E Q U I P M E N T E X C H A N G E B U L L E T I N

Jan. 5, 1965 Issued twice monthly Vol. 1, No. 1.

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SILICON CONTROLLED RECTIFIERS: Part I.

-- by R. Reynolds, VK7ZAR

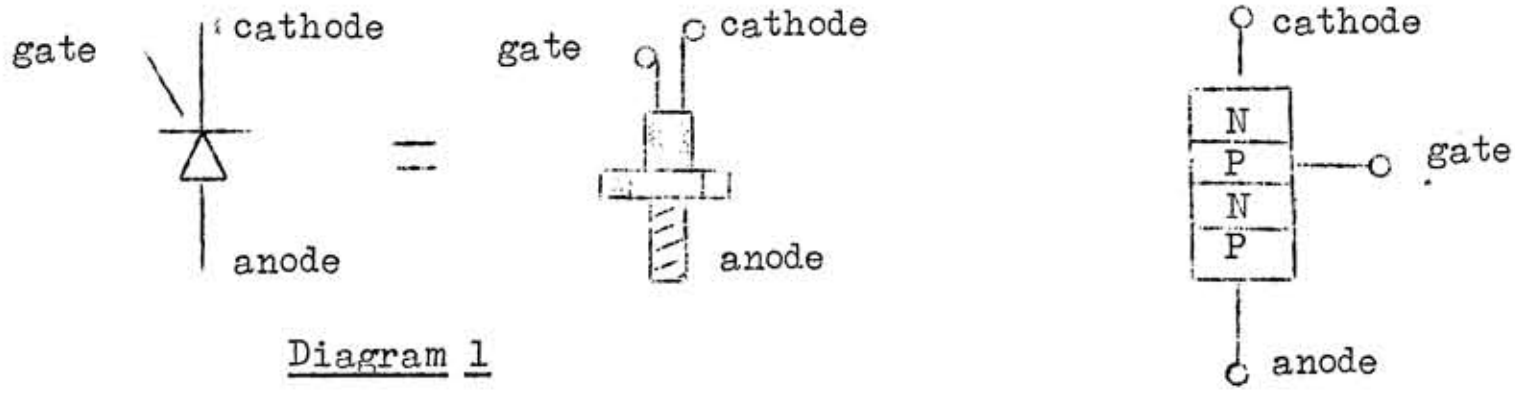
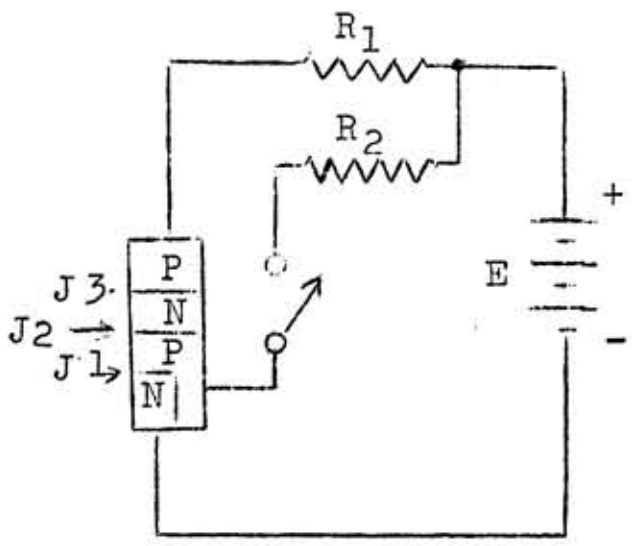


Diagram 1

For some time, electric power circuits have been controlled by thyratrons, a.c. reactors, variable resistors, and other units -- generally bulky, expensive, and power consuming.

Investigation into semiconductor theory has produced a unit capable of passing a much higher current in a small a size of unit, with a voltage drop of 1-2 volts, and which is much easier to control. Reverse voltage ratings commonly available can be as high as 600V Peak, whilst a commercially available unit goes as high as 150 Amps forward current rating.



This remarkable device is the Silicon Controlled Rectifier, or SCR. It has much the same appearance as a Stud-type diode, and similar size for the same current rating. The difference is that the SCR has an extra connection near the cathode, known as the 'gate' electrode. Note also that the stud end of the diode is normally the cathode, whereas that of an SCR is the anode.

The SCR is constructed in the following way:- There are two layers of N-type silicon and two layers of P-type silicon connected as shewn. Now, for current flowing between cathode and anode in either direction, either one or two junctions will be reverse biased, and hence very little current will flow. If we connect an SCR as in Diagram 2, Junctions 1 and 3 are forward biased, and Junction 2 is reverse biased. If we can make a small current flow in Junction 1, a current will flow in Junction 2, and thence through Junction 3. As the current rises in Junction 2, more current will flow in Junction 1, and so on; the current is limited by R_1, and the internal resistance of SCR and battery. We can make this starting current flow by several possible methods:

1. Increase the voltage beyond the turnover point of Junction 2 (Diag. 3).

Silicon Controlled Rectifiers (continued):

2. Since these units are light sensitive, we could shine a light on the second junction, if the SCR case were transparent.
3. Heat the unit (not recommended for ordinary applications!).
4. Pass a forward current through Junction 1, by means of the gate electrode.

