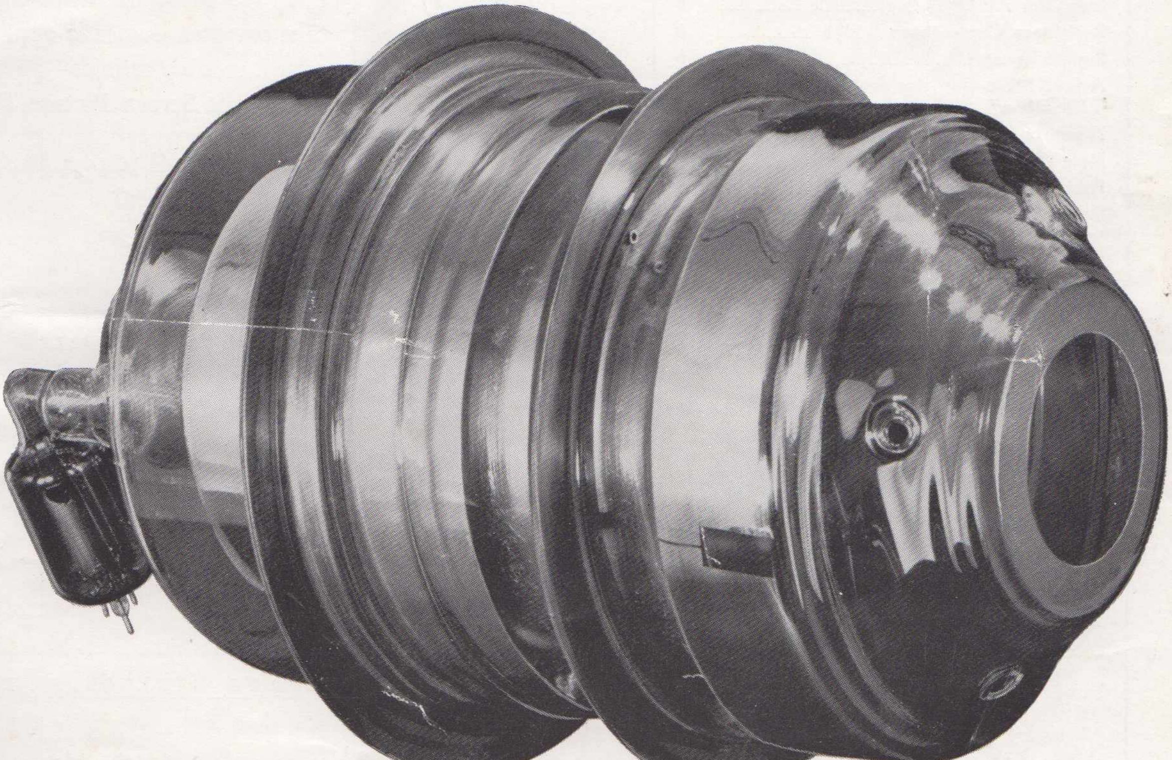
Mullard Outlook

AUSTRALIAN EDITION



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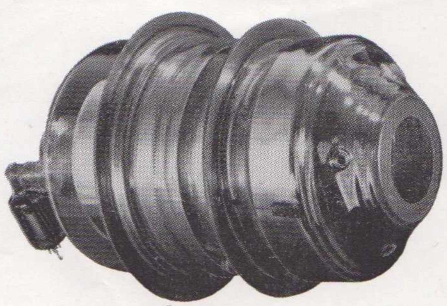

The Mullard image converter tube shown, the first of its kind which is entirely electrostatically focussed, has a built-in electron-optical zoom lens.

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Associated with
MULLARD LTD., LONDON

"It wouldn't have done for the Duke, Sir, It would never have done for His Grace . . ."

With respect to the butler in this music-hall monologue and the exacting and impeccable standards of His Grace, we like the theme of the endeavour correct.

To some the fetish of correctness and quality has the air of the finicky, something fickle and fortuitous, rather than being precisely and patiently formulated with both feet on the ground—for it was no idle claim we made in 1956 that Mullard picture tubes had Long Life.

Over six years of TV in Australia have highlighted the need for quality and reliability in a complex domestic appliance and on the whole TV receivers have been most reliable articles—particularly those equipped with Mullard Long Life Radiant Screen Picture Tubes.

Back to the butler and with all respect to Outlook readers, will it ever do not to use these Long Life Tubes?

The Inventory

We use the term of our American friends — the inventory — the stock; and reprint the second of a series of articles from Mullard Outlook, U.K., for capable stock administration is related closely to nett profit and to the nimble wits of our accountant colleagues, cost and otherwise.

M.A.B.

VIEWPOINT WITH MULLARD

EVERYTHING UNDER CONTROL

This article is complementary to "Training Your Sales Staff", which appeared in Outlook, Vol. 5 No. 6. Both articles are written by Mr. Francis X. Carus, managing editor of "The Dealer", the magazine of the Radio and TV Retailers' Association in the United Kingdom.

One can still find shops where, behind a modern front and lushly-carpeted showroom, there lies a stockroom which is looked after—but hardly controlled—by the most junior member of the staff. Here the stock function is often dismissed as a mere matter of storing goods accessibly in the minimum of space.

It is a stark fact that poor stock control has brought many a promising business to bankruptcy. It might be as well, therefore, to summarise the effective role that properly-organised stock-keeping plays in the successful enterprise.

It ensures that the maximum of stock in the widest saleable variety, in perfect condition, is instantly available. It prevents out-of-stock positions—with consequent loss of sales—arising. It gives warning of changes in trends and demands in time to prevent overstocking of obsolete lines and to dispose of them without delay. It makes sure that working capital is fully employed only in stock that is sold quickly and is ordered at the right times and in the right quantities to achieve the highest possible rate of stock turn.

. . . overstocking of obsolete lines . . .

Minimum Replacement Periods

Once the stockroom has been laid out in an orderly manner any system of stock control depends for its success on co-operation at every stage. Sales check counterfoils are of little value if they are so badly written they can't be read. Minimum-stock indicators are useless if not reported on.

Every item must be considered individually when fixing the period to be allowed for its replacement. Lamps, for instance, might be replaceable by the local wholesaler in a matter of hours. A new TV model in brisk demand might take as many days. These minimum replacement periods are the basis of good stock control and, taken with the average or estimated sale rate, enable a minimum stock figure to be arrived at.

Minimum-stock level warnings can take the form of simple devices at the point of store. For some stock, coloured, identified cards for each sub-section can be inserted as separators, such cards giving description, quantity and price and enabling the buyer to place an immediate order.

Here, the human element shows up: in his haste to serve his customer or replenish his counter stock the salesman might easily forget to hand in the card to the office.

Better, then, to have a master control system which can be operated within the office.

Convenient Unit

This may be in one of several forms, the majority far too elaborate for an ordinary retail business. At its simplest it is a box of cards and separators. Each card represents the convenient unit of purchase: say a dozen dry batteries or one model of a radiogram. A card is made out—carrying as much detail as thought necessary at the time of ordering. It is then housed in a box marked "Deliveries Pending". When the invoice has been checked against delivery the card is transferred to another box labelled "Stock". When the salesman's duplicate check comes in the card is lifted up into a third box tagged "Sales". Ideally cards should be entered up each morning from the returns of the previous day.

This basic version can be adapted to provide a lot of valuable information. Different classes of stock can be arranged in separate boxes and the minimum levels shown by coloured separators. By using cards of different colours, or with cut corners or by attaching coloured metal tags, the length of time in stock can be seen at a glance.

Theoretically the controller need never come into personal contact with his stock. But so as not to over-complicate the master system he can use a second level indicator in the stockroom as a check on his cards.

Three Hats

The problems of future trends is rightly one for the sales manager and the buyer rather than the stock-controller. But in the smaller businesses all three hats are likely to be worn by the same person. Probable demand for established lines, not subject to seasonal or fashion change, can be estimated from past records. But the potential of a new item can only be assessed from the showroom floor or by "flair". Reports from salesmen or the comments of customers can also be helpful. The size of initial orders—which must be governed by cash values of existing stock and turnover of similar lines—can be settled by the information from the cards.

In the smaller business all three hats are likely to be worn by the same person

The card system does not, of course, show the cash position. A supplementary memo stock account can quickly be entered with purchases and sales and supply a running inventory of the value of stock in hand.

Some retailers combine the "forward" or counter stocks of smaller items, held at the service positions, with minimum stock levels held in the storeroom. When the reserve is brought forward it is time to be placing further orders.

Interested Party

Inaccuracies in stock records are often only brought to light at the annual stock-taking. Sometimes discrepancies are due to pilfering, especially when attractive items are openly displayed. Any action to counteract such losses will be too late at the end of the financial year.

To keep a weekly or daily check it is necessary to book out showroom or forward stock and balance a physical stock-taking against sales. This might be restricted to

Continued on page 11

MULLARD-AUSTRALIA PERSONALITIES

MR. BARRY BRICE

Newly appointed Mullard-Australia resident representative for South Australia, Mr. Brice is located at our Adelaide Office and Valve and Picture Tube Service Centre, 180 Wright Street West.

His technical background has centred around professional electronics, the past six years on telecommunications equipment development.

A keen sportsman and family man, his smiling countenance is now a familiar mark within the industry in Adelaide.

