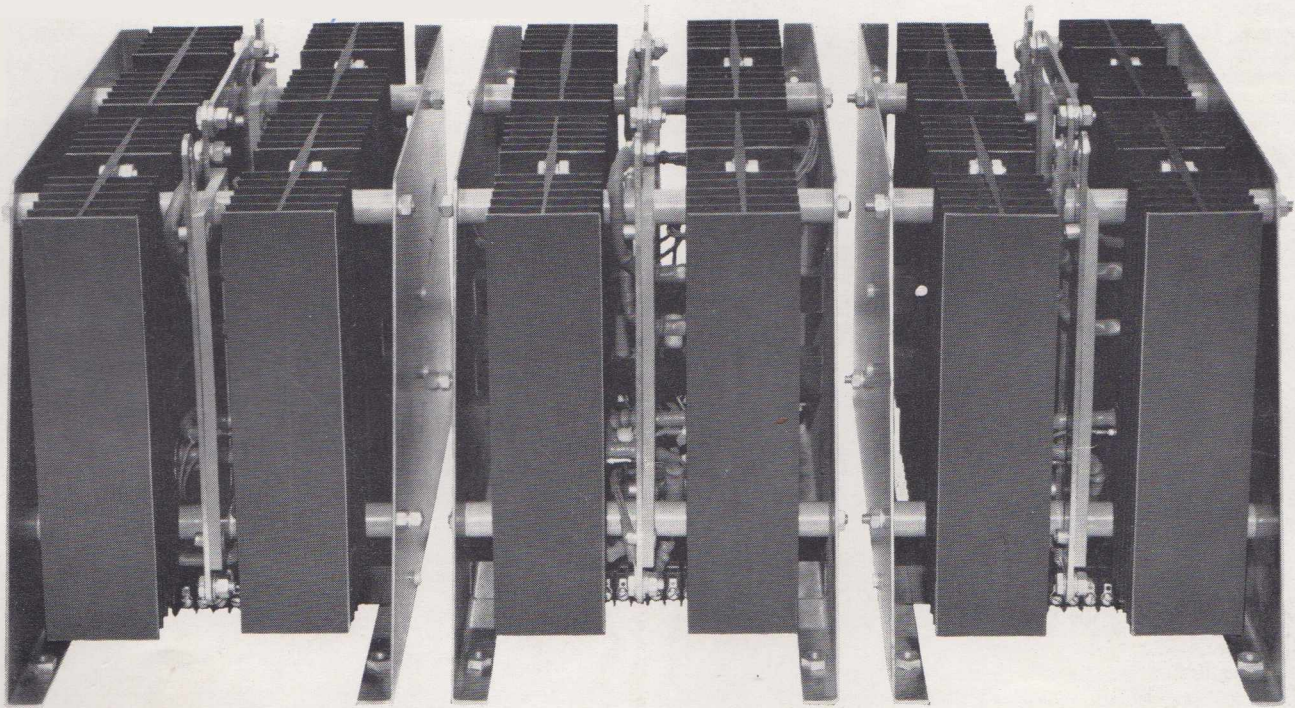


# Mullard

# Outlook

AUSTRALIAN EDITION



VOL. 7 No. 4  
JULY-AUGUST, 1964



MULLARD-AUSTRALIA PTY. LTD.



VOL. 7 — No. 4

JULY-AUGUST, 1964

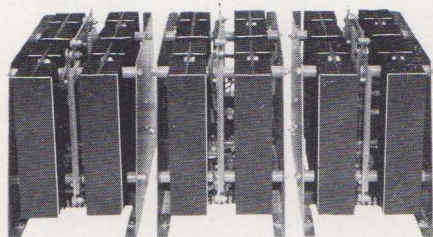
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These three assemblies make up a three-phase thyristor stack type OTK117-1206. It is rated for a maximum DC output voltage of 1050V (with a resistive or inductive load) and a maximum average DC output current of 117A. The stack is intended for use in a variety of control applications.

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## THE BEDSIDE MANNER

We have endeavoured with Outlook to seek the fresh and original and from time to time applaud the other fellow. We are therefore pleased to reprint in this issue an article on Customer Relations from a U.S. magazine. Where the bedside manner extends beyond Tom Jones and Dr. Kildare, we strongly commend it to our readers that it may assist their business and the sale of our products.

### Q621.3805

1

This is the reference number of Mullard Outlook in the archives of the Mitchell Library, amongst thousands of other papers and publications but nevertheless indexed, with a reproduction service for copies out of print, and what is considered an Australian journal of education and scientific value, tracing a pattern of one company in a fast-moving industry. At first we set a relatively small circulation and whilst its growth has been somewhat flattering to us, with costs abounding, the introduction of a 12/- subscription two years ago has shown an added growth with a direct mailing circulation now exceeding 8,000, extending the hand of friendship and commercial activity where we cannot ourselves call regularly.

M.A.B.

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# VIEWPOINT WITH MULLARD

## CUSTOMER RELATIONS\*

After you land a customer let him know you are grateful to have him with you.

Did you ever walk into a store and receive discourteous treatment from a sales person?

Did a distributor you telephoned ever give the impression he didn't much care whether he got your business?

Did you ever receive, in response to a complaint, a reply that implied you didn't know what you were talking about?

If so, then you were the victim of faulty customer relations. You got the feeling that your business wasn't appreciated. You were offended, and rightly so.

Elimination of such customer-souring experiences should be a major concern of businessmen everywhere. Oddly enough, however, this isn't always the case.

Although millions are spent each year to create favourable business images and attract new customers, comparatively little is spent on a conscious effort to keep existing customers from drifting away.

### Perpetuating Goodwill

Surveys show that relatively few firms do anything to cultivate and perpetuate the goodwill of customers already in hand. Service-dealers and technicians, for example, seldom have anyone specifically assigned to receive telephone complaints.

In Philadelphia, an organization known as the Customer Relations Research Foundation is doing something about all this. Endowed by business firms, and believed to be the only organization of its kind, this foundation is conducting original research into customer relations practices (and mis-practices).

The foundation defines customer relations as the art of cultivating and perpetuating the goodwill of established customers. This means a "rifle" approach—a zeroing-in on specific customers and complementing the "shotgun" or general-image mission of public relations and advertising.

Basic studies of customer habits, and the reasons for business infidelity, show this standout fact: Indifference emerges, time after time, as the No. 1 customer killer.



The business relationship, it is apparent, must be constantly nurtured all year long, not just when the sales curve levels off.

Business transactions, it is clear, are significant only when they become something more than cold-cash deals. The customer is happier if he feels his money is going to someone interested in him as a friend.

The salesman becomes the contact-image of the company—and the distributor personifies the factory.

After you land a customer, says the Customer Relations Foundation, let him know you are grateful to have him with you. It's somewhat like romance; it pays to be attentive to the gal, even after you've sold yourself!

### Handy Information

Some service-dealers and technicians get good mileage out of "new customer kits" containing facts about the company, its sales policy, its service policy and its repair parts policy. This information is particularly useful and appreciated when accompanied by something in handy form. Things like imprinted ballpoint pens, ash-trays and pocket calendar cards have been found effective.

Remember, in business you can win an argument and lose a friend. Always say "thank you". When the customer is in a rush, move faster. When the customer "knows it all," don't argue. Be courteous, tactful and enthusiastic.

Telephone manners, if faulty, can be readily corrected. The person who answers the phone shouldn't ask "Who's calling?" before telling the caller whether the boss is in. This, in effect, is making the caller justify himself as important enough to merit the privilege of conversing with Mr. Big.

