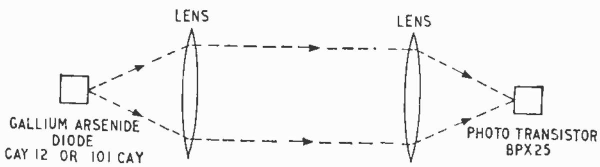
A ready-to-use, compact ($6\frac{1}{4} \times 4\frac{1}{8} \times 2\frac{1}{2}$ in) unit, providing up to 17.5 kV for television and radar supplies is available from the Marconi Specialized Components Division. An input supply of 15.5 V drives a push-pull sine-wave oscillator, whose output frequency in excess of 20 kc/s is fed to a Cockcroft-Walton type silicon diode multiplier stack. An external corona stabilizer is employed at the output to provide a constant voltage over a wide current range up to 200 μA. Adjustment of output terminals across the multiplier stack provides various e.h.t. voltages of either polarity. Short circuits of the output, lasting for a few seconds will not damage the circuit provided the input current is limited to 0.7 A. It is stated that this e.h.t. unit conforms to all relevant military, air and ground specifications and will operate in a dry heat of +55°C and in damp heat at +40°C at 95% relative humidity. It will withstand vibrations of 63 to 150 c/s at 10g. The Marconi Company Ltd., Chelmsford, Essex.



WW 317 for further details

Ga As DIODES

A SIMPLE, compact communications system is one of the suggested applications for the Mullard gallium arsenide diodes CAY12 and 101CAY. When subjected to a voltage of about 1.5 V, both diodes emit coherent radiation at about 0.9 μm. Since this wavelength is close to the peak of the response curve of photo transistor BPX25, a diode and photo transistor could be employed to transmit information as shown. Radiation from the diodes is modulated by the diode current. High-frenquency performance and high switching speeds permit these diodes to be used in a.m. or pulsed communication links. Mullard Ltd., Mullard House, Torrington Place, London, W.C.1.



WW 318 for further details

Semiconductor Tester

PRODUCTION quality control and other departments concerned with the rapid and accurate assessment of semiconductor parameters will be interested in the Semcon semi-automatic transistor/diode tester SP11. This instrument is described as a "go/no go" tester which has plug-in modules for automatic set-up of conditions required for test. One test button is used for the complete sequence of operation. Test potential available is 300 V 100 mA and tests can be programmed for pulse durations of 50 ms and 200 μs. Eight pulsed d.c. tests are carried out in two seconds and "pass" or "fail" are indicated by lamps. Production Techniques Ltd., Cores End Road, Bourne End, Bucks.

WW 319 for further details

Miniature Neon Indicator

AVAILABLE for 250 or 110 V operation, the miniature neon indicator by Oxley Developments Co. Ltd., Priory Park, Ulverston, North Lancs, has an overall diameter of 0·35 in. Its height above panel is 0·5in. The recommended panel thickness is 10/16 s.w.g.

WW 320 for further details

COUNT RATE METER

FOR use with a batch counter, the Kappa FK22 count rate meter provides an immediate and continuous indication of the count rate (objects per minute). Count-pulses generated by a batch counter are fed into a time integrating circuit (within the count rate meter), and the resultant output displayed on a large panel meter, which is calibrated to objects per minute or per hour. When count rate only is required, a self-contained version, the FK20, can be used. Kappa Electronics Ltd., 159 Hammersmith Road, London, W.6.

WW 321 for further details

P-N-P POWER TRANSISTORS

AMONG the applications for the Motorola p-n-p silicon power transistors 2N4398-9 are employment in high output audio or servo amplifiers where current demand is high. With an I_C of 10 A and a V_{CC} of 30 V the delay and rise time for these two devices is only 400 ns. Marketed in a low silhouette, copper-base TO-3 package the 2N4398 costs £3 8s and the 2N4399 £4 1s 6d. Motorola Semiconductor Products Inc., York House, Empire Way, Wembley, Middlesex.

WW 322 for further details

Operational Amplifier

AN exceptionally low drift rate of 3 μV/°C maximum is claimed for the Burr-Brown operational amplifier 3003/15. It also has a 0·3 nA/°C maximum bias current drift. Both of these characteristics apply over the temperature range −25°C to +85°C. The noise content of this unit is 3 μV r.m.s. from d.c. to 10 kc/s and the low quiescent power supply drain is 5 mA maximum. The output is a conservative rating of ±10 V ±20 mA. Intended applications include stable amplification of low level signals, linear current source, and current-to-voltage conversion. General Test Instruments Ltd., Gloucester Trading Estate, Hucclecote, Glos.