TRANSISTOR RESISTOR LOGIC USING THE ASZ21

Transistor resistor logic utilises the low impedance at the base of an ON transistor, and its low bottoming voltage, to make an inexpensive method of using resistors for logic and transistors for power amplification and inversion.

If all the input resistors R1 in Fig. 1 are connected to bottomed transistors, then the voltage at the base of the transistor Tr1 is positive to earth, so that it is cut off. If one or more of the input resistors is connected to a transistor which is cut off, the transistor Tr1 will be bottomed by the current flowing into the base.

When a '1' is represented by the catching voltage and a '0' by earth, the logical operation performed by the circuit is NOT-OR as the output is approximately at earth when any one input is at the catching voltage.

If a '1' is represented by earth potential, then the logic performed is NOT-AND.

The unit is a printed circuit building block of the dotted portion of the circuit of Fig. 1. The circuit has been designed to give maximum fan-in and fan-out of four simultaneously. The maximum delay per stage, with 100pF stray capacitance at the collector of the transistor of each stage over which the delay is measured, is 110ns. The added capacitance is to simulate the stray capacitance when the circuit is used in a complete system. The circuit is designed to work up to a maximum ambient temperature of 60°C. The dissipation per stage is about 350mW.

Figs. 2a, 2b and 2c are photographs of collector waveforms from two alternate collectors with 100pF added stray capacitance giving the maximum propagation delay over two stages. They are for a fan-in of 4 and fan-outs of 4, 3 and 2 respectively, from a simulated worst case circuit.

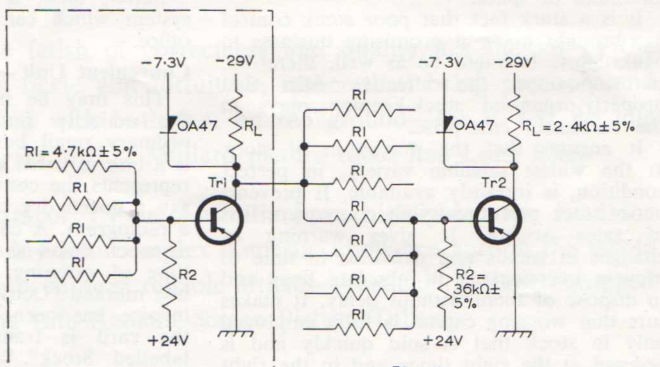


Fig. 1

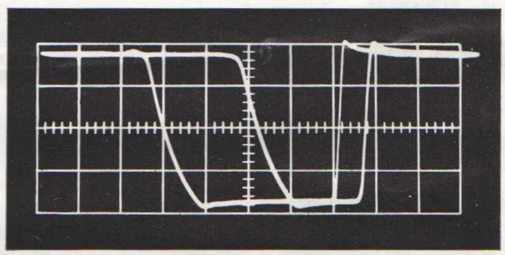


Fig. 2a

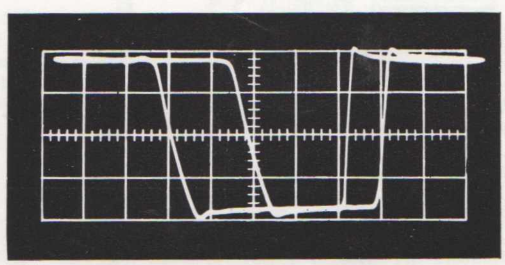


Fig. 2b

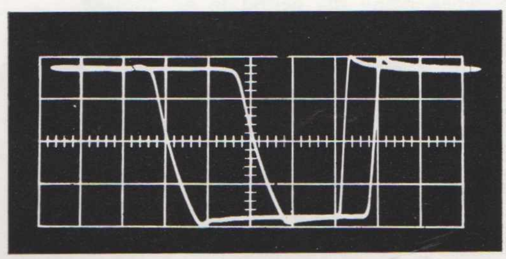


Fig. 2c

scales: $x = 100ns/cm$ $y = 2V/cm$.

ASZ21 JUNCTION TRANSISTOR

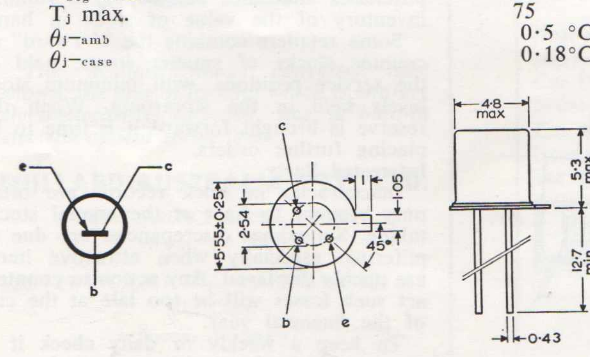
PRELIMINARY DATA

Germanium transistor of the p-n-p alloy diffused type intended for use in high speed logic circuits.

Typical parameters for pulse operation at $T_{amb} = 25°C$			
Collector depletion capacitance ($V_{CB} = -6V$, $I_E = 0mA$)	c_{tc}	3·0	pF
Emitter depletion capacitance ($V_{EB} = -1·0V$, $I_C = 0mA$)	c_{te}	10	pF
Storage time	t_s	50	ns
Frequency at which $\lvert h_{fe} \rvert = 1$	f_1	450	Mc/s
Measured at $V_{CB} = -3V$, $I_C = 7·5mA$.			
Collector voltage			
V_{CB} max. ($I_E = 0mA$)		-20	V
V_{CE} max. ($+V_{BE} > 500mV$)		-15	V
V_{CE} max. ($I_C = 50mA$)		$-8·0$	V
Collector current			
I_{CM} max.		50	mA
*$I_{C(AV)}$ max.		30	mA
Emitter current			
I_{EM} max.		60	mA
*$I_{E(AV)}$ max.		35	mA
Base current			
I_{BM} max.		25	mA
*$I_{B(AV)}$ max.		5·0	mA
†**Reverse base-emitter current**			
$-I_{BM}$ max.		10	mA
$I_{B(AV)}$ max.		5·0	mA

*Averaged over any 50ms period.
†To ensure that this limit is not exceeded under voltage drive conditions —V_{EBM} max. = 2·5V.

Temperature ratings		
T_{stg} max.	+75	°C
T_{stg} min.	−55	°C
T_j max.	75	°C
θ_{j-amb}	0·5	°C/mW
θ_{j-case}	0·18	°C/mW



All dimensions in mm

TO-18 encapsulation. The collector is connected to the envelope.

CIRCUITS FOR SERVICING AUDIO EQUIPMENT

This article describes useful pieces of equipment for servicing and checking audio amplifier circuits. The equipment includes:

1. A three-transistor battery-operated AF oscillator covering the frequency range 15c/s to 20kc/s.

2. A simple RC bridge for measuring resistance in the range 100Ω to 1MΩ and capacitance in the range 100pF to 1μF.

3. A simple signal tracer for locating and monitoring signals in audio circuits.

TRANSISTOR AF OSCILLATOR

Circuit Description

The circuit shown in Fig. 1 is essentially an RC phase shift oscillator arranged to form a Wien bridge network. The components of the bridge are RV11, R12, C4, C7, RV9, R10 and the internal base resistance of Tr1 together with the emitter resistors R2 and R3 associated with Tr1. To maintain oscillation the components of the bridge are so arranged that the inherent phase shift of the transistors is added to the phase shift produced by the components of the bridge. The ganged variable resistors RV9 and RV11 permit the frequency to be adjusted within the range selected by S1. The overall phase shift of the amplifier is kept low by the use of direct coupling between transistors. The p-n-p and n-p-n pair of transistors Tr1 and Tr2 provides the first stage with a high gain, and the unbypassed emitter resistances of Tr1 and Tr2 provide ample negative AC feedback. The thermistor R5 acts as an amplitude control device ensuring that the output of the oscillator is independent of supply voltage changes and changes in ambient temperature.

Performance

The frequency coverage of the unit is from 15c/s to 20kc/s in three switched ranges: 15 to 200c/s, 150c/s to 2kc/s, and 1·5 to 20kc/s, the lower frequencies being associated with the larger capacitances. The upper frequency limit of the oscillator could be extended appreciably by changing transistor Tr3 to an OC41 and altering the values of C4, C7 suitably. This modification will enable the oscillator to work satisfactorily at frequencies in excess of 100kc/s.

The output voltage is continuously variable (by means of the linear potentiometer RV7) from 50mV to 1V r.m.s. If it is required to vary the output voltage in definite steps, an attenuator consisting of a network of resistors can be incorporated at the output. This may take the form of a separate unit with its own switching arrangements. The external load connected to the oscillator should not be less than 10kΩ. This prevents damping and distortion of the output voltage. Under these conditions the overall distortion is less than 0·7%. The circuit is thermally stable up to about 40°C. In the prototype unit, for a change in supply voltage from 9 to 12V, the changes in frequency and amplitude were found to be less than 1%. At a nominal supply voltage of 9V the unit consumes about 10mA.