It's better to answer, "Why yes, I believe Mr. Big is in. May I tell him who is calling?" If the "boss" is too "big" to converse with a customer it's time for him to retire.

The old phrase, "The customer is always right," may be trite but is everlastingly true. Even a giant like Sears, Roebuck & Co. knows this, as witness the company's policy of not arguing with those who return merchandise, regardless of the reason.

Good customer relations, it is apparent, mean performance not only of products of managerial methods and policies—all the many things that go into affecting attitudes toward a business or organization, from within and from without.

One trouble is that many business organizations frequently wait until they are in difficulty before worrying about customer relations. Businessmen are sometimes so preoccupied with the notion of selling things that they often fail to recognize developing customer relations problems until too late.

## MULLARD-AUSTRALIA PERSONALITIES



MR. JOHN G. ALEXANDER

Mr. Alexander heads our Industrial Electronics Applications Group, having specialised in this field for some years. His particular interest at this time is in solid state devices for industrial control and the ancillary circuit logic.

He completed his tertiary education at the University of N.S.W. and his spare time is devoted to motor sports, squash and, more recently, to aviation.

Many businesses have grown so large that unless a broad effort is made to humanize them, customers see the firms only as impersonal machines.

People admire efficiency, progressiveness, scientific achievements, but far more important in building good customer relations, is simple, everyday courtesy. Courtesy is no substitute for efficiency, but it takes nothing away from it and adds to it enormously.

When any situation arises to prevent your doing what the customer expects, use appropriate mediums and methods to tell frankly and forthrightly why the situation exists—what you're doing about it, what you plan to do and what, if anything, the disappointed customer can do about it in the meantime. In short, put your cards on the table. You'll find customers will be reasonable and fair and will like your candour.

The whole idea can be summed up by this slogan:

"Never forget a customer—never let a customer forget you."

\* This article, by John LaCerde, is reprinted by kind permission of the Editors of "Electronic Technician".

# AN ELECTRONIC THERMOMETER

The thermometer described in this article uses an NTC (Negative Temperature Coefficient) resistor connected in a bridge circuit, as the temperature sensing device. Five temperature ranges covering  $-50$  to  $+200^{\circ}\text{C}$  in steps of  $50^{\circ}\text{C}$ , are provided. The out-of-balance bridge current is fed to a differential amplifier using two silicon transistors, and the temperature is indicated by a  $200\ \mu\text{A}$  meter connected between the collectors of these two transistors.

An NTC thermometer using standard silicon transistors in the differential amplifier can be built and calibrated successfully using a linear scale meter, when adequate compensation is provided for the NTC resistor and transistor characteristics. A useful and accurate tool may be obtained by observing the precautions outlined.

## DC Amplifier

Silicon transistors BSY11 are used in the circuit and connected to form a differential amplifier circuit, with a common emitter resistor. Each base potential divider forms one arm of the bridge circuit. An increase of positive base potential by a reduction of resistance in the NTC resistor, produces an increase in collector current in an n-p-n transistor. This increase in collector current in one transistor increases the voltage drop across the common emitter resistor in a positive direction. As the second transistor has a fixed base potential divider, and therefore constant base-emitter voltage, the increased positive voltage drop across the common emitter resistor tends to decrease the collector current in the second transistor. This difference in collector current produces negative and positive potentials across each collector load resistor. A meter with a full scale deflection of  $200\ \mu\text{A}$  is connected to the collector of each transistor and registers current as a function of temperature change.

## NTC Properties

The relation between resistance and temperature\* of an NTC resistor can be approximated by:

$$R = Ae^{B/T} \quad \dots \quad (1)$$

where  $R$  is the resistance value at an absolute temperature  $T$ ,  $A$  and  $B$  are constants for a given resistor and  $e$  is the base of the natural logarithm ( $e = 2.718$ ).

For a given NTC resistor the value of  $B$  may be found in the following way. The resistance value is measured at two temperatures  $T_1$  and  $T_2$ ,

$$R_1 = Ae^{B/T_1}$$

$$R_2 = Ae^{B/T_2}$$

dividing these two, yields:

$$\frac{R_1}{R_2} = e^{(B/T_1 - B/T_2)}$$

or:

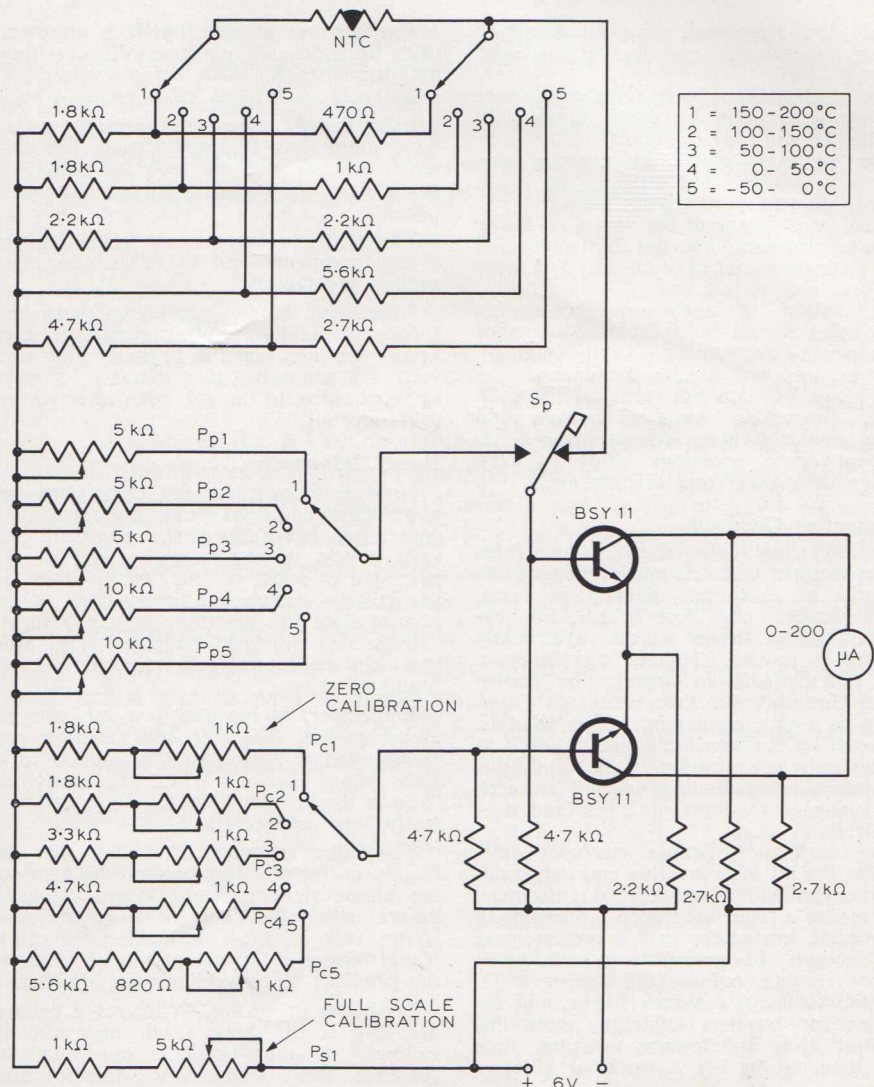
$$\log R_1 - \log R_2 = B \left( \frac{1}{T_1} - \frac{1}{T_2} \right) \log e,$$

which gives:

$$B = \frac{1}{\log e} \cdot \frac{\log R_1 - \log R_2}{\frac{1}{T_1} - \frac{1}{T_2}} \quad \dots \quad (2)$$

When calculated from this formula,  $B$  is found not to be a true constant; with increasing temperature there are small deviations.