WW 323 for further details

Subminiature Connectors

THE SREC series of sub-miniature removable, crimped contact connectors have been introduced by Ether Ltd., Caxton Way, Stevenage, Herts. These connectors have 0.030 in diameter crimp (4 indents) type removable contacts with 0.094 in centre-to-centre spacing. The crimped contacts accommodate 7/00076 in. to 7/0048 in wire sizes, and are precision machined to assure solid pin and socket reliability. They are self aligning and polarized.

WW 324 for further details

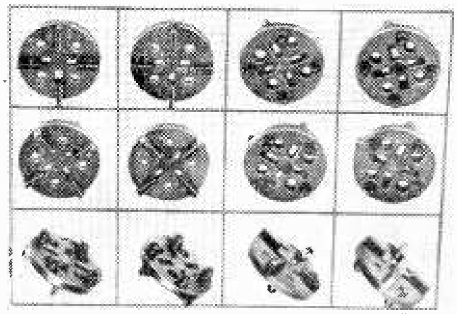
VIDEODISC RECORDER

MAGNETIC videodisc recorders by the MVR Corporation, U.S.A., are available in the U.K. through The Crow Co., P.O. Box 36, Reading, Berks. Although the limited storage capacity of a magnetic disc prevents it from supplanting the videotape recorder, it is claimed that greater flexibility of operation makes it a useful addition to existing television systems. The recording medium is a $\frac{3}{16}$in thick, 12 in diameter aluminium disc with a magnetically sensitive surface coating. Thousands of hours of repetitive use with little or no damage to the surface or degradation of the signal are claimed for this disc. Up to 500 tracks of video or analogue information may be stored on a 12 in disc, which rotates at 1500 r.p.m. at the 25 frames per second rate, thus each revolution represents one television picture frame. The total time is 40 ms per revolution. The same size disc will also permits 20 s of real time continuous information to be recorded in a spiral manner. Flexibility of operation throughout the range of nine basic models includes non-destructive playback of single-frame images, slow-motion presentation. The range available includes single-channel, single head; two channel, two head; and a three-head system for recording fast moving objects.

WW 325 for further details

Universal Transistor Pad

ONE side of the universal transistor pad T0518-001 accepts T05 transistor leads on an 0.2 in matrix for either straight-through mounting or conversion to 0.2 in T05 configuration. This pad is said to be useful where frequent changes are made from T018 to T05 on the same printed circuit boards. It is moulded in nylon A100 (melting point greater than 200°C). Jermyn Industries, Vestry Estate, Sevenoaks, Kent.



WW 326 for further details

R.M.S. Voltmeter

BALLANTINE Laboratories, of Boonton, New Jersey, U.S.A., have introduced a new r.m.s. voltmeter that will operate between 10 c/s and 20 Mc/s and can be powered either from the mains or from rechargeable batteries. The voltmeter, designated Model 323, operates on the square law response of silicon diodes to measure the true r.m.s. value of distorted sine waves, square waves, random signal or pulse waveforms with duty cycles as low as 0.04. The instrument has a crest factor 5 at f.s.d. increasing to 15 down scale. Twelve voltage ranges are incorporated being 300V to 330μV, input impedance is 2 MΩ shunted by 15 pF on all but the 1 to 30 mV ranges where the shunt capacity is 25 pF. In its null detection mode the instrument has a sensitivity of 70 μV.

WW 327 for further details

New Triac Range

MOTOROLA have introduced a range of three 8-amp triacs (MAC 1-2-3). The devices feature a new chip design, with a built-in copper lug for added protection, facilitating current spreading, while allowing a high surge current rating, typically 100 A. Significant figures from the specification are—r.m.s. conduction current 8 A max, gate trigger current 30 mA, holding current 30 mA, gate trigger voltage 2 V and peak blocking voltage (1) 50 V, (2) 200 V and (3) 400 V. The devices, which cost between 15s and 36s 6d for 100 up quantities, are available in three different packages. MAC 1 is of the lug terminal type, MAC 2 is a $\frac{7}{16}$ inch stud package and the MAC 3 is a three lead package for printed circuit mounting. Celdis Ltd., Milford Road, Reading, Bucks, are the U.K. agents.

WW 328 for further details

Versatile X-Y Recorder

EITHER X or Y axes may be geared to time function in the X-Y recorder "function/riter" (trade mark) by Texas Instruments Inc. Plug-in function modules available, are a single range signal input module and a multirange attenuator module. Either vertical or horizontal mounting is possible, and the recording surface may be angled to 45° or 90° from horizontal when the recorder is used as a tabletop unit to allow visibility of recording when the operator is seated. Vacuum hold-down of charts is quiet, and chart sizes of $8\frac{1}{2} \times 11$ in and 11×17 in can be used. Inking is carried out through disposable plug-in ink cartridges. Solid-state servo systems are employed, and enclosed infinite-resolution slide wires are used instead of helical-wound resistance elements to ensure high precision. Texas Instruments Incorporated, 3609 Buffalo Speedway, Houston, Texas, U.S.A.