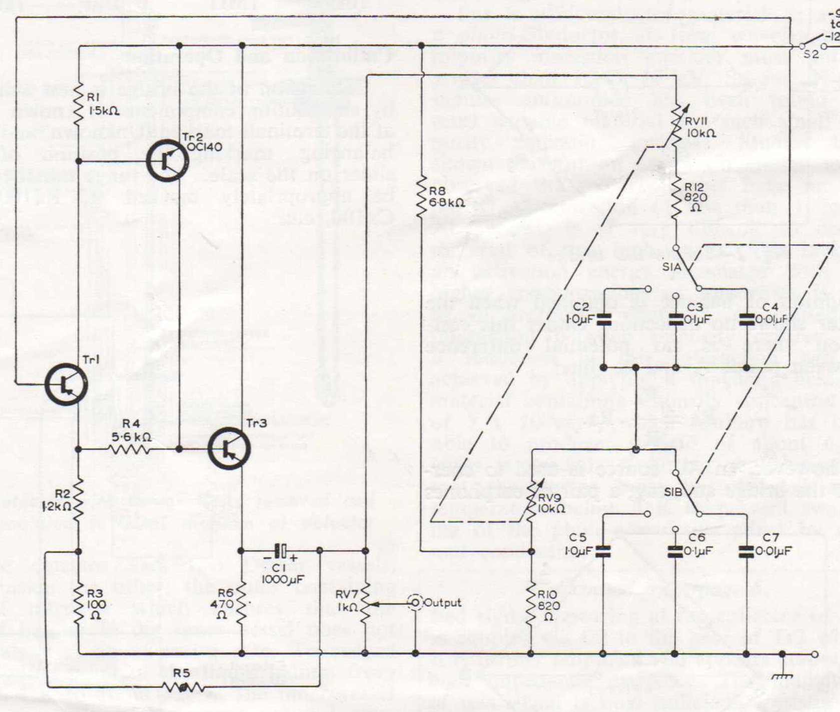


Fig. 1—Circuit diagram of AF oscillator

LIST OF COMPONENTS

Resistors

Circuit Ref.	Value	Description
R1	1·5 kΩ	10%
R2	1·2 kΩ	10%
R3	100 Ω	10%
R4	5·6 kΩ	10%
R5	Thermistor type R53 (Nom. value at 20°C, 5kΩ)	
R6	470 Ω	10%
RV7	1 kΩ	lin potentiometer
R8	6·8 kΩ	10%
*RV9	10 kΩ	log potentiometer
R10	820 Ω	10%
*RV11	10 kΩ	log potentiometer
R12	820 Ω	10%

* ganged

Capacitors

Circuit Ref.	Value	Description
C1	1000 μF	electrolytic
C2	1·0 μF	polyester
C3	0·1 μF	polyester
C4	0·01μF	polyester
C5	1·0 μF	polyester
C6	0·1 μF	polyester
C7	0·01μF	polyester

Transistor Complement

Tr1, AC107
Tr2, OC140
Tr3, OC74

RESISTANCE CAPACITANCE BRIDGE

Continued from page 5

Theory of the Bridge

The circuit shown in Fig. 2 is the well-known Wheatstone bridge network. If a DC voltage is used to energise the bridge, a

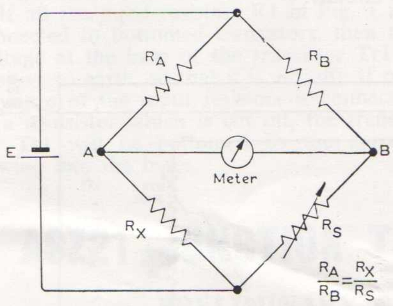


Fig. 2—Simple DC bridge

condition of balance is obtained when the meter shows no deflection. Under this condition there is no potential difference between points A and B, thus:

$$R_X = \frac{R_A}{R_B} . R_S.$$

If, however, an AC source is used to energise the bridge and, say, a pair of earphones

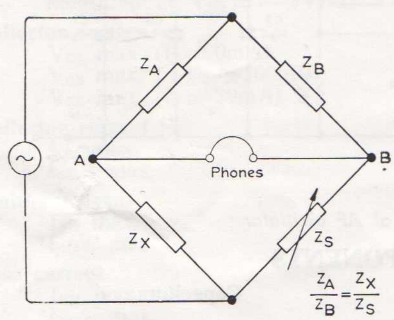


Fig. 3—Simple AC bridge

is used as the detector (Fig. 3), the condition of balance (noticeable as a marked decrease in volume) is obtained when the magnitude and phase relationships of the voltage across A and B are equal. Under these conditions the relationship

$$Z_X = \frac{Z_A}{Z_B} . Z_S$$

is obtained, where Z_A, Z_B and Z_S are known impedances and Z_X is the impedance to be determined. It is this principle that is utilised in the design and operation of the bridge.

Practical circuit

The practical circuit is shown in Fig. 4. RV3 is the balancing potentiometer, and standard resistors and capacitors are switched in and out of the circuit by means of the two rotary switches S1 and S2, to give two ranges for resistance measurement and two for capacitance measurement. Provision is also made for comparison against an external standard component.

Of the many ways in which the switching can be arranged the one illustrated proved to be extremely simple to connect and also to operate. With the circuit shown the values of resistance and capacitance which may be measured are as follows:

Resistance		Capacitance	
Range 1	Range 2	Range 1	Range 2
100Ω	10kΩ	100pF	0·01μF
10kΩ	1MΩ	0·01μF	1μF

Calibration and Operation

Calibration of the bridge is best achieved by substituting components of known value at the terminals marked 'Unknown' and after balancing, marking the position of the slider on the scale. The range switches can be appropriately marked R, Rx100, C, Cx100, etc.

To operate the instrument, the signal tracer (see Fig. 5) is connected to the appropriate socket and the component under examination connected to the terminals marked 'Unknown'. If the unknown component is a resistor, the capacitance switch is moved to position R and the resistance switch to the appropriate range marked R or Rx100 for internal standard or to 'Ext' if an external resistor is used. The output from the AF signal generator (See Fig. 1) is fed to the bridge and the output adjusted for a signal of about 0·5V at a frequency of 1kc/s. The slider of the potentiometer RV3 is then slowly rotated until the null point is reached. The value of resistance is then read directly from the dial.

If the unknown component is a capacitor, the resistance switch is moved to position 'C', the capacitance switch to the appropriate range and the above procedure repeated.

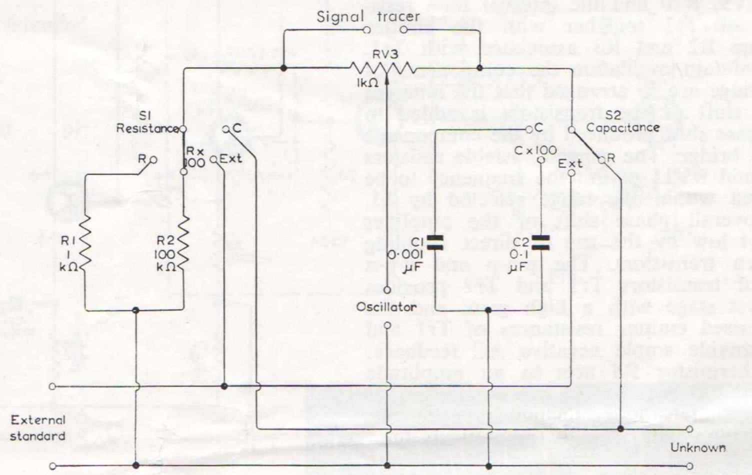


Fig. 4—Circuit diagram of resistance-capacitance bridge

LIST OF COMPONENTS

Resistors

Circuit Ref.	Value	Description
R1	1 kΩ ¼W	High stability
R2	100 kΩ ¼W	High stability
RV3	1 kΩ	Linear wirewound

Capacitors

Circuit Ref.	Value	Description
C1	0·001 μF	High stability
C2	0·1 μF	High stability

SIGNAL TRACER

Circuit Description

The circuit shown in Fig. 5 is a two-stage transistor RC coupled amplifier with an ear-piece (approx. 1kΩ) in the collector of Tr2. The input is applied across a 100kΩ potentiometer and a variable proportion of this signal is fed to Tr1 via the coupling capacitor C1. The ampli-

Continued on page 7.

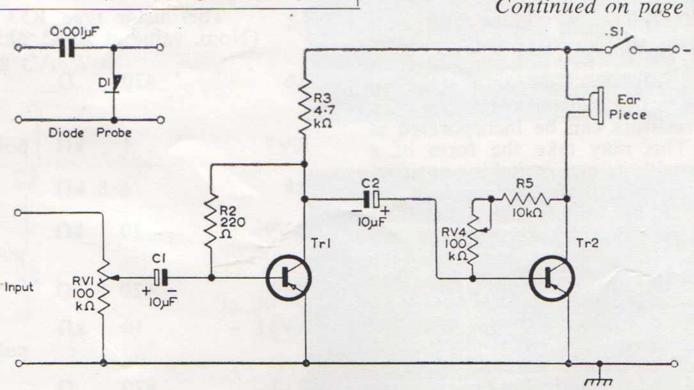
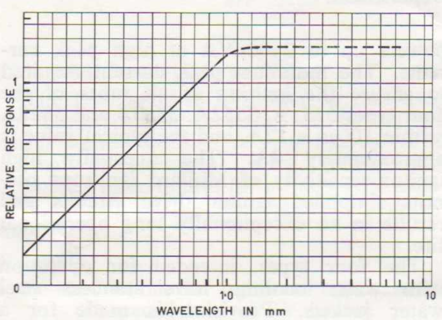


Fig. 5—Circuit diagram of signal tracer

A FAST PHOTO-DETECTOR FOR SUB-MILLIMETRE RADIATION

Mullard is now manufacturing a fast-response photo-detector of sub-millimetre radiation developed by scientists in the Physics Department of the Royal Radar Establishment, Malvern, England.