Method No. 4 is the one normally used in the SCR. Other methods apply to units such as light activated switches, etc. Note that when current flows in the reverse direction to that shown in Diagram 2, the unit behaves as an ordinary diode which is back biased, since then the gate has no effect on Junction 3.

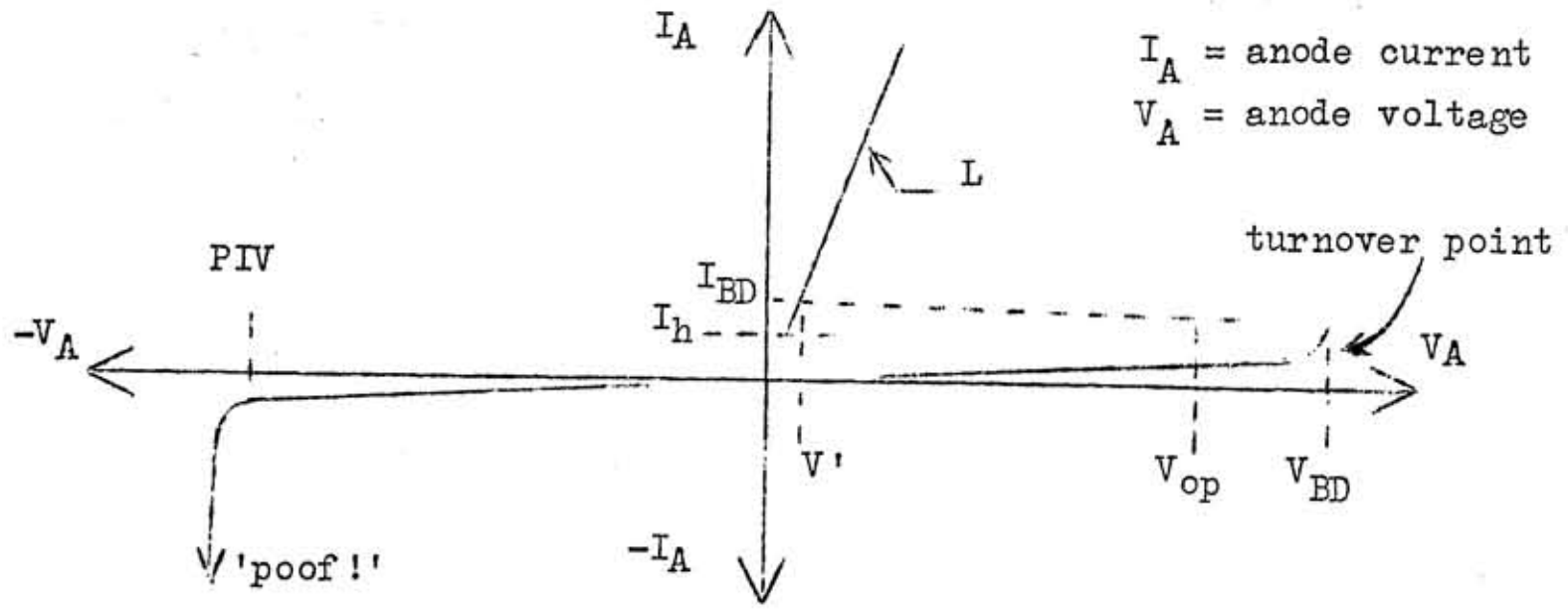


Diagram 3

Now consider Diagram 3, which describes the operating parameters of an SCR. Voltage applied in the reverse direction merely results in the typical reverse characteristic of a silicon diode ($-V_A$). With zero gate voltage, voltage applied in the forward direction ($+V_A$) also appears to show a typical reverse characteristic (because in fact, Junction 2 is reverse biased), but at the breakdown voltage, V_{BD}, the breakdown current flows, I_{BD}, and voltage drops rapidly (in 2-5 µsec.) to some low value, V' (about 1V.). If, then, forward current is increased further, voltage rises slowly along characteristic L.

Ordinarily the SCR will not be operated near its breakdown voltage, but at some lower point, V_{op}. At this voltage, the SCR will conduct only a small leakage current (eg. a few milliamperes); but if a small current is passed through the gate electrode, breakdown will occur at V_{op}, and the SCR forward resistance will again drop to a low value. This resistance is low indeed, and a quite remarkable property of Junction 2 is that it is able to pass many Amperes in spite of the fact that it is initially a reverse junction. The SCR will continue to conduct after it has been triggered, until anode current falls below I_h, the holding current. In this respect it behaves like a thyratron valve.

One other point to note is the behaviour of SCR forward current with time. Time sequence is an important factor in switching an SCR. If forward voltage is applied too soon after the unit has been conducting, the current will flow again, inasmuch as charges around Junction 2 have not had time to reform. The usual period required for this recovery time is of the order of 50 µsec. For I_A greater than I_h, the unit will conduct, and for I_A less than I_h, the current will drop to a low value (the leakage current).

(continued page 5.)

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WANTED: Marconi B28 receiver or similar. Rodney Reynolds, St. George's Rectory, Battery Point, TAS.