\* The properties of NTC resistors were discussed in Mullard Outlook, page 53, Volume 5, Number 5.



Circuit diagram of electronic thermometer.

A better formula for the resistance value is:

$$R = AT^C e^{B/T}$$

where  $C$  is a small positive or negative number and in some cases is zero.

From equation (1) the temperature coefficient of an NTC may be derived:

$$\alpha = \frac{1}{R} \cdot \frac{dR}{dT} = \frac{B}{T^2}$$

## Probes

A combination of series and shunt resistors is used on some ranges to partly compensate for the non-linear characteristics of the NTC. Shunting reduces the sensitivity of the NTC and avoids large changes

at the output of the amplifier for small temperature changes in the input. Compensation for the NTC is necessary since a linear meter scale is used as an indicator. For ranges 0 to 50, 50 to 100, 100 to 150 and 150 to  $200^{\circ}\text{C}$ , the Mullard High Temperature probe (colour coding yellow, violet, orange) is used; for the low temperature range  $-50$  to  $0^{\circ}\text{C}$ , the Mullard Low Temperature probe (colour coding orange, orange, red) is used. The additional probe is considered necessary due to the very high probe resistance of the low temperature probe ( $0$  to  $-50^{\circ}\text{C}$ ). This very high probe resistance introduces non-linearity beyond  $\pm 3^{\circ}\text{C}$ , which is considered impractical. Even with heavy shunting, however, some degree of non-linearity remains.

### Calibration Accuracy

Final accuracy of the thermometer depends on the accuracy of the indicating meter, the care of calibration and the accuracy of the reference source against which the instrument will be calibrated.



The probe is shown here actual size. For this application two probes are available, Low Temperature and High Temperature. They are distinguished by their colour coding as explained in the text.

water. Below 0°C (-50 to 0°C), oil may be used that will not congeal at -50°C.

While the thermometer is being calibrated, the heat transfer liquid should be kept in continuous motion to ensure uniform temperature throughout.

When calibrating on any range, the liquid is first brought to the temperature corresponding to zero on the meter (-50, 0, 50, 100 and 150°C). Once the temperature has been stabilised, potentiometer (P<sub>e1</sub>, P<sub>e2</sub>, P<sub>e3</sub>, P<sub>e4</sub> or P<sub>e5</sub>) is adjusted for zero meter deflection. The full scale potentiometer P<sub>s1</sub> has only a small effect during this adjustment but may be set at mid-position during zero adjustment.

The liquid is then raised to the temperature corresponding to full scale on the meter, 0, 50, 100, 150 and 200°C. When the temperature has again stabilised, the potentiometer P<sub>s1</sub> is adjusted for full scale reading. Once P<sub>s1</sub> has been adjusted S<sub>p</sub> is depressed and potentiometer (P<sub>p1</sub>, P<sub>p2</sub>, P<sub>p3</sub>, P<sub>p4</sub> or P<sub>p5</sub>) is adjusted to full scale reading once more. The liquid must be circulating continuously during zero and full scale calibration.

For final zero adjustment, the liquid should be returned to the temperature corresponding to zero meter indication and the potentiometer (P<sub>e1</sub>, P<sub>e2</sub>, P<sub>e3</sub>, P<sub>e4</sub>, or P<sub>e5</sub>) adjusted once more to counteract the slight effect that P<sub>s1</sub> has upon zero adjustment. The effect P<sub>s1</sub> has upon zero adjustment depends on the differences in gain between the two BSY11 transistors, as they are not matched for current gain.

Since the unit is battery operated, voltage changes will occur during battery life and to counteract this, the thermometer should be set to full scale each time it is used by adjusting P<sub>s1</sub> and depressing S<sub>p</sub>, until full scale meter reading occurs on the range to be used. When changing the temperature range, P<sub>s1</sub> will require adjusting to full scale reading.

#### Note:—

This instrument is primarily designed to be operated at normal ambient temperatures. If the electronic thermometer is used outside these limits, then the error will depend upon the differences in current gain of the transistors.

To test for the non-linear characteristic associated with the NTC resistor within the measuring probe, a Model 8 'Avometer' was used as an indicator. Several ranges of good quality 'Taylor' glass thermometers having an accuracy of ± 1°C were used for the calibration source. Assuming the indicator and source to be constant, discrepancy between the prototype and source was ± 3°C maximum on each scale (-50° to 200°C).

### Calibration Procedure

When calibrating the ranges 100 to 150°C and 150 to 200°C, a silicone liquid (Dow Corning Silicone Liquid 550) was used. Oils should be avoided in these ranges, particularly 150 to 200°C, as these temperatures are dangerously close to the flash point of many oils.

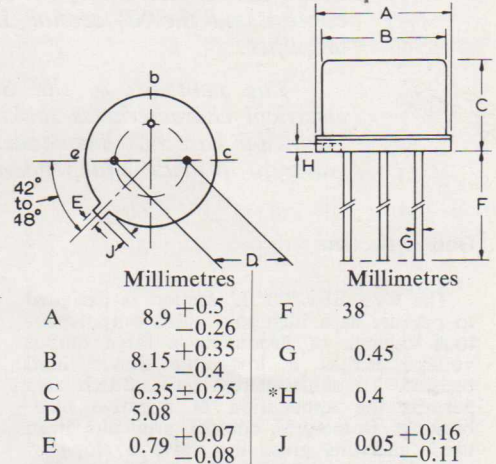
For ranges 0 to 50°C and below 50 to 100°C, water can be used as the heat transfer liquid providing that the tinned wire leads of the NTC probe are not exposed to the water. Exposure of the leads to water will result in shunting of the NTC resistor, the magnitude of which depends upon the impurities present in the

## BSY11 SILICON MESA N-P-N TRANSISTOR

**Abridged Preliminary Data**

V <sub>CB</sub> max.	+45	V
H <sub>FE</sub> (I <sub>E</sub> = 10mA)	60-125	—
I <sub>CM</sub> max.	50	mA
f <sub>i</sub>	>60	Mc/s
P <sub>tot</sub> at T <sub>amb</sub> = 100°C	150	mW
T <sub>j</sub> max.	175	°C

### Outlines and Dimensions



\* Thickness of locating tab.

## ABTQ3 Up 1 Mc/s

The Australian Broadcasting Control Board has found it necessary to increase by approximately 1 Mc/s the frequency of Television Station ABTQ3 in Townsville, Queensland.

### Special Channel 3 Biscuits

The tuning range of the conventional biscuits accommodates the increase in frequency, except in some isolated fringe areas where it is necessary to use the specially redesigned biscuits to ensure optimum television receiver performance.