The cell will provide a means of detecting radiation in that part of the spectrum between heat rays and radio waves—that is, between wavelengths of 0.1mm and 1.0mm.

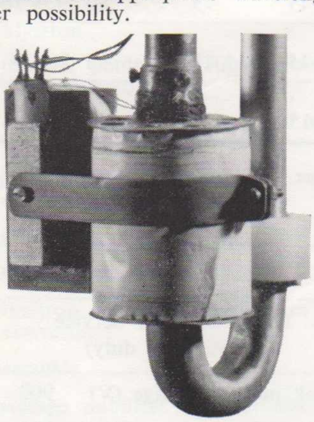


Curve showing spectral response of the detector

Bolometers, thermocouples and Golay cells have, in recent years, enabled measurements to be made within this band but such devices are satisfactory only for use with continuous radiation or pulses of radiation in the order of milliseconds, or longer, in duration.

The new cell, however, has the very fast response time of less than one microsecond and is the first device ever produced capable of measuring, at these wavelengths, the time distribution of the radiated energy during a pulse generated from a plasma generator.

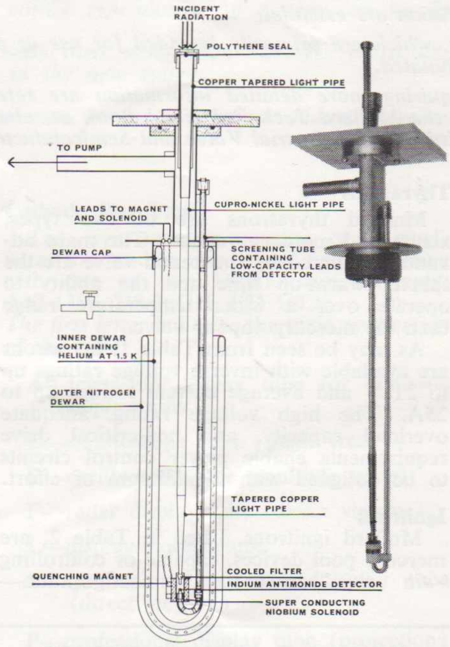
Other applications include microwave spectrometry, the examination of resonances in large molecular bondings, the measurement of absorption in inorganic materials, the investigation of sub-millimetric maser phenomena, and the detection of radiation from the sun and moon. The study of cloud formation and rain by direct observations at appropriate wavelengths is another possibility.



Close-up of super-conducting solenoid

Construction

The detector element is a slice of indium antimonide, approximately 5mm x 5mm x 2mm, placed in the field of a superconducting magnet, which consists of niobium wire on a bobbin the size of a cotton reel. Leads are brought to the cell and to the magnet coil down a pipe of copper nickel alloy. The whole assembly, together with the "light pipe" used to direct the incident radiation on to the sensitive element, is immersed in liquid helium.



Detector with Dewar flasks removed and annotated sectional diagram of detector

The detector uses two Dewar vessels, one inside the other, the outer containing liquid nitrogen which ensures that the liquid helium in the inner vessel does not boil away at an excessive rate. To reduce the boiling point of the liquid helium from about 4°K to about 1.5°K, the inner vessel is continuously pumped to a reduced pressure. The capacity of the Dewars is sufficient to give an operating time of about 8 hours with approximately 1.5 litres of liquid helium.

The new detector should be a most useful addition to the physicist's range of probes for electromagnetic radiation, both because of its very fast response time and the fact that it operates in a portion of the spectrum which has so far been neglected.

At present the device has a wavelength range of 0.1mm to 8mm, but in the near future, it is planned to extend the range towards 0.01mm or less by providing a range of doped germanium crystals which will be interchangeable with the indium antimonide element used at present.

Principle of Operation—Intrinsic Photo-conductivity

In a semiconductor material there is an energy gap between the highest bands of energy levels (i.e. the valence and conduction bands) which may be occupied by electrons. If an electron absorbs the energy from a photon so that it has sufficient energy to be raised across the energy gap to the conduction band, it becomes free to move, as does the hole left behind in the valence band. The result is an increase in the conductivity of the material. This phenomenon is called intrinsic photo-conductivity.

As the energy of a photon is inversely proportional to wavelength, the maximum wavelength which can be detected is given by the minimum energy of ionisation. The choice of energy gap is restricted by the variety of crystals which can be produced with the necessary degree of purity.

By the introduction of impurities into the material, impurity levels are set up between the valence and conduction bands. The energy of activation of these levels can be much less than that across the intrinsic gap and so lead to an increase in the threshold wavelength to which the device is sensitive.

For a semiconductor material to act as a photo-conductor at 1mm wavelength its impurity ionisation energies must not be greater than 1.2 x 10^{-3}eV. So far, N-type indium antimonide has been found the most suitable material for such small impurity activation energies. Studies have shown that for an activation energy to be observed the material must have an impurity concentration of less than 10^{12}cm^{-3}. At present, it is very difficult to obtain material of this high purity. The lack of an activation energy associated with the higher concentrations of impurities is due to an overlap in energy levels caused by interaction between impurity centres, but a reduction in this interaction can be achieved by applying a magnetic field. In material containing impurity concentrations of 3 x 10^{13}cm^{-3}, which Mullard has been able to produce, a field of about 6,000 gauss is needed. A further requirement is that the device must be operated at a temperature below 2°K to prevent swamping of the photo-conductive effect by normal conduction.

Continued from page 6.

fied signal appearing at the collector of Tr1 is coupled via C2 to the base of Tr2 where it is further amplified and appears across the high impedance ear-piece. The magnitude of this signal is now sufficient. Resistor R2 and the variable resistor RV4 set the operating points of Tr1 and Tr2 respectively. RV4 is set so that the collector current Tr2 is approximately 3mA.

To trace HF signals such as those occurring in the IF circuits of receivers, a simple diode probe such as the one shown in Fig. 5 is adequate, the diode OA91 acting as a half-wave rectifier. The power requirements of the unit are met by a miniature 4·5V dry battery switched into circuit by means of the single-pole, single-throw switch on RV1.

LIST OF COMPONENTS

Resistors

Circuit Ref.	Value		Description
RV1	100 kΩ		Carbon potentiometer incorporating switch S1
R2	220 Ω	¼W	10%
R3	4·7kΩ	¼W	10%
RV4	100 kΩ		Carbon potentiometer
R5	10 kΩ	¼W	10%

Capacitors

Circuit Ref.	Value	
C1	10 μF	16V
C2	10 μF	16V

Transistor and Diode Complement

Tr1, Tr2, OC71; D1 OA91

THYRATRON AND IGNITRON POWER CONTROL

Mullard thyratrons and ignitrons are available for industrial applications such as motor and welder control, power regulation, switching, DC to AC inversion, lighting control, relay and contactor operation, heat control and a variety of other switching functions. Thyratrons are particularly valuable where precise control, rapid response and low loss of power in the control operation are essential.

Hydrogen thyratrons, which are primarily intended for use as pulse modulators at high peak currents, are not tabulated.

Design engineers requiring more detailed information are referred to the appropriate sections of Volume 3 of the Mullard Technical Hand Book or, alternatively, it is suggested they contact our Transmitting and Industrial Valve and Semiconductor Department.

The Tables below, giving a selection from the wide range of Mullard thyratrons and ignitrons, have been compiled to enable the design engineer to select the thyratron or ignitron best suited for a particular application.

In many cases the requirements of the problem automatically define the type and ratings required. In others the choice requires a careful appraisal of the merits of each class of device.

Thyratrons and ignitrons exhibit a considerable similarity in the normal mode of operation and a low power input signal is required to fire them into conduction. They revert to their blocking condition when the anode voltage or current is caused to fall below a certain level.

Thyratrons

Mullard thyratrons are of two types, xenon and mercury vapour. The main advantages offered by the xenon valve are the shorter warm-up time and the ability to operate over a wider temperature range than the mercury vapour valve.

As may be seen from Table 1, thyratrons are available with inverse voltage ratings up to 21kV and average current ratings up to 25A. The high voltage rating, adequate overload capacity, and non-critical drive requirements enable power control circuits to be designed with a minimum of effort.

Ignitrons

Mullard ignitrons, listed in Table 2, are mercury pool devices, capable of controlling —in a "back-to-back" configuration— powers up to 2400kVA at high peak currents. The minimum peak current required to ensure the ignition of all tubes of the four types 5551A, 5552A, 5553B and 5822A within 100μs is 12A, and the typical value is approximately 8A. The unusually high ignitor sensitivity of Mullard ignitrons permits simplified ignitor drive circuits and results in an exceptionally long operational life.

The four types, intended for operation with water cooling, have stainless steel water jackets. Provision is made for a thermostat to give control of the water flow for protection against overheating. Mullard ignitrons are used for resistance welding and power rectification, achieving long life under the most arduous conditions of continuous heavy loading.