WANTED: First edition of the RSGB Radio Handbook, and ancient copies of ARRL Handbooks. R.L. Gunther, Physics Dept., Box 252C, G.P.O. Hobart, TAS.

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THE ELECTRONICS ASSOCIATES PAGE

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PIV	Five	Ten
600	-	57/6
800	-	70/-
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1400	112/6	200/-

Our supply of the above diodes is relatively limited at this time; please specify suitable alternatives from our regular stock of diodes. A few of them are listed here:

PIV	Amps	Price*	PIV	Amps	Price*
100	0.75	2/- each	50	1.5	3/6 each
300**	0.75	3/6	20	3.0	2/6***
500**	0.75	5/9	50	3.0	4/6
700	0.75	8/6	100	3.0	5/-
900	0.75	11/6	100	12.0	16/-
1100	0.75	15/3	200	20.0	23/6

*Minimum order: ten diodes, but may be assorted.
**In late January or early February.
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Germanium diodes are also available as Point Contact computer type for VHF or detection, or as Junction type to handle up to 1 Amp, each, in power rectification circuits. Our big shipment of the Junction type arrives later this month. S.A.E. for full details of our many irexpensive ratings in the January Catalogue.

Each order is accompanied by comprehensive technical information. Please read it before installing the diodes.

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Please make Postal Notes or Money Orders to the Post Office at 'Sandy Bay, Tasmania'. Postal stamps OK for small sums.
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ELECTRONICS ASSOCIATES: 76 View Street, Hobart, Tasmania.

Silicon Controlled Rectifiers (continued from page 2).

A final and important note: When used in an a.c. circuit, an SCR is a half wave device, and as such must be considered similar to a half-wave diode for PIV and forward current ratings (average and surge), with all appropriate safety precautions. The SCR can control on one half of the cycle, but gives essentially zero output on the other half. It is possible to use SCRs in complete a.c. circuits, but this requires multiple controls and some care in equalising outputs (eg. matched SCRs), or the use of full wave bridge rectifying circuits which present both half-waves to the SCR (see article in next issue).

For the home experimenter, applications for the SCR are endless: lamp faders, electronic ignitions for cars, food mixers, movie projector speed control, electric drill motor speed control, and so on. Let us know if you have an interesting application of Silicon Controlled Rectifiers, and we may be able to publish it here.

In our following articles we shall also describe several basic applications of SCRs.

R. Reynolds.

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NEWS SHEET

January 1965

This News Sheet is being sent only to those of you who returned a Reply Sheet from our November publication, plus a few subsequent customers who did not receive the November News Sheet. To the latter we might mention that for the past year we have been issuing a periodical News Sheet in which we presented various items of technical and commercial interest. The response from the November Reply Sheets has been remarkable, compliments have been frequent, and we have received some warm letters. Thank you, all of you.

Popularity has its drawbacks. You seem to enjoy our informal style, low prices, and so forth. But we have received such a large number of Reply Sheets that we are now back where we started: with a large (and expensive) mailing list. We have, therefore, decided to place News Sheet and advertisement material regularly in the Equipment Exchange Bulletin, because their new low subscription rate promises to provide a large circulation for advertising. Otherwise there is no connection between the EEB and EA, other than the fact that they use our antique duplicating machine, for which we charge a suitable fee.

On the other hand, why should you pay even 3/- p.a. for something you would get free? Because, as you can see from the enclosed material, the EEB is considerably more than a source of low-cost advertisement space: it has graduated to the status of a real technical publication. This new journal reduces our advertising costs, and relieves us of publication worries.

We are willing to share this good fortune with you, and to the readers of this News Sheet (only) we shall offer 100V/0.75A diodes for 15/- per ten, and 200V/0.75A diodes for 22/6 per ten -- until February 5th, or until the supply of diodes is exhausted, whichever occurs first. Limit: 20 per customer. If we run out of 200V diodes first, we shall substitute for them 15 100V diodes for every 10 200V ones ordered. In order to handle these orders economically we shall have to reduce the book keeping to a minimum. We ask you, therefore, not to include in the same envelope any order for other diodes, but to put them in a separate envelope, with separate payment. And on the lower left hand corner of the special envelope, please write '100V' or '200V' (or both), as the case may be.... We have a few hundred of the diodes, but in event of our selling all of them, please indicate whether you wish refund or alternative merchandise. A current Catalogue accompanies this News Sheet. If you are grateful, please subscribe to the EEB.

Friends tell us that they talked to so-and-so, who had bought some of our diodes, and was amazed that they worked so well. Puzzled, we asked 'well, what did he expect?'. The answer: 'a real bargain is rare.' Aye, verily. We are not getting rich, but we're enjoying it!

We did get some transistors, finally: a half-dozen nice big 100V power transistors, ideal for electronic ignitions, etc. Three of them were open or shorted to begin with. The other three broke down utterly under typical dynamic switching conditions. So much for surplus power transistors. A discouraging and expensive lesson, but we shall be receiving several different kinds of transistors during the next few months, and we hope that some of them will be suitable. In particular we have much hope for silicon (or possibly germanium) transistors with f above 200mc/s; the Reply Sheets showed much enthusiasm for them, and the only [illegible] prices. We are trying.