### Special Channel 3 Biscuit Type Numbers

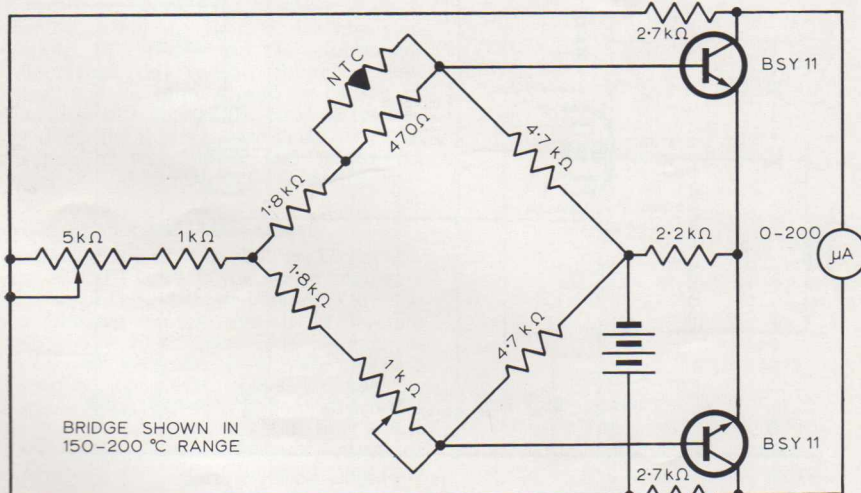
Tuner	Biscuit Type Number
NT3009	CZ.319.800
NT3011	CZ.320.199

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Simplified Circuit of the Electronic Thermometer.

# 6Y9/EFL200 DOUBLE PENTODE

The 6Y9/EFL200 is a video valve of unique construction developed by Mullard to meet the needs of future television receivers. An article entitled "New Valves for Television", in *Outlook Volume 7 Number 3*, discussed some aspects of this valve in television receiver circuits. Abridged preliminary data, outlines, dimensions and pin connections are also given. This present article covers more specific design features of this double pentode as well as showing a circuit application where the 'L' section of the 6Y9/EFL200 is used as a video output stage with high level contrast control and the 'F' section is used as a high-gain AGC amplifier, cathode-coupled to the video amplifier.

The pentodes in the 6Y9/EFL200 are dissimilar and have been given complementary electrical characteristics making possible the design of exceptionally economic television receivers. Particular care has been taken in the pinning and in the screening between the two sections of the valve to provide independence of operation.

## Output Section

The 6Y9/EFL200 'L' section is designed to operate as a high-gain video output pentode capable of producing a large output voltage across a low-value anode load resistor. To achieve high gain, which also permits the application of negative feedback, a frame-grid control grid has been used, and this gives the valve a slope of approximately 21 mA/V at 30 mA. The high gain of this section will also make the valve particularly useful in hybrid television receivers in which the last IF amplifier is transistorised.

The design of the 'L' section has taken note of the increasing popularity of high-level contrast control circuits in which the contrast control potentiometer is placed in the anode circuit of the video output valve. Such circuits provide constant drive to the synchronising pulse separator and AGC system regardless of the setting of the contrast control. The capacitance added to the anode when this technique is employed necessitates the use of a low-value anode load resistor. The 6Y9/EFL200 can provide adequate current to produce a composite video output voltage of 100V peak-to-peak across an anode load as low as 2k $\Omega$ .

Care has also been taken in the valve design to permit screen-grid dissipation limits which allow for short term overloading. This can arise when switching a tuner in a television receiver operating from a signal having negative modulation so that neither video signal nor noise is present to provide bias for the grid of the video output valve.

## Amplifier Section

The 'F' section of the 6Y9/EFL200 is a voltage-amplifying medium-slope pentode designed for 'jungle' applications. In receivers where synchronising pulse separation is usually effected by using an interference-gated circuit employing a heptode valve, the 'F' section of the 6Y9/EFL200 may be used to advantage as a high-gain AGC amplifier, or as an intercarrier sound IF amplifier. To facilitate these applications, care has been taken to reduce to a minimum, the feedback capacitance from the anode of the 'F' section to other electrodes in the double valve.

## Video Output Stage using High-Level Contrast Control

In Fig. 1, the 'L' section of the 6Y9/EFL200 is used as a video output stage with a high-level contrast control. The output section of the valve is designed to accommodate the large shunt capacitances which occur when a contrast control is incorporated in the anode circuit. It is capable of providing a signal current swing of 50mA and thus a peak-to-peak output voltage of 100V across a 2k $\Omega$  anode load.

Some resistance in the cathode circuit is desirable to prevent operation of the valve too close to its positive grid region on minimum signals (peak with negative modulation). Under such a condition, the flow of grid current could load the video detector and distort the signal. The high mutual conductance of the valve enables adequate stage gain to be achieved when a cathode resistor is used, even with a 2k $\Omega$  anode load. The cathode resistor also assists in controlling the no-signal operating conditions as well as providing means for HF compensation.

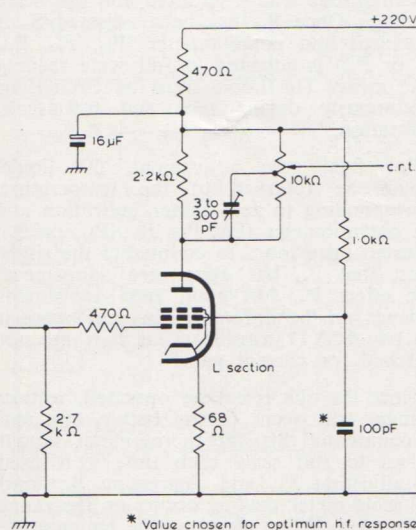


Fig. 1—Video output stage using high-level contrast control.

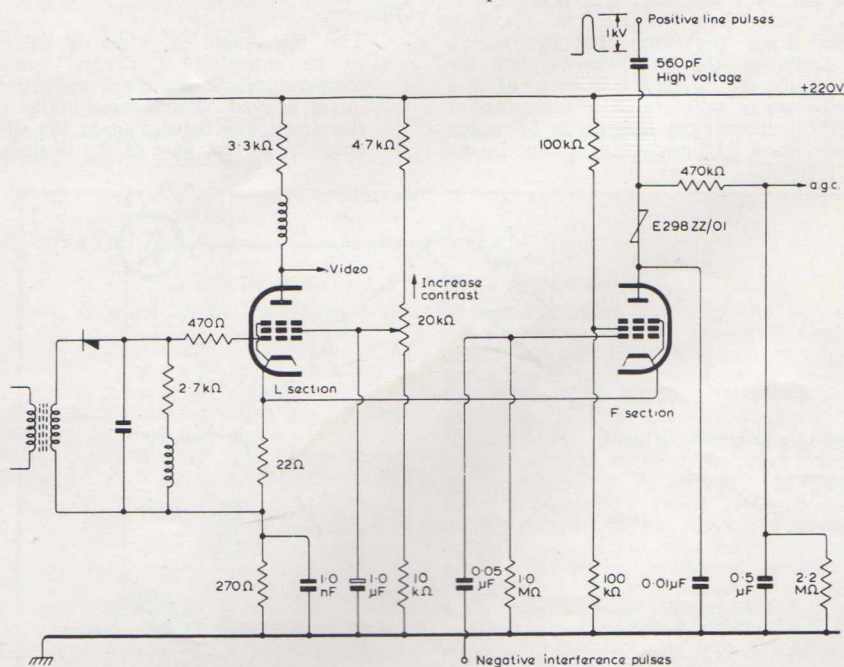


Fig. 2—Video amplifier and AGC circuit for negative modulation receivers.

# INDUSTRIAL TRIODE TY6-5000 NOW AVAILABLE WITH HELICAL COOLING

The TY6-5000W, one of the most popular valves in the Mullard range of industrial triodes is now available with a helical cooling system, as well as the previously used conventional water jacket. The helical cooling system forming an integral part of the anode, gives the valve the consequent advantages of a smaller cooling water consumption and, therefore, a smaller circulating pump. These factors reduce both the cost of ancillary equipment and complete installation. The ratings of the helical-cooled valve are identical to those of the version using the conventional water jacket.