TABLE 1 THYRATRONS

	XENON				MERCURY VAPOUR							
	Approx. ambient temp. range—55°C to 70°C. Typical heating-up delay from 0·2 to 0·1 mins. Suitable for static or mobile equipment. Suitable for operation up to approx. 2·5kc/s.				Approx. ambient temp. range 10°C to 50°C. Typical heating-up delay at ambient temp. 20°C from 7 to 17 mins. Suitable only for static equipment and for low-frequency operation.							
Type No.	XR1–1600A	XR1–3200A	XR1–6400A	XR1–12A	XG5–500	XG1–2500	ZT1000	XG2–6400	XG15–10	XG15–12	XG2–12	XG2–25
Max average current (A)	1·6	3·2	6·4	12·5	0·5	2·5	2·5	6·4	10	12·5	12·5	25
Max peak current (A)	30	40	80	160	2·0	15	10	40	45	75	80	160
Max forward voltage (kV)	1·5	1·5	1·5	1·5	2·5	1.0	21	2·5	15	15	1·5	1·5
Max peak inverse voltage (kV)	1·5	1·5	1·5	1·5	5·0	1·5	21	2·5	15	15	2·5	2·5

TABLE 2 IGNITRONS

	5551A		5552A		5553B		5822A
	Single-phase control, welder duty. Two valves in inverse parallel on 600V supply						
Maximum demand (kVA)	200	600	400	1200	800	2400	
Max average current (A)	56	30·2	140	75·6	355	192	
Max averaging time (s)	7·5	7·5	5·8	5.8	4·6	4·6	
	Three-phase welder service						
Peak anode voltage (V)	1200	1500			600	1500	1500
Peak anode current (A)	600	480			4000	2400	1200

5555		
Power Rectifier Service (continuous duty)		
Max peak inverse voltage (V)	900	2100
Average anode current (A)	200	150
Peak anode current (A)	1800	1200

NEW VALVE AND TUBE NOMENCLATURE

A new type designation has been devised in order to accommodate the continuous multiplication of types, the introduction of new devices and a degree of definition and rationalisation that the earlier type-numbering system can no longer adequately provide.

Earlier types will retain their designation numbers whilst all future valves and tubes will have type numbers in the new system.

Details of the new system, so far as it affects industrial valves and cathode ray tubes, are given below.

Industrial Receiving-type Valves

The type number is similar to that used for 'entertainment' receiving valves, but the serial number consists of four figures. (The normal entertainment valve system now stipulates three figures for all new type numbers instead of the two figures previously used.)

Example

EC1000 Triode for industrial applications, special base, 6·3V heater.

Industrial Valves, Tubes, etc., other than Receiving-type Valves

The type number for these devices consists of two letters followed by four figures. *The first letter* indicates a fundamental characteristic of the device:

X—photosensitive tube

Y—vacuum valve or tube (except photodevices)

Z—gasfilled valve or tube (except photodevices)

The second letter indicates the construction or application of the device:

A—diode

C—trigger tube

D—triode or double triode

G—miscellaneous

H—travelling wave tube

J—magnetron

K—klystron

L—tetrode, pentode, double tetrode, or double pentode

M—cold cathode indicator or counter tube

P—photomultiplier tube or radiation counter tube

Q—camera tube

T—thyratron

X—ignitron, image intensifier, or image converter

Y—rectifier

Z—voltage stabiliser or reference tube

The group of four figures is a serial number. The last figure is 0 for basic types. Variants of the basic type are indicated by the figures 1 to 9.

Examples

YL1030 Transmitting double tetrode

ZM1020 Cold cathode indicator tube

ZM1021 Cold cathode indicator tube, variant of ZM1020

Cathode Ray Tubes

The type number consists of a single letter followed by two sets of figures, ending with one or two letters. For example: A47-13W, D8-10GH, F21-10LD.

The first letter indicates the main application of the tube:

A—television display tube for domestic applications

D—oscilloscope tube (single trace)

E—oscilloscope tube (multiple trace)

F—radar display tube (direct viewing)

L—display storage tube

M—professional television display tube (direct viewing)

P—professional display tube (projection)

Q—flying spot scanner

The first group of figures indicates the diameter or the diagonal of the screen in centimetres.

The second group of figures is a two-figure serial number.

The second group of letters indicates the properties of the phosphor screen.

The first letter denotes the colour of the luminescence, and is in accordance with the colour designations proposed by K. L. Kelly. These are based on the American Inter-Society Colour Council/National Bureau of Standards (ISCC—NBS) system (1940) for surfaces and light-transmitting layers, extended by Kelly in 1943 to apply to self-luminous areas. See *J. Optical Soc. Am.*, Vol. 33, pp. 627 to 632.

A —Reddish-purple, purple, bluish-purple

B —Purplish-blue, blue, greenish-blue

D —Blue-green

G, H —Bluish-green, green, yellowish-green

K —Yellow-green

L —Orange, orange-pink

R —Reddish-orange, red, pink, purplish-pink, purplish-red, red-purple

W —White

X —Tri-colour screen

Y —Greenish-yellow, yellow, yellowish-orange.

The second letter is a serial letter to denote particular phosphors. For the 'standard' television picture tube phosphor the letter 'W' is used without a second letter.

Phosphor Equivalents

The following table gives the old, new, and E.I.A. designations for the phosphor screens used in Mullard tubes.

Old designation	New designation	EIA No.
A	BD	—
B	BE	P11
C	BA	—
D	LA	—
E	LB	—
F	LC	—
G	GJ	P1
G (projection)	GK	
H	GH	P31
J	GN	
K	GE	P24
L	LD	P33
M	GB	P32
N	GL	P2
P	GM	P7
U	BF	
V	BC	—
W	W	P4
X	X	P22
Y	YA	
—	KA	P20

FACTS ABOUT OXYGEN

Tasteless, colourless, without smell, oxygen is by far the most abundant of all the elements. In fact, there is more of it than all the rest put together.

It is the only element with a property capable of supporting most forms of life. Even fish rely for their existence on the dissolved oxygen in the water in which they live. In medicine they call it the "breath of life". Sometimes it is inhaled on its own or, oddly enough, in chemical combination with nitrogen it can produce anaesthesia in the form of "laughing gas".

A familiar sight on the roads are those spherical tankers which most motorists treat with a wholesome respect. These tankers are made of copper, double-walled like an ordinary domestic vacuum flask. And they carry liquid oxygen—an intensely cold liquid which boils at 183 degrees below zero.

Fusion Welding

There are many applications for oxygen in industry. In its gaseous form, for instance, it is employed for the fusion welding of metals by means of the oxy-acetylene flame at a temperature of 5000°C.

At the Mullard factories, oxygen is used in the many cutting and welding processes involved in the manufacturing of valves and TV tubes; and at the Research Laboratories oxygen plays an important part in low temperature research.

COLOUR TEMPERATURE

This is the second in a series of articles (see Outlook Vol. 5 No. 5) on photometry and closely allied subjects. In the first article an attempt was made to explain the principles of photometry, and to put a case for the exclusive use of metric units.

The present article is both a footnote to the discussion of photometry and a preface to an article on colorimetry that will be published in the future.

Temperature and Colour

One way of specifying the colour of a light source is by means of its *colour temperature*. If—to take a familiar example—a steel poker is heated to, say, 500°C, it will emit energy in the infra-red region, producing a sensation of warmth but no visible radiation. Further heating will increase the disturbance of the molecular and atomic structure of the poker, and the band of radiation will widen to include the red end of the visible spectrum. The poker will be red-hot.

Still further heating will shift the upper frequency limit of the radiation progressively towards the violet end of the visible spectrum; and, since by the laws of colour-mixing the visible spectrum adds up to white, the appearance of the poker will approach closer and closer to white as the successive bands of the spectrum (yellow, green, blue . . .) are added. Of course, the individual colours of the spectrum, other than red, are not seen in this series, as, because of the continued presence of the radiations of longer wavelength there is a process of continuous colour-addition.

These colours must not be confused with the tempering colours familiar to the metal-worker—'light straw', 'peacock', and so on—which are phenomena of oxidisation, not of radiation.

Black-body Radiation

If we now discard the heated poker and think in terms of a so-called *black body*, we can arrive at the concept of colour temperature. A black body is an object which totally absorbs all the radiant energy (within the limits of the visible spectrum) to which it is exposed. No such bodies exist, of course, since no surfaces are entirely without the ability to reflect; but the concept is useful for some purposes. In practice, a close approximation to the ideal black body is possible.

Since the black body is an ideal absorber, it is also an ideal radiator; and it is this aspect of its operation that constitutes its usefulness. If a black body is raised to a particular temperature, it will produce radiation having a well-defined energy spectrum and a typical colour sensation. This colour can be used as a standard of comparison and a reference point for other radiations. A radiator exhibiting a matching colour will have (within certain limits) a matching energy spectrum. For each black body temperature there is a known energy spectrum.

Of course, the colours obtainable are those of the 'poker' series—from red to white—and the concept of colour temperature is applicable only to light sources whose colours lie within or near this series. On the colour triangle which is used for the specification of colours, the series can be plotted as a slightly curved line passing through the white region and ending in the bluish-white region.

Let us, then, take a light source which produces a colour sensation of, say, yellowish-white or bluish-white. It may be a lamp filament; it may be a 'north sky'. To find the colour temperature of this source, we heat a black body until its radiation is a visual colour match for the source under test. The actual temperature of the black body is then the colour temperature of the source. In practice there is a limit to the temperature to which a black body can be raised. The higher colour temperatures quoted are theoretical extrapolations.

Limitations

The colour temperature, it must be noted, is an indication of the *colour* sensation produced by the radiating body; it is *not* an indication of its temperature. If the source is a heated filament, then its actual temperature may be somewhere near its colour temperature—either above it or below it, dependent on the actual energy spectrum of the source (which, in practice, will show a deviation of some kind from that of a black body). But if the source is, say, the sky, then the colour temperature (which may be as high as 20 000°K or more) will have little relevance to the physical condition of the source. The statement that the sky has a colour temperature of 20 000°K means that the sky produces a visual sensation matching that of a black body at 20 000°K, and that its energy spectrum is also a near match within the limits of the visible spectrum. The 'sky', of course, is at no such physical temperature. Nor, indeed, is any practical black body.