E Q U I P M E N T E X C H A N G E B U L L E T I N

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CONTENT:

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THE USE OF REVERSE-POLARITY DIODES.

by R.L. Gunther, W6THN/VK7

It is not always convenient to use mica washers to isolate Stud Diodes from heat sinks, because they are susceptible to dirt, puncture by burrs, and are somewhat less efficient for heat transfer -- The thermal resistance of 0.005" thick mica is about ten times that of a metal-to-metal contact. Stud Diodes with reverse-polarity are available from various manufacturers, and can be most useful in combining heat sinks. Consider these circuits:

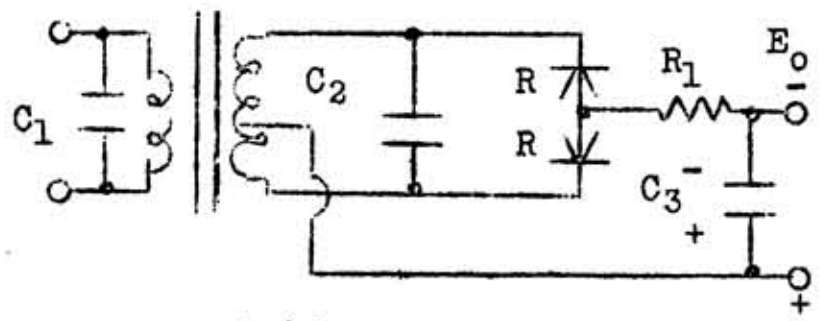

Fig. 1: $E_o=(1/2)E$. PIV = E. Full Wave.

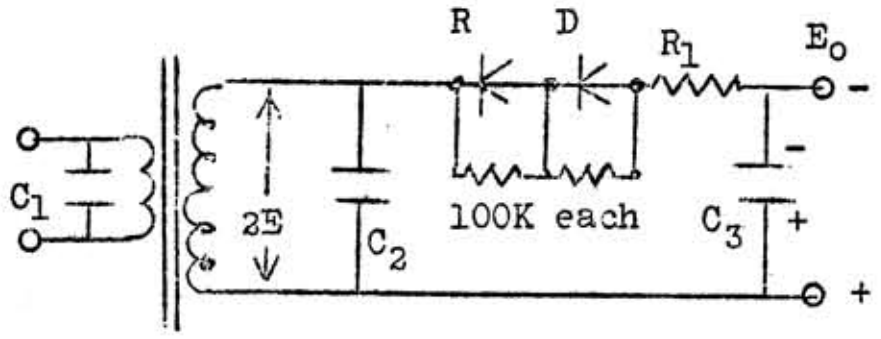

Fig. 2: $E_o = 2E$. PIV= 2E/2. Half Wave.

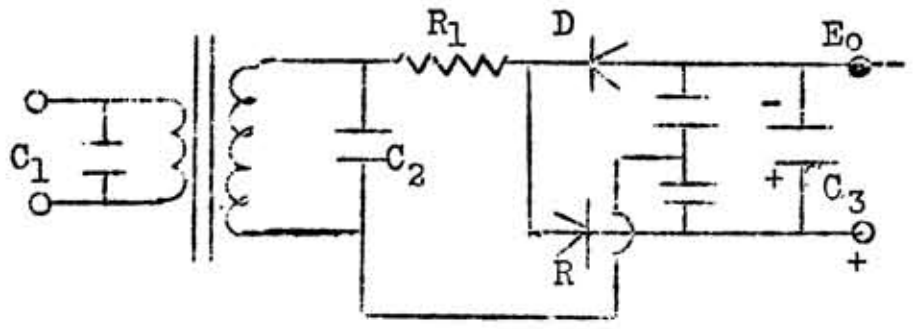

Fig. 3: $E_o= 2E$. PIV = 2E. Voltage Doubler

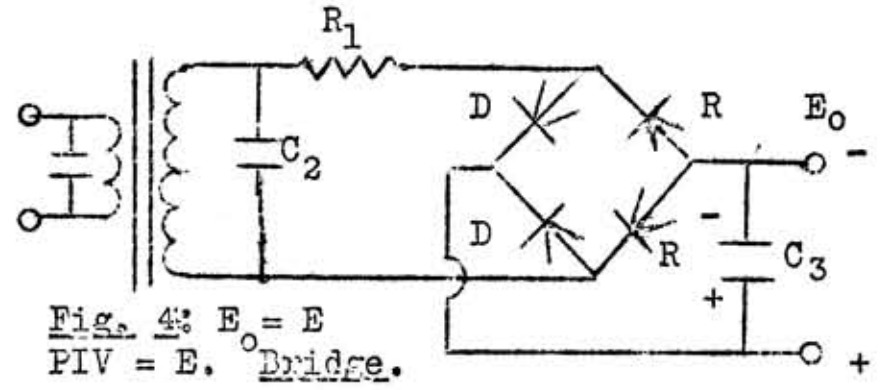

Fig. 4: $E_o = E$ PIV = E. Bridge.

Here, PIV= peak inverse voltage appearing across each Stud Diode, and of course the diode PIV rating itself must be 1-½ to 2 times this voltage.