The TY6-5000H is one of six water-cooled triodes available with helical cooling systems which are part of the range of 27 triodes and tetrodes specially designed for industrial service. They are intended for applications in Class 'C' oscillators for RF heating and in power audio applications. These valves are extremely robust and are designed to withstand the temporary accidental electrical overloads occurring in industrial service. Mullard industrial valves are used in the majority of current equipment for dielectric pre-heating and welding and for induction heating. In audio service, Mullard industrial valves are to be found in vibration amplifiers for environmental testing, audio relay amplifiers, power amplifiers for producing waveforms with very low distortion and ultrasonic generators for cleaning and other industrial uses.

A brief guide to the most commonly used triodes and tetrodes in the industrial range is given opposite. Other types with helical-cooling, recently added to the range are TY8-15H, TY8-6000H and TY12-25H.

For more detailed information, please consult Volume 3 of the Mullard Technical Handbook or contact the Mullard Technical Service Department.

## Industrial Triodes and Tetrodes

Type No.	Class B Audio Applications		Class 'C' Oscillator		
	$P_{out}$ (kW)	$D_{tot}$ (%)	$P_{out}$ (kW)	$f_{max}$ (Mc/s)	$\eta_a$ (%)
MZ2-200	1.21	2.9	—	—	—
QV06-20	0.09	9.0	0.052	175	78
QV08-100	0.30	6.5	0.20	30	70
QY3-125	0.55	5.0	0.375	200	75
QY4-250	1.24	5.0	1.00	120	80
QY4-400	1.75	—	1.10	110	79
QY5-500	2.25	5.0	1.76	110	80
QY5-3000A QY5-3000W	9.5	—	4.10	220	74.5
TY2-125	0.70	5.0	0.39	200	76
TY3-250	1.34	4.4	0.845	150	77
TY4-350	2.40	—	1.44	75	80
TY4-400	1.5	4.4	1.2	100	78
TY4-500	2.44	5.0	1.86	100	74
TY6-5000A TY6-5000H TY6-5000W	13.3	4.0	6.90	110	76.5
TY7-6000A TY7-6000H TY7-6000W	20	—	8.25	85	78
TY12-15A	40	—	41	30	76
TY12-20A TY12-20H TY12-20W	61.5	—	39	30	7.25
TY12-50H TY12-50W	202	—	108	30	75
TY12-120W	450	—	324	30	83

### 6Y9/EFL200 Double Pentode (cont.)

A resistor is also necessary in the screen-grid circuit to prevent the screen-grid dissipation exceeding the limit under no-signal conditions. To retain the DC component of the signal, this resistor should be decoupled, and its value should be chosen in conjunction with that of the cathode resistor to establish the desired stage gain. In Fig. 1 the values of the cathode and screen-grid resistors are  $68\Omega$  and  $1k\Omega$  respectively.

### Video Amplifier and AGC Circuit

In the circuit of Fig. 2, the 'F' section of the 6Y9/EFL200 is used as a high-gain AGC amplifier cathode-coupled to the video amplifier (comprising the 'L' section of the 6Y9/EFL200). This circuit is designed for receivers employing negative modulation. The AGC valve governs the DC restoring action of a voltage dependent resistor to which positive-going line pulses are AC coupled. An important feature of the circuit is the independence of time-base synchronisation on the AGC potential.

The method used to develop the AGC

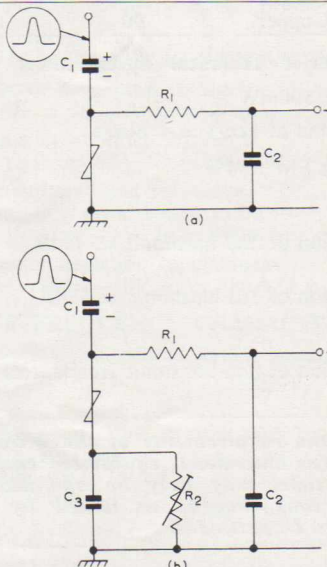


Fig. 3—Method of developing AGC potential.

bias potential is shown basically in Fig. 3. In Fig. 3a, a positive pulse is applied to a circuit incorporating a VDR. This non-linear device clips the positive-going pulses and produces a negative potential across  $C_2$ , the components  $R_1$ ,  $C_2$  forming a filter. The magnitude of the potential depends on the amplitude and waveform of the pulse. If a capacitor is connected in series with the earthy end of the VDR ( $C_3$  in Fig. 3b), the potential across the VDR will be floating with respect to earth. Shunting  $C_3$  with a variable resistor enables the negative output potential to be varied. In the practical circuit,  $R_2$  is replaced by the 'F' section of the 6Y9/EFL200, the conduction of which is controlled by the video signal.

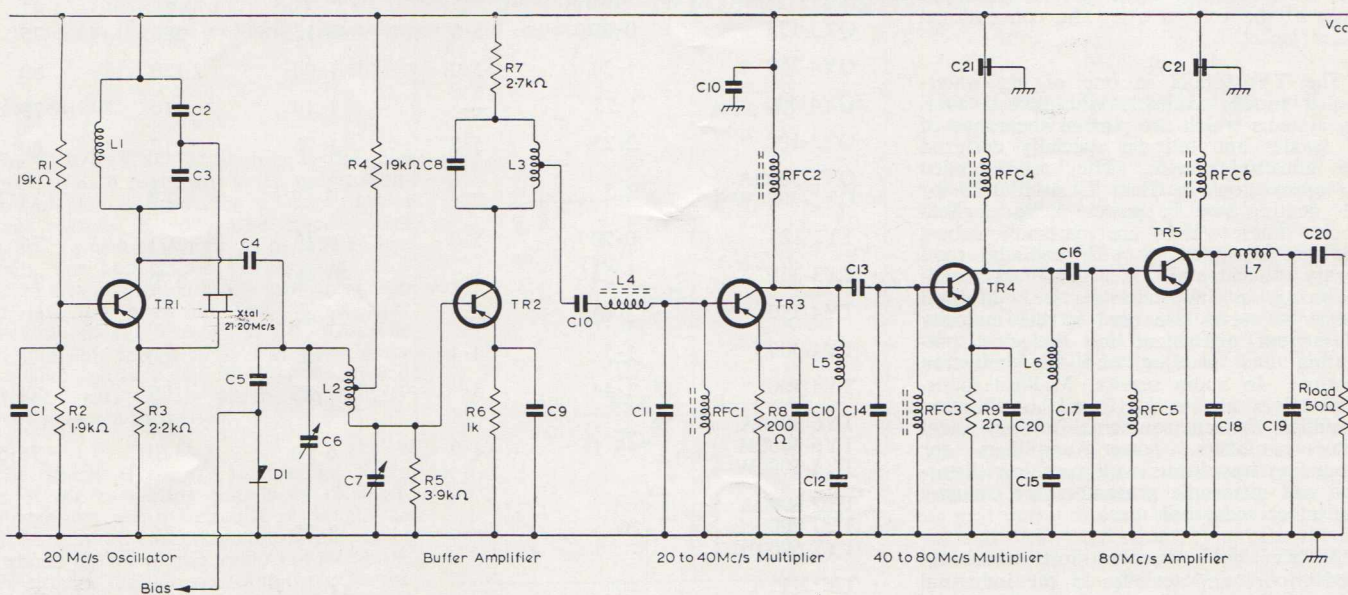
The valve is driven at its cathode by the video signal developed across the common cathode resistor. As with a heptode synchronising pulse separator circuit, negative-going interference pulses can be applied to the control grid to prevent the AGC system responding to such spurious interference pulses. In a complete receiver suitable pulses can be taken from the control grid of the separator valve.