Failure to keep this interpretation in mind leads to misunderstanding of the colour temperature concept, and to a lack of appreciation of either its usefulness or true limitations.

Confusion can also result from drawing analogies with optical pyrometry. Here, of course, there is simple visual comparison of two heated bodies. The comparison body is not a 'black body' but a heated filament, calibrated in terms of temperature and supply voltage. When a match is obtained, the temperature of the test object is taken to be that of the calibrated filament. The device is simply a kind of thermometer.

The chief limitation of colour temperature, apart from its restriction to the red-white series, is the fact that the energy distribution of the source under test will probably not exactly match that of the black body. In other words, although at some particular black body temperature a good colour match is obtained, this does not necessarily mean that the test source has an energy spectrum precisely matching that of a black body at that temperature. A visual sensation of, say, white can be the product of a variety of spectral distributions; that is, a particular colour sensation can be the result of many different mixtures of component colours.

Practical Uses

For such sources as tungsten lamp filaments, over a useful range of operating temperatures, the spectral distribution is reasonably close to that of a black body and it is, therefore, practicable and convenient to specify photometric standard lamps by their colour temperature—this being obtained at some defined condition of operating voltage or current.

A photometer lamp, specified in this convenient manner, provides both a defined visual stimulus and a defined spectrum of visible energy. For photometric purposes, therefore, the 'white' light used may be defined as a lamp operating at, say, 2042°K. This particular value is used for the definition of the candela. (Strictly speaking, the definition refers to the temperature of solidification of platinum, since this can be more accurately maintained than measured.)

Since much practical photometry has been concerned with incandescent lighting, photometer lamps are now operated at higher colour temperatures—2353°K, 2788°K, or 2854°K—since these more closely resemble the colour temperature of normal tungsten lamps and are closer to the conventional idea of whiteness.

Standard illuminants for use in colorimetry have colour temperatures of 2854°K (Illuminant A), 4900°K (Illuminant B), and 6700°K (Illuminant C). These are alternative illuminants by which colour samples may be viewed in colorimeters, and they are intended to represent (A) lighting by tungsten lamps, (B) sunlight, and (C) the light from an overcast sky—these being the typical conditions under which coloured objects will be seen in everyday life. The growing use of fluorescent and sodium lighting has, however, greatly complicated the question of colour matching and evaluation.

The interesting point about these three illuminants is that (A) is a tungsten lamp, operated under certain specified conditions, whilst (B) and (C) are the same lamp used in conjunction with filters. The physical temperature of the lamp is, of course, the same in each instance, but the colour temperatures are widely different—a neat illustration of the distinction between real temperature and colour temperature.

Perhaps it might be as well to point out that these three illuminants are not the three 'reference stimuli' used in colorimetry.

It should be noted that certain other kinds of light source cannot usefully be specified in terms of colour temperature, either because they fall outside the red-white series of colours or because they have discontinuous energy spectra. Examples will be found in tables of light-sources, no value being quoted in the colour temperature column. Some of these sources do, indeed, produce a colour sensation (when viewed directly by the eye) which is indistinguishable from that of a source in the black body series. But attempts to match the colours of objects and materials by means of their light would be very misleading.

A 300mW COMPLEMENTARY AUDIO AMPLIFIER

Two 300mW audio amplifiers are described,* demonstrating the simplicity of Class 'B' push-pull circuit design where complementary transistors (p-n-p and n-p-n) are employed. Both amplifiers are provided with pre-amplifier stages to achieve sufficient gain and input impedance when driven from a crystal pick-up.

The first amplifier employs a "boot-strapped," common collector input stage. In the second amplifier, an input circuit utilising an n-p-n common emitter stage is employed.

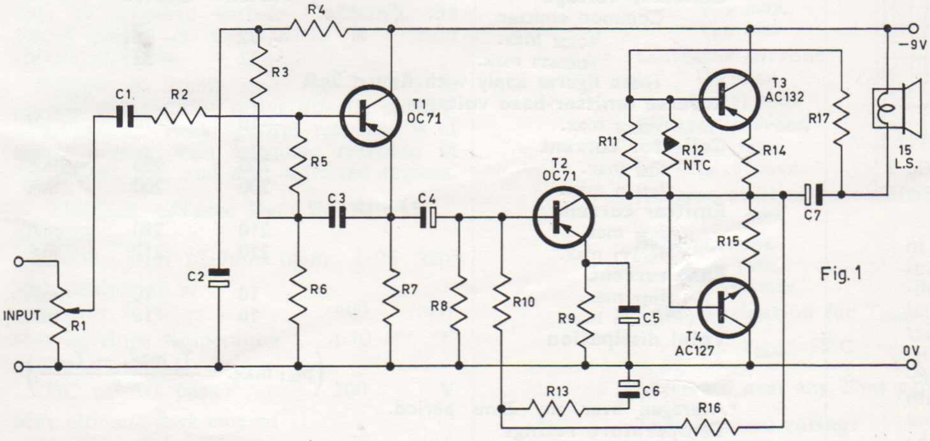


Fig. 1

Complementary Amplifiers

In the past it has been impractical to eliminate the interstage coupling transformer from transistor audio amplifiers, but now, with the advent of the n-p-n/p-n-p complementary pair AC127-AC132, it is possible to design a simple amplifier suitable for portable receivers and record players. The amplifier is small and light and, although an extra transistor may be needed to achieve the same gain as with conventional amplifiers, the absence of iron-cored components makes it comparable with them in cost.

Complementary Output Circuit

In the circuit diagrams Figs. 1 and 2, the transistors in the output stage are connected in common collector and are operated under a Class 'B' projected cut-off condition. The driver stage is operated in conventional Class 'A' condition and is directly coupled to the output pair. When the collector potential of the driver transistor rises towards the negative supply, the p-n-p transistor conducts and the n-p-n transistor is cut off. The reverse takes place when the potential at the collector of the driver moves in the positive direction. The collector currents of the output transistors flow via the loudspeaker voice-coil to the supply.

In order to permit symmetrical drive to the output pair, the potential at the collector of the driver is slightly more negative than half the supply voltage, as excursions in the positive direction are limited by the voltage across the emitter resistor R11 and the base-to-emitter voltage of the driver transistor.

In the circuit diagram (Fig. 1) it will be seen that a feedback loop from the output circuit to the base of the driver transistor provides DC as well as AC negative feedback. The AC feedback is limited to 6dB by means of a resistance-capacitance network R13, C6 at the junction of R16 and R10. The combined driver and output stage is thermally stable at temperatures of up to 55°C. It will be noted that the collector load resistance of the driver stage R17 is connected to the high-AC-potential-end of the loudspeaker rather than the supply. This provides a form of "bootstrapping," reducing the shunt loss caused by the collector resistor; in effect this resistance appears as almost an infinite impedance to the AC signal.

Quiescent biasing of the output stage is provided by an NTC resistor R11 in parallel with a fixed resistor R12.

AMPLIFIER 1

RESISTORS

Circuit Reference	Value	Tolerance %	Description	Rating (W)
R1	1 MΩ		log taper potentiometer	
R2	330 kΩ	10	carbon	½
R3	82 kΩ	10	carbon	½
R4	4.7kΩ	10	carbon	½
R5	100 kΩ	10	carbon	½
R6	100 kΩ	10	carbon	½
R7	22 kΩ	10	carbon	½
R8	4.7kΩ	5	carbon	½
R9	220 Ω	10	carbon	½
R10	8.2kΩ	5	carbon	½
R11	270 Ω	10	carbon	½
R12	130 Ω		NTC 130E	
R13	2.2kΩ	10	carbon	½
R14	3.3 Ω	5	wire wound	½
R15	3.3 Ω	5	wire wound	½
R16	10 kΩ	5	carbon	½
R17	1.5kΩ	10	carbon	½

CAPACITORS.

	Value	Description	Rating (V)
C1	0.1 μF	ceramic	25
C2	10 μF	electrolytic	16
C3	0.22μF	ceramic	25
C4	10 μF	electrolytic	16
C5	100 μF	electrolytic	4
C6	100 μF	electrolytic	16
C7	100 μF	electrolytic	16

MULLARD TRANSISTORS.

T1	OC 71
T2	OC 71
T3	AC132
T4	AC127

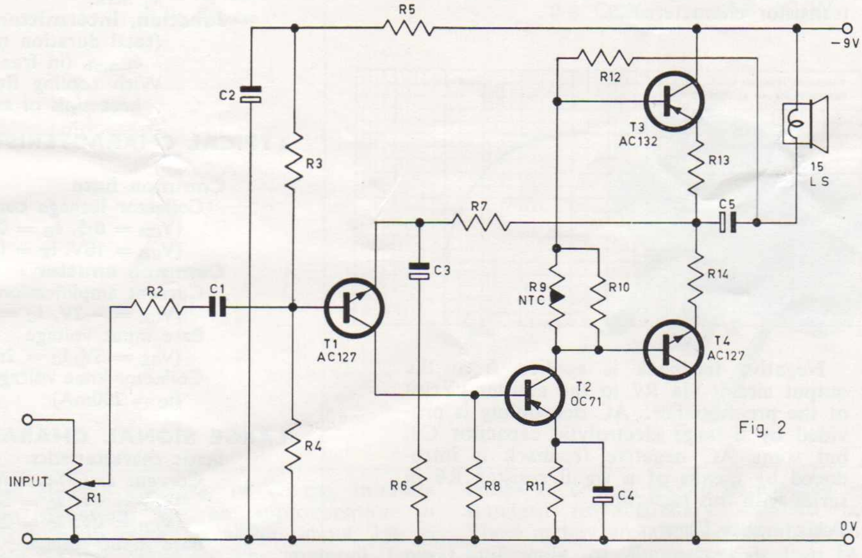


Fig. 2

AMPLIFIER 2

RESISTORS.