WW 329 for further details

Multiple-function Test Unit

BOTH a.c. (r.m.s.) and d.c. voltages can be measured up to 1100 V in four ranges by the Model 1002 multimeter by Honeywell Controls Ltd., Brentford, Middlesex. The a.c. frequency range extends from 20 c/s to 20 kc/s. The three basic elements constituting this unit are a Zener-regulated ±11 V reference supply, an electronic null detector, and a six-decade Kelvin-Varley voltage divider with numerical readout. The other functions of this unit are (a) voltage reference source, for precision calibration of potentiometric instruments—voltage levels of 6 digit resolution are available, accurate to ±0.0025% and varying from 0 to 11 V; (b) null detection, to provide highly sensitive indications of input changes as small as 100 nV or input currents of 10^{-13} A; (c) decade voltage divider—accurate voltage level divisions to ±0.001% using a 6-decade Kelvin-Varley divider network; and (d) ratiometer, for precise d.c. ratio measurements in full scale voltage ranges of 1:1, 10:1, and 100:1, with ±0.001% accuracy. The 1002 multimeter has a common mode rejection of 120 dB: an input resistance potentiometric to 11 V is 10 MΩ. The reference polarity is reversible at the front panel and the Kelvin-Varley divider output is at the rear panel.

WW 330 for further details

Dynamic Microphone

WEIGHING 6 oz, the Reslo EC.1 cardioid dynamic microphone has a miniature insert having a directional sound pick-up field. Designed for speech, solo voice or solo instrument work, it is also supplied with an acoustic resistance cap (wind shield) for use outdoors. The frequency response over the range 100 c/s to 17 kc/s is −10 dB at 100 c/s, and −2 dB at 12 kc/s, referred to the level at 1 kc/s. Polar response is strongly directional, and partially suppressed at the rear where the pick-up is −10 to 20 dB over 150 c/s to 15 kc/s. Model L has an impedance value of 30-50Ω; Model M a dual impedance 250 or 600Ω; and Model H a dual impedance 40kΩ or 30 to 50Ω. Models M & H include miniature line transformers. Connections are from a Reslo 3-contact socket at end of case: low impedance floating from earth and phased; high impedance, single ended and phased. Reslosound Ltd., Spring Gardens, London Road, Romford, Essex.

WW 335 for further details

UNIPHASE GAS LASER

DEVELOPED by Scientifica and Cook Electronics Ltd., the high-power uniphase gas laser B18 produces a high output (8 mW) at 6328Å, although outputs in the infra-red region are obtainable by the use of suitable mirrors. It can also be supplied for operation at 11,523Å or 33,912Å. Beam diameter is approximately 2 mm at exit aperture. The tube has silica Brewster windows with single isotope filling and the mirrors are hard coated and finished to 1/20th wavelength. The B18 can be mounted on a table or optical bench. Scientifica and Cook Electronics Ltd., 148 St. Dunstan's Avenue, Acton, London, W.3.

WW 336 for further details

INFORMATION SERVICE FOR PROFESSIONAL READERS

To expedite requests for further information on products appearing in the editorial and advertisement pages of *Wireless World* each month, a sheet of reader service cards is included in this issue. The cards will be found between advertisement pages 16 and 19.

We invite professional readers to make use of these cards for all inquiries dealing with specific products. Many editorial items and all advertisements are coded with a number, prefixed by WW, and it is then necessary only to enter the numbers on the card.

Postage is free in the U.K. but cards must be stamped if posted overseas. This service will enable professional readers to obtain the additional information they require quickly and easily.

F

OCTOBER CONFERENCES & EXHIBITIONS

Further details can be obtained from the addresses in parentheses

LONDON

Oct. 2-11 — Olympia
Business Efficiency Exhibition
(Business Equipment Trade Assoc., 109 Kingsway, W.C.2)

Oct. 31-Nov. 1 — St. Ermin's Hotel
Ultrasonics for Industry Conference and Exhibition
(*Ultrasonics* Conference and Exhibition, Dorset House, Stamford St., S.E.1)

BUXTON

Oct. 19 — Palace Hotel
Printed Circuits Symposium & Exhibition
(Inst. of Metal Finishing, 178 Goswell Rd., London, E.C.1)

EDINBURGH

Oct. 17-19 — Napier Tech. Col.
Electronics in Action Exhibition
(P. M. Elliott, 21 Craigmount Loan, Corstorphine, Edinburgh, 12)

OVERSEAS

Oct. 2-5 — Pittsburgh
Power Semiconductors
(I.E.E.E., 345 E.47th St., New York, N.Y. 10017)

Oct. 4-6 — Vancouver
Ultrasonics Symposium
(R. W. Moss, Imperial College, South Kensington, London, S.W.7)