# PERFORMANCE OF THE AFY19 IN VHF TRANSMITTERS

The AFY19 is a germanium alloy-diffused VHF power amplifying transistor for use in portable and mobile communications equipment. It is capable of a power output of 550mW at 80Mc/s with a power gain of 10.8dB and 500mW at 160Mc/s with a power gain of 7.5dB. The power figures are inclusive of circuit losses. It is encapsulated in the internationally accepted TO-39 construction with the collector connected to the case.

Two typical circuits utilising the AFY19, the first a 500mW FM transmitter at 80Mc/s, using a single AFY19 in the output stage and the second a 1W PEP AM transmitter at 85Mc/s using a pair of AFY19 transistors in the output stage, are presented, together with a tabulation of appropriate data for the AFY19.

## 500mW Transmitter for FM $f = 80\text{Mc/s}$



Coils	No. of turns	Wire diam. (s.w.g.)	Material	Internal coil diam. (mm)	Value ( $\mu\text{H}$ )	Notes
L1	15	28	Copper	7.5	2	Tapped 5 turns from positive end Tapped 2.5 turns from collector
L2	25	28	Copper	7.5	2	
L3	25	28	Copper	7.5	2	
L4	—	22	Copper	—	0.8	
L5	11	18	Copper	100	0.5	
L6	3	18	Copper	90	0.09	
L7	4	18	Copper	90	0.08	

### Capacitors

C1	3300
C2	1000
C3	33
C4	4
C5	22
C6	3 to 30
C7	4.60
C8	4.60
C9	3300
C10	0.01 $\mu\text{F}$
C11	60
C12	120
C13	50
C14	180
C15	148
C16	50
C17	191
C18	60
C19	85
C20	0.01 $\mu\text{F}$
C21	1000

### Semiconductors

TR1	AF114N
TR2	
TR3	AF115N
TR4	AFY19
TR5	AFY19
D1	BA102

### Brief Technical Specifications

$P_{\text{out}} = 500\text{mW}$   
 Deviation at 1kc/s =  $\pm 5\text{kc/s}$   
 AM on FM = 4%  
 Rejection of 2nd harmonic = 45dB  
 Rejection of 3rd harmonic = 55dB  
 Rejection of non-harmonic frequencies > 45dB

### BASIC DESIGN FORMULAE

- RF Output Power  

$$P_{\text{out}} = \frac{(V_{\text{cc}} - V_{\text{sat}})I_{\text{CM}}}{4}$$
 where  $V_{\text{cc}}$  is the supply voltage and  $V_{\text{sat}}$  is the saturation voltage
- Load resistance which must be presented to the collector in order to obtain the calculated RF output power  

$$R_L = \frac{2(V_{\text{cc}} - V_{\text{sat}})}{I_{\text{CM}}}$$

- Maximum Permissible Heatsink Thermal Resistance

$$\theta_h = \frac{T_j \text{ max.} - T_{\text{amb}}}{P_{\text{tot}} \text{ max.}} - \theta_m$$

where  $\theta_h$  is the heatsink thermal resistance  
 $T_j \text{ max.}$  is the maximum permissible junction temperature  
 $T_{\text{amb}}$  is the ambient temperature  
 and  $P_{\text{tot}} \text{ max.}$  is the maximum total dissipation.

*In order to comply with the requirements of the Wireless and Television Act, 1904 (as amended), equipment such as that described in this article, may only be operated in accordance with the relevant Licence as issued by the P.M.G.'s Department.*

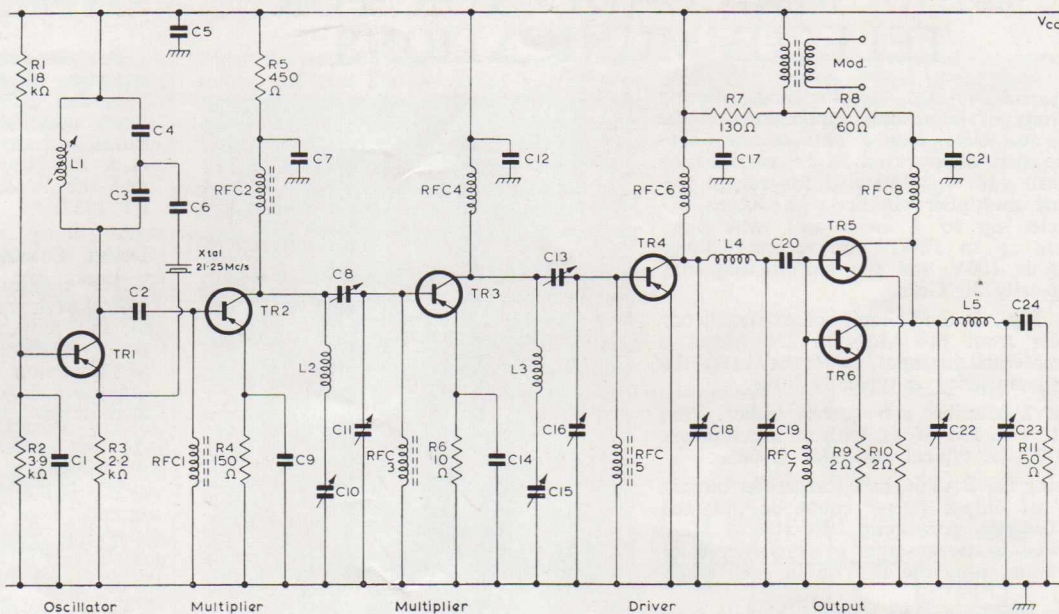
(all values in pF unless otherwise shown)



### 1W PEP Transmitter for AM $f = 85\text{Mc/s}$

#### Brief Technical Specifications

- $P_{out} = 1\text{W}$  peak envelope power when 100% amplitude modulated
- $P_{mod} = 330\text{mW}$  across secondary of transformer ( $R_{wdg} = 93\Omega$ )
- Total power taken from DC supply  $\approx 1.5\text{W}$
- Rejection of 2nd harmonic = 40dB
- Rejection of 3rd harmonic = 50dB
- Rejection of non-harmonic frequencies  $> 50\text{dB}$



Coils (all values in $\mu\text{H}$ )	Transistors	Capacitors (all values in pF unless otherwise shown)			
L1 2	TR1 AF114N	C1 0.01 $\mu\text{F}$	C7 0.01 $\mu\text{F}$	C13 60	C19 40
L2 0.5	TR2 AF115N	C2 3	C8 45	C14 0.01 $\mu\text{F}$	C20 68
L3 0.07	TR3 } to AFY19	C3 30	C9 0.01 $\mu\text{F}$	C15 200	C21 0.01 $\mu\text{F}$
L4 0.07		C4 1000	C10 115	C16 145	C22 80
L5 0.06	TR6 } to AFY19	C5 0.1 $\mu\text{F}$	C11 30	C17 0.01 $\mu\text{F}$	C23 90
		C6 100	C12 0.01 $\mu\text{F}$	C18 50	C24 0.01 $\mu\text{F}$

#### AFY19 PRELIMINARY DATA

VHF germanium junction transistor of the p-n-p alloy-diffused type in TO-39 construction. Intended for use as a power amplifier in transmitters of frequencies up to 160Mc/s. When approaching the maximum limiting values, either electrically or thermally, the comprehensive data and curves, as contained in Volume 4 of the Mullard Technical Handbook, should be consulted.