Circuit Reference	Value	Tolerance %	Description	Ratings (W)
R1	1 MΩ		log taper potentiometer	
R2	330 kΩ	10	carbon	½
R3	22 kΩ	5	carbon	½
R4	22 kΩ	5	carbon	½
R5	1.8kΩ	10	carbon	½
R6	4.7 Ω	5	wire wound	½
R7	1 kΩ	10	carbon	½
R8	1 kΩ	10	carbon	½
R9	130 Ω		NTC 130E	
R10	82 Ω	10	carbon	½
R11	68 Ω	10	carbon	½
R12	680 Ω	10	carbon	½
R13	3.9 Ω	5	wire wound	½
R14	3.9 Ω	5	wire wound	½

CAPACITORS.

	Value	Description	Rating (V)
C1	0.22μF	ceramic	25
C2	40 μF	electrolytic	10
C3	320 μF	electrolytic	10
C4	100 μF	electrolytic	4
C5	320 μF	electrolytic	10

MULLARD TRANSISTORS.

T1	AC127
T2	OC71
T3	AC132
T4	AC127

Input Circuit

It is necessary for the pre-amplifier stage to present a high impedance to the pick-up. For this reason, in the circuit Fig. 1 a grounded collector stage is used. The shunt loss produced by the biasing network of this stage R3, R5, R6 is further reduced by "bootstrapping"; that is, by applying a signal from the emitter via C3 back to the bias network, thus causing the bias network to appear as a high impedance to the input signal.

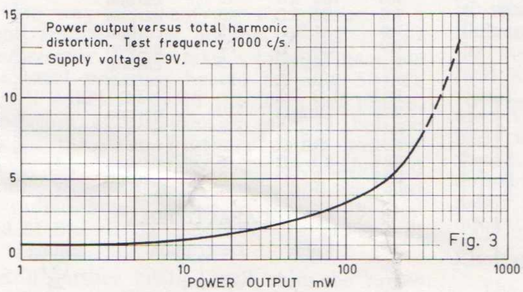


Fig. 3

The pre-amplifier in Fig. 2 is novel in that an n-p-n transistor has been used, thus permitting a completely DC-coupled amplifier. The input n-p-n transistor serves a dual function. Firstly it acts as a pre-amplifier for the AC signal and secondly, as a DC differential amplifier, comparing the base-to-ground voltage of the pre-amplifier with the emitter-to-ground voltage of the output pair. Due to the high loop gain of the system, the difference between the voltages is constant, irrespective of the spreads in transistor characteristics.

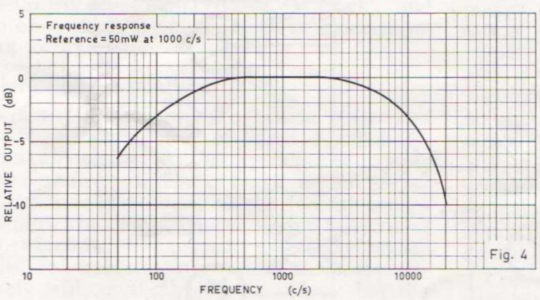


Fig. 4

Negative feedback is applied from the output circuit via R7 to the emitter circuit of the pre-amplifier. AC decoupling is provided by a large electrolytic capacitor C3, but some AC negative feedback is introduced by means of a small resistor R6 in series with this capacitor.

Performance Figures

Both amplifiers have an input impedance of 330kΩ and require 770mV r.m.s. for the full output of 300mW. Fig. 3 shows output versus distortion and is applicable to both amplifiers. Fig. 4 shows the frequency response of both amplifiers. It is to be noted that the response has been tailored to produce a symmetrical curve in order to give the most pleasing audio output from equipment using small baffles and speakers.

For best compromise between battery economy and crossover distortion the output stage quiescent current is set at 4.6mA. The total amplifier quiescent current is 11mA.

* This article is based upon investigation carried out by R. B. Chorley of the Mullard Applications Laboratory, Sydney.

JUNCTION TRANSISTORS AC127/AC132

FOR COMPLEMENTARY SYMMETRY APPLICATIONS

PRELIMINARY DATA

ABSOLUTE MAXIMUM RATINGS

The equipment designer must ensure that no transistor exceeds these ratings. In arriving at the actual operating conditions, variations in supply voltages, component tolerances and ambient temperature must also be taken into account.

	AC127	AC132	
Collector voltage			
Common emitter			
V_{CEM} max.	+32	−32	V
*$V_{CE(AV)}$ max.	+32	−32	V
These figures apply with $R_{BE} < 2k\Omega$			
Reverse emitter-base voltage			
V_{EBM} max.	+10	−10	V
Collector current			
I_{CM} max.	200	200	mA
*$I_{C(AV)}$ max.	200	200	mA
Emitter current			
I_{EM} max.	210	210	mA
*$I_{E(AV)}$ max.	210	210	mA
Base current			
I_{BM} max.	10	10	mA
*$I_{B(AV)}$ max.	10	10	mA
Total dissipation			

$$\left(P_{tot} \text{ max.} = \frac{T_j \text{ max.} - T_{amb.}}{\theta}\right)$$

*Averaged over any 20ms period.

	AC127	AC132	
Temperature ratings			
T_{stg} max.	75	75	°C
T_{stg} min.	−55	−55	°C
T_j max.	75	75	°C
Junction, intermittent operation			
(total duration max. 200 hrs.)	90	90	°C
θ_{j-amb} (in free air)	0·37	0·3	°C/mW
With cooling fin mounted on a heat sink of at least 12·5 cm²	0·16	0·09	°C/mW

TYPICAL CHARACTERISTICS AT $T_j = 25°C$

		AC127	AC132	
Common base				
Collector leakage current I_{CBO}				
($V_{CB} = 0{\cdot}5$, $I_E = 0$mA)		<10	<10	μA
($V_{CB} = 10$V, $I_E = 0$mA, $T_j = 85°$C)		<1000	<1000	μA
Common emitter				
Current amplification factor h_{fe}				
($V_{CE} = -2$V, $I_C = 3$mA)				
Base input voltage	V_{BE}			
($V_{CE} = 5$V, $I_C = 2$mA)		+120	105	mV
Collector knee voltage	$V_{C\,(knee)}$			
($I_C = 200$mA)		+450	350	mV

LARGE SIGNAL CHARACTERISTICS ($T_j = 25°C$)

		AC127	AC132	
Static characteristics				
Current amplification factor h_{FE}				
($V_{CB} = 0$V, $I_C = 50$mA)		115	115	
($V_{CB} = 0$V, $I_C = 200$mA)		90	70	
Base input voltage	V_{BE}	Max.	Max.	
($V_{CB} = 0$V, $I_C = 100$mA)		+600	600	mV

CHARACTERISTICS OF MATCHED PAIR AC127/AC132 ($T_j = 25°C$)

Ratio of the current amplification factors of the two transistors at :—
$I_C = 50$mA $<1{\cdot}25 : 1$

OPERATING NOTES

1. Transistors may be soldered directly into the circuit but the heat conducted to the junction should be kept to a minimum by the use of a thermal shunt.
2. Transistors may be dip soldered at a solder temperature of 245°C for a maximum of 5 seconds up to a point 1·5mm from the seal. The temperature of the envelope in contact with the printed board must not exceed 115°C for two minutes.
3. Care should be taken not to bend the leads nearer than 1·5mm to the seal.

RPY15 SMALL CdS CELL FOR DIRECT RELAY OPERATION

A new plastic encapsulation technique is used in the RPY15 cadmium sulphide cell. The cell is electrically similar to the ORP11 (introduced four years ago) but the new technique allows a substantial reduction in physical dimensions. Thus, although the ORP11 and the RPY15 have almost the same diameter and the same area of sensitive surface (1·25cm²), the seated height of the ORP15 is 6·5mm instead of 47mm.

Despite its small size, the RPY15 is capable of operating relays directly without amplification. Peak spectral response is at about 0·7µm, with adequate response in the yellow, red, and near infra-red regions.

Abridged Advance Data for RPY15

Sensitive area		
Circular with 12·7mm diam	1·25	cm²
Max dissipation at t_{cell} = 25°C	400	mW
Max envelope temperature	+70	°C
Max cell voltage (DC or AC peak)	200	V
Max ultimate dark current at 200V and 25°C	20	µA
Equilibrium cell current*		
Min	3·0	mA
Nominal	6·0	mA
Max	12·0	mA

*cell voltage = 10V DC, illumination = 54 lux (5·0 foot-candle), colour temperature of light source = 2700°K.

EVERYTHING UNDER CONTROL

Continued from page 3

more easily pilferable goods, ignoring the "smalls" held in counter drawers or closed display cabinets.