E= peak voltage appearing across the whole secondary winding of the transformer, except in fig. 2, which is shown to illustrate the rating-multiplying advantage of the series connection.

D= conventional diode. R= reverse polarity diode (viz. anode is diode body). The D.C. output voltages shown are approximate only, and in fact are somewhat less. A discussion of the actual voltage and current relationships will be presented in a

following article.

When using the ordinary diodes with the cathode at the diode body connection (viz, the end with the threaded screw), Fig. 1 could give only a + polarity from the heat sink connection, but with reverse-polarity diodes, the situation is as shown. This is not particularly important for a well isolated secondary winding used in Full Wave, but shows its advantage in Fig. 4, where the Full Wave Bridge now needs only two separate heat sinks rather than three. Fig. 2 shows how the PIV rating of the diodes may be doubled by the series connection. More than two diodes can be used in series, but this requires more heat sinks.* For the record, however, I do not recommend using the Half Wave configuration for a rectifier, except in circuits with small loads and low supply voltage. Reasons for this will be discussed later.

In each of the above circuits, the condenser, C_1 is 0.01μF, and C_2 is about 0.1μF for a 25V supply, half that for twice the voltage, etc. These condensers are installed for reduction of transient voltage spikes, and at least one winding must be so protected if silicon diodes are used with a PIV safety factor less than 5-fold. A somewhat improved transient protection characteristic can be obtained by putting a resistor in series with larger values of C_1 and C_2. This will be discussed quantitatively in the next issue of the EEB.

Condenser C_3 is the normal input condenser of the hum filter, and for low voltage output would nominally have a capacity of several hundred microfarads. R_1 is essential for protecting the diodes from surge currents, and will have a minimum value (for diodes rated at 3A or less) of about one ohm for a 50V supply (2 ohms for 100V, etc.), though more resistance is better if voltage regulation is unimportant. If the maximum output voltage under load is desired, the value of the surge current resistor (R_1) can be reduced by the amount of the d.c. resistance of the secondary of the transformer and the resistance referred to it from the primary.

When you combine heat sinks, remember that for two diodes the combined heat sink must have at least twice the area. If you run less than the rated maximum current through a diode, the heat sink can be somewhat smaller, if space is important. An ordinary metal chassis can make an adequate heat sink, if it is not unduly heated by other components (eg. resistors or transformers). In this regard, Fig. 1 is useful, because the chassis heat sink can be at negative potential if mica insulators are not employed (R_1 would then go in the + lead, of course). This would be convenient for valve circuit power supply.

A complete list of useful technical references on diodes and SCR's will be presented in a forthcoming issue of the EEB.

-- R. L. Gunther

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* When more than two diodes are connected in series, it is wise to shunt each diode with a 0.001μF to 0.005μF condenser (of suitable voltage rating) in addition to the voltage equalising resistors, because of the 'hole storage' effect. It is a complicated phenomenon, but it exists and requires the use of the condensers to ensure against rectifier failure. In addition, when any of the following conditions apply, the shunting condensers should be used when diodes are connected in series: When PIV safety factor is low, when operating frequency is above 150cps (but the maximum useful frequency for Studs is about 400cps, and perhaps 50kcs for Top Hats), when the input waveform is non-sinusoidal, or when the load is inductive. For the latter condition, when the load is a choke input filter or d.c. motor, an additional transient suppressor should be connected across the output of the supply (eg. in place of C_3), consisting of a 0.1μF condenser in series with a resistor. For LT, the resistor is 0 ohms, and for HT, it could be 1K ohm.

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SILICON DIODES: Guaranteed, tax paid, post free. New stock: Special Reverse-polarity 3A Stud Diodes, at no extra cost! Normal type (N) has cathode at Stud end (the end with the threaded screw). Reverse type (R) has anode at stud end. Present stock of 3A diodes: 20PIV (N): 2/6, 50PIV (Nor R): 3/9, 100PIV (N or R): 4/-, 200PIV (N or R) 4/6, 300PIV (N): 5/-, 400PIV: 5/9. We have a few 3A diodes at 900PIV and 1000PIV; If you give us a good reason for using them (we are interested), you can have them for the 400V price..... Minimum order: ten diodes, any assortment. We also have 2 Amp diodes from 200PIV to 400PIV, and in fact quite a lot of diodes of various ratings from 0.4 to 50A, 50 to 1500PIV, all at most reasonable prices. S.A.E. for Catalogue.
Electronics Associates, 76 View Street, Hobart, TAS.

-- (continued, next page)

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WANTED: Pair of Walkie-Talkies. Must be cheap. R.L. Gunther, C/- Physics Dept., Box 252C, G.P.O. Hobart, TAS.