$V_{CB}$ max. ( $I_E = 0\text{mA}$ )	-32	V
$V_{CE}$ max. ( $I_C = 1\text{mA}$ )		
$I_{CM}$ max.	300	mA
$P_{tot}$ max.	800	mW
$f_i$	350	Mc/s
<b>Collector voltage</b>		
$V_{CB}$ max. ( $I_E = 0\text{mA}$ )	-32	V
$V_{CE}$ max. ( $I_C = 1\text{mA}$ )		
<b>Collector current</b>		
$I_{CM}$ max.	300	mA
* $I_{C(AV)}$ max.	150	mA
<b>Emitter current</b>		
$I_{EM}$ max.	350	mA
* $I_{E(AV)}$ max.	200	mA
<b>Reverse emitter current</b>		
- $I_{EM}$ max.	30	mA
*- $I_{E(AV)}$ max.	10	mA

#### CHARACTERISTICS (at $T_{amb} = 25^\circ\text{C}$ unless otherwise specified)

	Typical Production Spread				
	Min.	Typ.	Max.		
Collector leakage current ( $V_{CB} = -10\text{V}$ , $I_E = 0\text{mA}$ ) ( $V_{CB} = -32\text{V}$ , $I_E = 0\text{mA}$ )	$I_{CBO}$	—	10	$\mu\text{A}$	
Emitter leakage current ( $V_{EB} = -500\text{mV}$ , $I_C = 0\text{mA}$ )	$I_{EBO}$	—	1.0	mA	
Base current ( $V_{CB} = -12\text{V}$ , $I_E = 80\text{mA}$ )	$I_B$	—	1.0	2.0	mA
Collector saturation voltage ( $I_C = 300\text{mA}$ , $I_B = 20\text{mA}$ )	$V_{CE(sat)}$	—	-1.0	V	
Frequency at which $ h_{re}  = 1$ ( $V_{CB} = -5\text{V}$ , $I_E = 100\text{mA}$ )	$f_i$	225	350	—	Mc/s
Base-emitter input resistance (output short-circuited to h.f.) ( $V_{CB} = -5\text{V}$ , $I_E = 100\text{mA}$ , $f = 100\text{Mc/s}$ )	$r_{ie}$	—	18	—	$\Omega$
Collector depletion capacitance ( $V_{CB} = -10\text{V}$ , $I_E = 0\text{mA}$ , $f = 500\text{kc/s}$ )	$C_{tc}$	—	12	—	pF

#### POWER/FREQUENCY CHARACTERISTIC

All values are measured in the common emitter configuration unless otherwise stated.

	25Mc/s	40Mc/s	80Mc/s	160Mc/s	160Mc/s Common base
$P_{out}$ (mW)	630	630	550	500	400
Power gain (dB)	20	15.6	10.8	7.5	7.0
Efficiency (%)	58	58	51	47	35

These values are inclusive of circuit losses.

\*The intermittent operation junction temperature of  $100^\circ\text{C}$  may also be reached by a peak dissipation of 1W.

NOTE:—For outlines and dimensions of the AFY19 see page 45. It should be noted that the metal envelope of this transistor is internally connected to the collector.



# A Low Frequency Multivibrator for Educational Purposes

The multivibrator shown in the circuit was introduced in its thermionic valve form by Abraham and Bloch in 1918. The multivibrator was first conceived as a square-wave generator and, since the square-wave is rich in harmonics, the name "multivibrator" was coined.

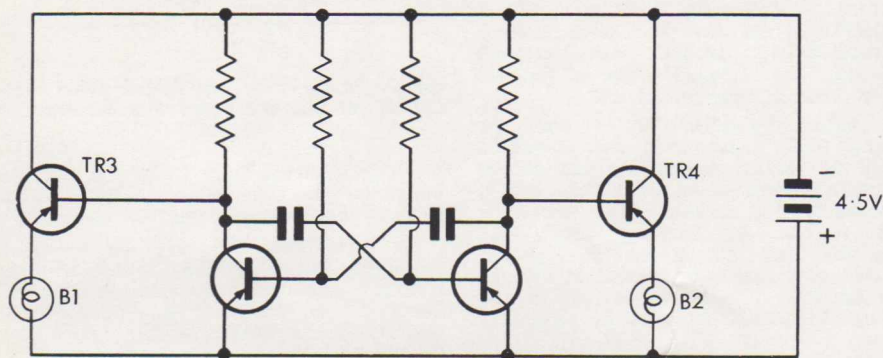
Upon switching on the circuit, slight unbalance in the components, or random variations in the currents, will cause the transistors to go into one of the unstable states. The circuit is therefore self-starting and subsequently oscillates between the two unstable states.

Positive feedback is provided by the capacitive cross-coupling from the collector of each transistor to the base of the other transistor. The loop gain is greater than one. Assuming an initial condition where Tr1 is on and Tr2 off, then as C1 charges, the base of Tr2 goes negative and brings Tr2 into conduction. Regenerative switching occurs, and Tr1 is now off and Tr2 on. C2 now charges, the base of Tr1 goes negative until Tr1 conducts, and the cycle starts again.

This multivibrator is a free-running oscillator, and, if required, pulses may be applied to synchronise the frequency.

The half-period of the multivibrator is controlled by the time constant C2 R1 and may be expressed as:

$$t \approx 0.7CR$$



This expression neglects, amongst other things, the fact that in reality C2 has two charging paths, one through R1 and the other through the base of the transistor. When the transistor is cut off, its base current is constant and equal to the leakage current. The frequency of operation may therefore be somewhat temperature-dependent. The output may be taken from either collector.

The multivibrator is sometimes used in frequency multiplication, the required harmonic of the fundamental frequency being selectively amplified and appearing as a sinusoidal output from the tuned circuit.

For educational purposes the meters M1 and M2 are connected to the collectors of Tr1 and Tr2 respectively. With the component values shown, the frequency of the multivibrator is sufficiently low for the pointers to respond. It can, therefore, be demonstrated convincingly that, as one transistor switches off the other switches on.

$$R_1 = R_2 = 10 \text{ k}\Omega, \frac{1}{4} \text{ W}$$

$$R_3 = R_4 = 1 \text{ k}\Omega, \frac{1}{4} \text{ W}$$

$$C_1 = C_2 = 100 \mu\text{F electrolytic (6V wkg.)}$$

If a more elaborate arrangement, for demonstration to larger audiences, is desired, two additional transistors may be used to switch a pair of torch bulbs on and off in time with the multivibrator. For this circuit, component values are as previously stated.

This arrangement is shown in the circuit on the left. For this circuit, component values are as previously stated and in addition two power transistors (Tr3 and Tr4) such as the Mullard AD140, OC28, OC29, OC35 or OC36, together with two 3.5V torch bulbs, may be used.

## ELECTRONICS IN INDUSTRY

The recent exhibition "Electronics in Industry" at the University of Queensland, St. Lucia, was the largest in this field ever to be held in that State. Leading manufacturers displayed a wide variety of electronic devices and components and some of the equipment shown was seen in Queensland for the first time.

The theme of the Mullard display was Applications Engineering Service, with emphasis on electronic control and switching. The exhibit included a selection from the Mullard range of heatsinks, rectifier stacks, silicon power transistors and rectifiers. Of particular interest was the range of Mullard Norbit Static Switches which have no contacts or moving parts and which may be described as "contactless switches". Since these units employ semi-

conductors, maintenance is reduced to a minimum and life is not limited by the number of operations. Immediate and constant speed operation, after prolonged idle periods, is another feature of the Norbits. These were discussed in Outlook, Volume 7 Number 3 and reprints of the article, together with data sheets, are available on application to Mullard offices.