No matter who may be detailed to keep the stockroom ship-shape and hump the goods about, the control of stock—in the smaller business anyway—is definitely a job for the proprietor himself.

It is work for the most interested party and for one who is not a beginner.

ADZ11-ADZ12 HIGH POWER SWITCHING AND GENERAL PURPOSE AUDIO TRANSISTORS IN TO-36 CONSTRUCTION

ADVANCE DATA

ABSOLUTE MAXIMUM RATINGS

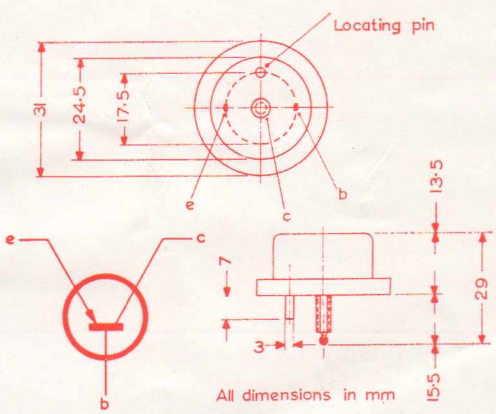
The equipment designer must ensure that no transistor exceeds these ratings. In arriving at the actual operating conditions, variations in supply voltages, component tolerances and ambient temperature must also be taken into account.

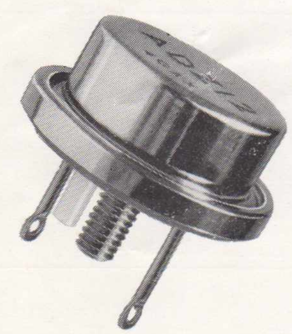
	ADZ11		ADZ12	
Collector voltage				
V_{CB} max.	−50	V	−80	V
V_{CE} max.	−40	V	−60	V
Collector current				
I_{CM} max.	20	A	20	A
*$I_{C(AV)}$ max.	15	A	15	A
Emitter current				
I_{EM} max.	22	A	22	A
*$I_{E(AV)}$ max.	17	A	17	A
Reverse emitter-base voltage				
V_{EB} max.	−30	V	−50	V
Base current				
I_{BM} max.	4·0	A	4·0	A
*$I_{B(AV)}$ max.	2·0	A	2·0	A
Total dissipation for $T_{case} \leqslant 55°C$	45	W	45	W

For $T_{case} > 55°C$: $P_{tot}\ max. = \dfrac{T_j\ max. - T_{case}}{\theta_{j-case}}$

*Averaged over any 20ms period.

	ADZ11		ADZ12	
Temperature ratings				
T_{stg} max.	75	°C	75	°C
T_{stg} min.	−55	°C	−55	°C
T_j max.	90	°C	90	°C
θ_{j-case}	<0·8	°C/W	<0·8	°C/W





Continued from page 10.

Practical Black Bodies

Nothing has been said of the mechanical structure of practical black bodies. The omission has been deliberate, since consideration of their operation can provide another source of possible confusion.

One form of black body is the structure used for the definition of the candela. It consists of a narrow-bore thoria tube contained in a crucible in which platinum is brought to the temperature specified in the definition. The radiation at the closed end of the thoria tube is viewed through a small hole which is in line with the open end of the tube.

It is assumed that the radiation within a closed cavity, whose walls are raised to a uniform temperature, is that of an ideal black body. The introduction of the essential viewing aperture, of course, modifies the radiation; but an approximation to black body radiation within about 3% is said to be possible. The material from which the cavity is constructed is of no consequence. The radiation is a function only of the temperature.

Units

Colour temperature is quoted in °K or in mireds ('micro-reciprocal-degrees'). To convert °K to mireds, divide °K into 10⁶; thus

2500°K = 400 mireds
5000°K = 200 mireds
8000°K = 125 mireds
∞°K = 0 mireds

Colour temperature meters, for the measurement of suitable sources, sufficiently accurate for routine checking of filament lamps for lighting purposes, are available from a number of suppliers. (Photometer lamps, of course, should be checked against standard or secondary standard lamps.) These meters are also used as checks on the uniformity of fluorescent lamps. In this case, however, the meter readings must be regarded simply as reference points and not as indications of colour temperature.

Bibliography

Further information can be found in Kaye and Laby under the headings *Full Radiation, Photometry*, and *Colour Temperature*, and in J. S. Preston: *Photometric Standards and the Unit of Light*. The following works discuss colour temperature in detail.

D. B. Judd. 'Color in Business, Science, and Industry'. John Wiley; Chapman & Hall, 1952 (section on 'One-Dimensional Color Scales', pp. 202 to 209).

R. M. Evans. 'An Introduction to Color'. John Wiley; Chapman & Hall, 1948 (pp. 24 to 27, and 213).

P. J. Bouma. 'Physical Aspects of Colour'. Philips Technical Library, 1947 (pp. 119 to 126).

W. D. Wright. 'The Measurement of Colour'. Hilger & Watts, 1958.

See also the works listed in the earlier article.

NEW CATHODE RAY TUBES

SYMMETRICALLY-DEFLECTED SPLIT BEAM TUBES E10-11GH and E13-10GH

Dual trace cathode ray tubes may be of double-gun type, or they may have a single gun with a beam-splitting system.

The disadvantages of the double-gun tube are bulkiness, expense (which may be disproportionate in otherwise simple instruments), and the necessary displacement of the guns from centrality. This last disadvantage means that the electron beams enter the post-deflection acceleration system off the axis of the electrical field, thus leading to pattern distortion which precludes direct measurement on the tube face. Corrective measures are possible but not, in general, economic.

Beam-splitting systems, hitherto, have necessitated asymmetrical deflection, because the splitter electrode has had to be held at zero potential. Problems of DC drift and of drive power requirements lead to the use of amplifiers that are disproportionately expensive; the extra cost of an amplifier for asymmetrical deflection may well approach the additional cost of a double-gun tube.

A third way of obtaining a dual trace display is to use a normal cathode ray tube driven by two amplifiers which are switched in alternately. The traces are held separate on the screen by a DC bias. The method is relatively inexpensive, but genuinely simultaneous traces are not obtained, and for rapid transition from one trace to the other the bandwidth of the final amplifier must be substantially increased.

In the single-gun E10-11GH and E13-10GH a new deflection system is used. There are two pairs of deflectors separated by a shield. Outside the two sets of deflectors are further shields. The design of the system, aided by precision assembly, enables the effective deflection centres to be only 2mm apart. Beam splitting is performed by the accelerating anode which precedes the deflection systems. This anode has two holes accurately aligned with the two deflection centres.

The introduction of the E10-11GH and E13-10GH makes possible the design of economic dual-trace instruments. Good alignment and freedom from pattern distortion are achieved, and circuit costs and power supply requirements are minimised.

Both types incorporate helical p.d.a. systems. The flat-face screens employ the medium persistence bluish-green H phosphor (GH in the new nomenclature). The E10-11GH is a four-inch tube; the E13-10GH, five inch.

OSCILLOSCOPE TUBES D13-19GH DH7-11 DN7-11

D13-19GH

The D13-19GH is a five-inch flat-face oscilloscope tube using the GH phosphor. The screen has a light output peak at 0·54µm (green) for visual observation, and a secondary peak at 0·47µm (blue) for photographic recording. The useful scan is 6 × 10cm, with high deflection sensitivity. Post-deflection acceleration is incorporated.

The tube is of particular value in precision measuring equipment where high brightness is required or where frequency components up to about 30Mc/s are to be measured.

DH7-11 and DN7-11

Versions of the DH7-78 and DN7-78 with reduced heater consumption have been introduced under the type numbers DH7-11 and DN7-11. The heater consumption of the new types is 95mA at 6·3V instead of 300mA at 6·3V. Both types incorporate helical post-deflection acceleration, and the 3-inch flat faces have either H or N phosphor as indicated in the type numbers.

The H and N phosphors (GH and GL respectively under the new nomenclature) are medium-persistence types with bluish-green and green luminescence.

High deflection sensitivity and low power requirements make these tubes suitable for use in battery-operated transistorised oscilloscopes.

ABRIDGED ADVANCE DATA

	D13-19GH	DH7-11 DN7-11	E10-11GH	E13-10GH	
V_h	6·3	6·3	6·3	6·3	V
I_h	300	95	300	300	mA
Min useful scan	60 × 100	45 × 60	50 × 80	60 × 100	mm
$V_{h-k(max)}$ with k —	125	15	125	125	V
$V_{h-k(max)}$ with k +	200	100	200	200	V
Typical Operating Conditions					
V_{a4}	10	1·2	4·0	6·0	kV
$V_{i.p.s.}$	1670	270 to 330	1000	1500	V
V_{a3}	1670	285 to 340	1000	1500	V
V_{a2}	330 to 570	20 to 150	100 to 350	200 to 450	V
V_{a1}	1·67	1·2	1·0	1·0	kV
V_g for visual cut-off	—53 to —82	—30 to —80	—45 to —90	—45 to —90	V
S_x	<33	9·4 to 12	17	18	V/cm
Sy′	<13·7	3·2 to 4·1	13	13	V/cm
Sy″	—	—	13	13	V/cm
Mechanical					
Max overall length	468	296	400	463	mm
Max seated height	448	273	385	446	mm
Max diameter	134·5	77·8	102	135	mm
Base	B14A	Special 14-pin	B12F	B12F	—

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