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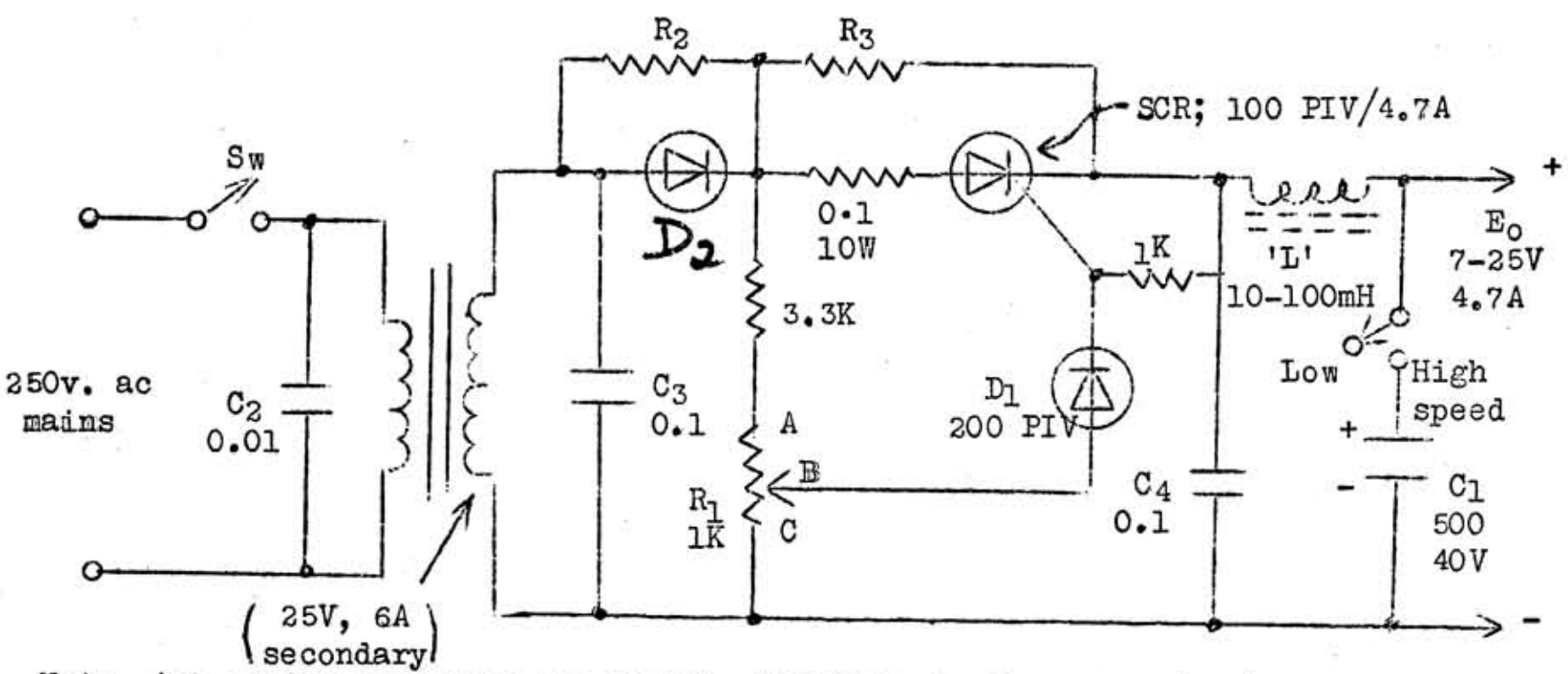
SILICON CONTROLLED RECTIFIERS (Part II) by Rod Reynolds, VK7ZAR

In the last issue of the EEB you were introduced to a discussion of general theory and practical applications of the Silicon Controlled Rectifier (SCR). We are now going to look at a few details of operation after first discussing a simple SCR power supply.



Note. All condenser values are in μF. Resistance values are in ohms.

Fig. 1. The power supply.

This unit may be used to control small lights and small d.c. or 'universal' type motors (dynamotors, electric trains, etc.), and also makes a very good battery charger. It can not be used to control any unit employing a transformer, or a shaded pole or induction a.c. motor.

We found last time that an SCR requires a specific gate current (and hence voltage) to fire, which is not substantially dependent on anode voltage. Consider the position of the slider of R_1 in fig. 1. With the slider at C, the voltage on the gate is insufficient to fire the SCR, and hence no current will flow. (see also, fig. 2). With the slider at B such that the trigger voltage is just reached, the SCR will fire over $\frac{1}{4}$ of the cycle. As the slider is advanced toward A , the SCR will fire earlier in the cycle, because the gate reaches the threshold sooner. When the slider reaches A, maximum conduction occurs, such that control is obtained over nearly $\frac{1}{2}$ of the positive portion of the cycle. The SCR will not conduct over the negative half of the input cycle. Note, however, the use of a diode D_1 in the gate circuit. This prevents destruction of the SCR during the negative portion of the cycle. The process is similar to that described for normal triggering, but in this instance a positive gate bias with a negative anode potential would result in irreversible destruction of the SCR junctions owing to high currents flowing in the wrong direction. For practical purposes one could assume that the positive gate potential has lowered the anode PIV below the safe level.

Therefore: A POSITIVE VOLTAGE GREATER THAN 0.25V MUST NOT BE APPLIED TO THE GATE

SILICON CONTROLLED RECTIFIERS (cont.)

(with respect to the cathode) WHILST THE ANODE VOLTAGE IS NEGATIVE WITH RESPECT TO THE CATHODE.