Oct. 4-6 — Monticello, Ill.
Circuit and System Theory
(I.E.E.E., 345 E.47th St., New York, N.Y. 10017)

Oct. 10-15 — Ljubljana
Modern Electronics Exhibition
(Ljubljana Fair, Post Box 413-VIII, Ljubljana, Yugoslavia)

Oct. 10-19 — Utrecht
Scientific & Industrial Instruments Show
(Royal Netherlands Industries Fair, Vrendenburg)

Oct. 12-15 — Genoa
International Communications Congress
(Instituto Internazionale delle Comunicazioni, Viale Brigate Partigione 18, Genoa)

Oct. 12-22 — Genoa
Fair of Communications
(Fiera Internazionale, Genoa)

Oct. 16-18 — Washington
EASTCON—Electronics & Aerospace Systems Technical Convention
(Mrs. H. Manley, Westinghouse Electric Corp., 1625 K.St., N.W., Washington, D.C. 20006)

Oct 16-20 — New York
Audio Engineering Convention
(Audio Engineering Soc., 60 E.42nd St., New York, N.Y. 10017)

Oct. 17-19 — Michigan
Antennas & Propagation Symposium
(Dr. T. B. A. Senior, Radiation Lab., University of Michigan, Ann Arbor, Mich. 48108)

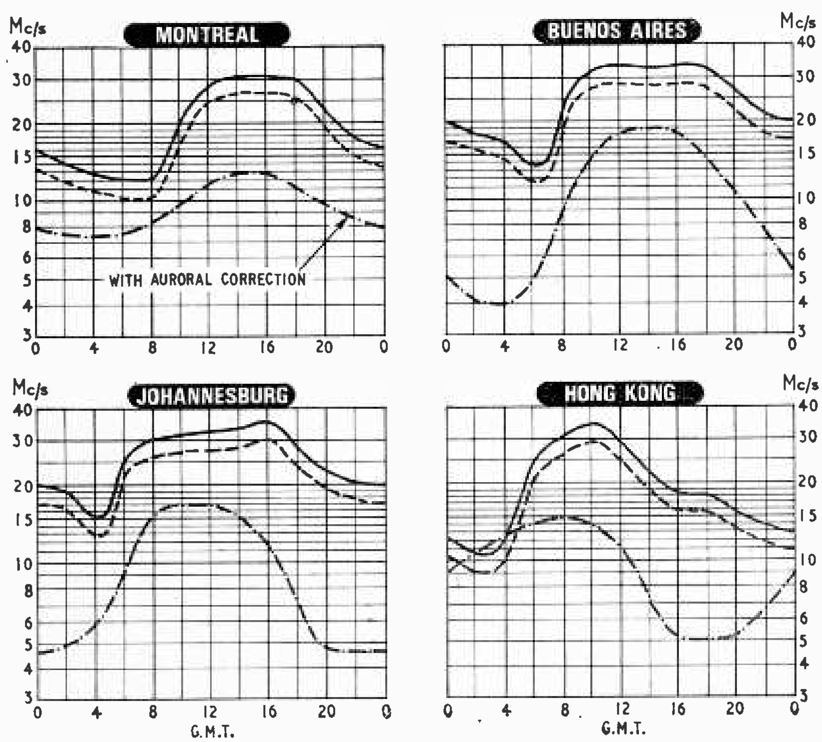
Oct. 18-20 — Washington
Electron Devices
(I.E.E.E., 345 E.47th St., New York, N.Y. 10017)

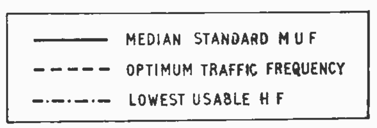
Oct. 18-20 — Austin
Symposium on Switching and Automata Theory
(Prof. C. L. Coates, Engineering Science Building, University of Texas, Austin, Texas 78712)

Oct. 23-25 — Chicago
National Electronics Conference
(I.E.E., 345 E.48th St., New York, N.Y. 10017)

Oct. 19-28 — Sydney
International Trade Fair
(Industrial & Trade Fairs Ltd., Commonwealth House, New Oxford St., London, W.C.1)

H. F. PREDICTIONS — OCTOBER





H. F. PREDICTIONS OCTOBER

Seasonal effects on the curves are most evident for the Hong Kong route; midnight to 06.00 G.M.T. appears unusable and several working frequencies will be required for the remaining hours.

Maximum usable frequencies are based on a predicted value for the Ionospheric Index (IF2) of 125. Sunspot maximum is expected about July 1968 with an IF2 considerably below the last maximum of 208 in December 1958. As the MUF is a median value, operation below the optimum traffic frequency is required for communication on 90% of the days.

LUF curves (drawn by Cable and Wireless Ltd.) are for reception of point-to-point telegraph circuits in the U.K. Curves for broadcast reception will be similar but for amateur operation will be considerably higher.