One of the guest speakers at the exhibition was Mr. John G. Alexander, a senior engineer of the Mullard Applications Laboratory, in Sydney.

His paper discussed electronic circuits and the application of the art of electronics to the industrial control field. Mr. Alexander reviewed the role of components and measurement techniques and further

outlined the application of linear, non-linear and logic control systems with particular reference to on-off regulators. In the second half of the paper, Mr. Alexander examined electronic transmission gates with the NOR type selected as the most suitable for industrial switching. The applications of the NOR gates were examined in detail and some typical examples were given. Finally, sequence control systems were discussed, with reference to counters, clocks and timers. An example was given of a common type of sequence control using the Mullard Norbit Static Switches.

Specially prepared lecture notes with diagrams were distributed to those attending the lecture.

# SWITCH-OFF SPOTS IN TV RECEIVERS

In Outlook Volume 5 Number 2 an article was published entitled "Voltage Dependent Resistors in Television Receivers". This present article discusses the problem of switch-off spot burn, its origin and its elimination.

When some television receivers are switched off, a bright spot appears at the centre of the screen for a short period. This spot often causes concern amongst viewers, and is a potential source of danger to the screen since it may, in time, cause localised discolouration of the screen coating.

Although the power supply is disconnected when the set is switched off, voltages throughout the circuit do not necessarily become zero at once. Various capacitances will be carrying charges, and time will be required for them to discharge. The discharge time will depend on the size of the capacitor and on the resistance of the discharge path—that is, on the time-constant of the particular CR-network.

If the EHT smoothing capacitance (formed by the aquadag coating of the tube) does not discharge rapidly, a high voltage can remain on the final accelerating anode of the picture tube. During this period, the cathode will still emit electrons while it is cooling, and if the bias on the control grid has decayed, an electron beam will be maintained after the set has been switched off. If the beam is deflected during this period, the result will be a fairly rapidly decaying raster, but if the scanning signals are absent during this period, a switch-off spot will be formed at the centre of the screen.

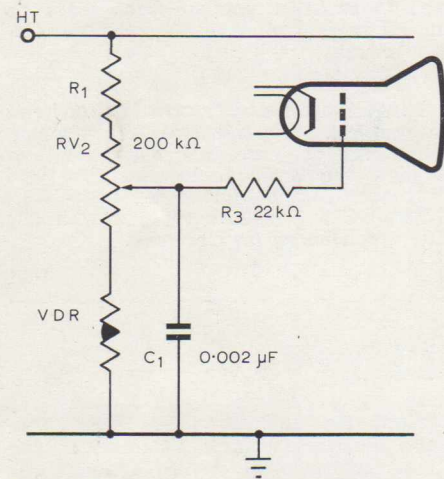


Fig. 1—Control grid potential maintained at switch-off by means of a VDR.

## Prevention of Spot Formation

Two methods of preventing the formation of the switch-off spot suggest themselves—the immediate discharge of the EHT filter capacitance, or the provision of a cut-off bias potential at the control grid of the picture tube until the cathode has cooled sufficiently to cease emitting electrons. The former necessitates the flow of beam current, since discharge of the smoothing capacitance is best effected by the beam

current; the latter implies the suppression of the beam current.

To ensure the flow of beam current, the cathode potential should decay more rapidly than the potential of the control grid. Of course, while beam current flows, scanning signals must be maintained to prevent the formation of the spot. Hence the time-constants of the scanning circuits must be comparatively long.

The rate of discharge of the EHT capacitance will depend on the amount of beam current flowing so that, to minimise the discharge time, the picture tube should be driven hard into conduction as soon as the receiver is switched off. The potential on the first anode should be maintained after switch-off, to ensure that electrons from the still-hot cathode are accelerated.

The time-constant associated with this anode must be longer than those associated with the cathode and grid of the picture tube, and also those of the scanning circuits.

In the second method, to prevent the flow of beam current, the control grid must be maintained negative with respect to the cathode or the cathode positive with respect to the grid after switch-off, until the cathode cools and ceases to emit electrons. This condition is very difficult to fulfil since the cathode remains hot for a considerable period and receivers employing this technique tend to produce a spot shortly after switch-off.

A further disadvantage is that the charged EHT capacitance can present a hazard to service engineers since picture tubes are capable of retaining their charge for considerable periods. The use of a 'leak' resistor to discharge the EHT capacitance has not, in the past, proved practicable. It is therefore apparent that the most satisfactory technique is that of employing the picture tube as the discharge device.

## Modification of the Control Grid Potential Decay Time

Voltage dependent resistors possess the property of increasing resistance with decreasing applied potential. They thus tend to stabilise a potential against change and can effectively lengthen the time-constant of a circuit. If a VDR is inserted in the brightness control chain as shown in Fig. 1, the control grid potential is maintained even though the HT potential diminishes at switch-off. The grid is therefore held at a more positive potential than the cathode, and the EHT capacitance is discharged by the flow of beam current before the scanning fields collapse.

To provide a satisfactory range of brightness control for all picture tubes, the control grid must be able to swing to an adequate negative potential with respect to the cathode. A limitation of this method is that the DC potential across the VDR sets a minimum value for the control grid potential.

## Line-pulsed VDR Circuit

A development of the previous circuit is to use the VDR to rectify positive-going line flyback pulses to produce a negative bias. The circuit is shown in Fig. 2. The non-linear VDR acts as a diode, developing a negative potential at its top end. This potential is applied to the lower end of the brightness control as shown in Fig. 2. Modulation of the grid potential by line pulses is prevented by the smoothing capacitor C<sub>2</sub>. Since

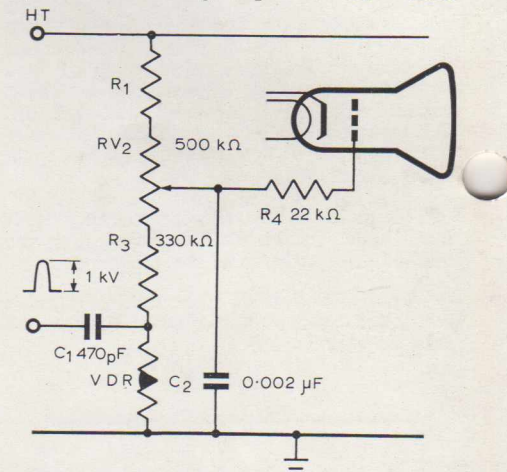


Fig. 2—Positive-going line flyback pulses rectified to produce a negative bias by means of a VDR.

this capacitor has only to bypass the line pulses, a low value is adequate and thus a short grid time-constant is obtained.

At switch-off the negative potential decreases, thereby tending to increase the control grid potential in a positive direction. In addition, the impedance of the VDR increases, which drives the control grid even further positive, resulting in rapid discharge of the EHT capacitance, again by means of beam current.

The choice of VDR is not critical, since it is only necessary to develop a negative potential for application to the lower end of the brightness control. A pulse of about 1kV is normally readily available from the line transformer, and the VDR is selected to provide a bias of approximately — 150V.

## IF YOU CHANGE YOUR ADDRESS

Don't forget to let us know in good time if you change your address, otherwise your Outlook may reach you late or never. And please, when you change, quote both your old and your new address. We can then be sure of destroying the obsolete mailing plate.