The SCR will not limit the current to a resistive load for a duty cycle shorter than $\frac{1}{4}$ cycle (ie. the minimum average output current will be greater than zero when R_1 slider is at position C), but it can control a commutator type (eg. 'universal') motor at a very low speed, owing to a feedback interaction between motor and gate electrode. The choke, 'L' in fig; 1. damps out 'hunting' in the motor at low speeds, because of certain complex phase interrelationships. At low motor speeds, better control is obtained with C_1 switched out of the circuit, but it is switched in at high speeds for smoother operation. Speed control of ordinary electric drills is best accomplished with C_1 connected into the circuit. More about motor speed control in a subsequent article.

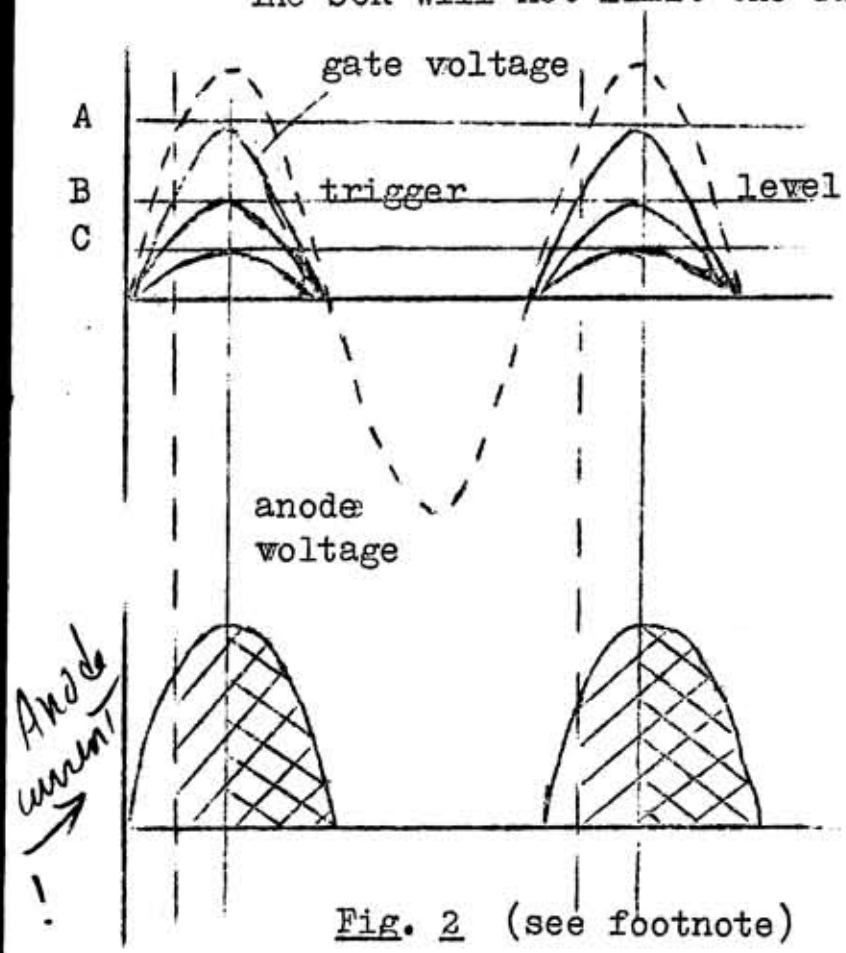


Fig. 2 (see footnote)

When used as a accumulator-battery charger, R_1 must be adjusted to avoid overcharging, so that as the battery voltage rises, the charging current falls to a low value.

Owing to the relatively high price of SCR's, some attention must be given to the problem of suppressing transient voltages, which can otherwise be destructive to an SCR as to any two-element silicon diode. The easiest way is to provide a High PIV safety factor, but this is expensive , and it can be modified by suitable circuit design. 'Thyrector' surge voltage suppressors (similar to high power double-en ded zener diodes), are ideal for this purpose, but they are not yet very common in this country, and other recourse is possible. Condensers C_2, C_3 and C_4 are adequate for transient voltage suppression. This subject will be discussed in the next article in this series.

With an SCR it is particularly important not to tighten the nut holding it to the heat sink, beyond 15 in-lb in torque. We shall refer to this again.

Rod Reynolds.

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Footnote: Applied anode voltage is in phase with the trigger voltage. This is very important in this circuit, if control is to be effected as designed.

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E Q U I P M E N T E X C H A N G E B U L L E T I N

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CONTENT.

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Editorial. It is heartening to receive so many subscriptions every week and we hope that this trend will continue. We have received word from several advertisers regarding the success of their advertisements in past issues of the EEB. Many thanks to those people who encouraged their friends to subscribe to the EEB.

CORRECTIONS to Vol.1 No.2. The vertical axis in Fig.2 should be labelled 'gate voltage' for the upper graph, and 'anode current' for the lower graph. Anode voltage applies to the dotted curve. In Fig. the unlabelled diode is D_2.

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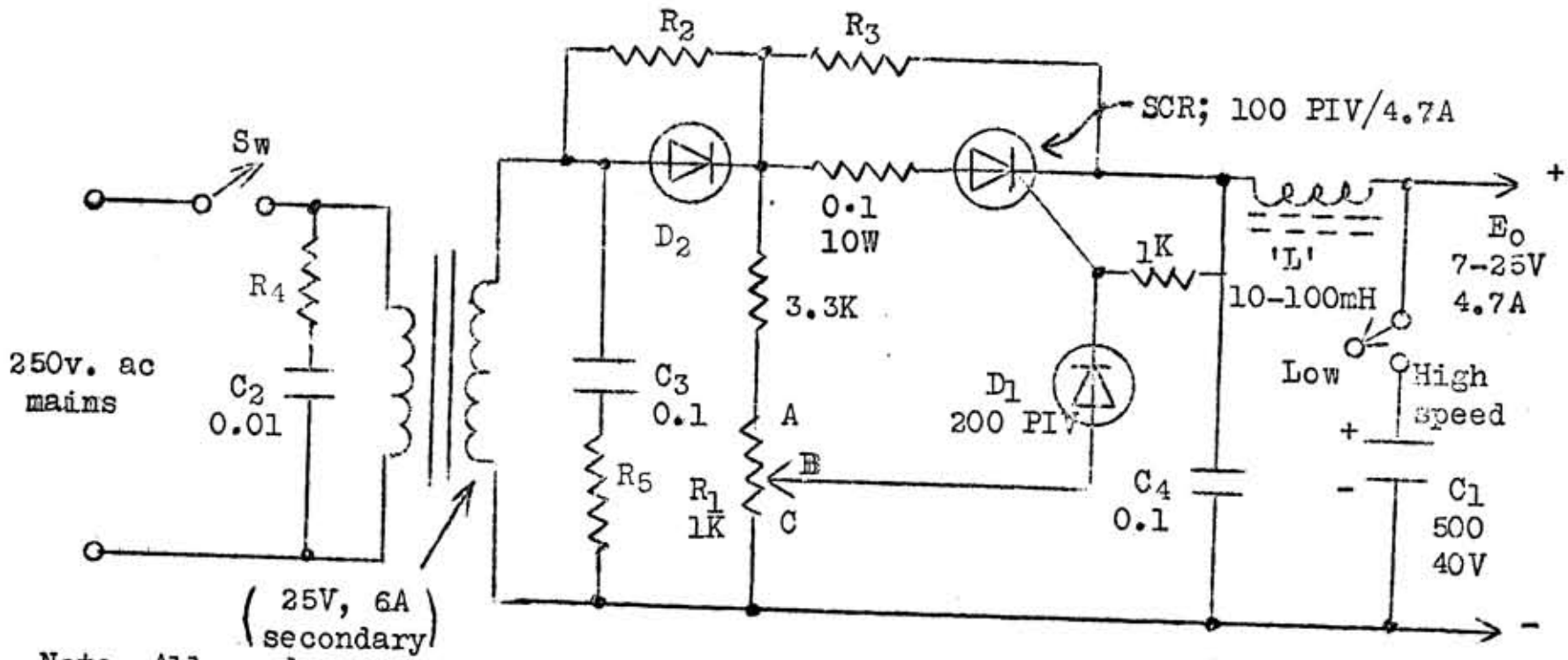
SILICON CONTROLLED RECTIFIERS..... Part III... by R.L. Gunther and R. Reynolds.

Reduction of transient overvoltages for SCRs and Diodes.

'... Because of the sharp transition of their dynamic reverse resistance from a very high value to a very low value in the region of avalanche breakdown, and because of their low thermal capacity, (SCR's and semiconductor diode rectifiers) usually have little margin between the value of voltage which they can block satisfactorily in the reverse direction on a continuous basis, and the transient overvoltage which will destroy a cell by shorting in a matter microseconds... The likelyhood and the severity



Note: All condenser values are in μF. Resistance values are in ohms.

Fig. 1. The power supply.

of trouble-making voltage transients tend to be greater in SCR circuits than in simple power diode circuits, because of the extremely fast switching action and the high commutating duty possible with SCR's. An understanding of the sources of transient voltages in circuits and the means of reducing them is therefore essential if optimum use of the ratings of SCR's and diode rectifiers is to be achieved."
--- from the G.E. Silicon Controlled Rectifier Manual, 2nd Edition, p. 201.

In the last issue of the EEB we presented a typical voltage control circuit (reproduced above, in Fig. 1) for varying the current through small resistive loads or motors, by varying the gate voltage in phase with anode voltage. One must, however, pay some attention to suppression of voltage transients, in order to keep the PIV safety factor to an economical minimum. This is a very complicated subject, and we can only treat it briefly here. Further references can be found in the bibliography at the end of this and subsequent articles.

In Fig. 1, with D_2 omitted, with C_4 not connected, and with a motor load one could expect appreciable commutating transients from the switching action of both SCR and motor. In addition to normal transient suppression methods, this can be met by using an SCR with a somewhat higher PIV rating than might be employed for a diode in a similar position. In Fig. 1 we show an SCR with a safety factor of about 3 over the nominal secondary peak voltage, rather than the 1-1/2 that could be used for an ordinary silicon diode. Later in this article we shall describe methods for reducing the SCR safety factor safely.

Commutating transients arising from the motor are largely bypassed by C_4. It would have a proportionately smaller capacity in a circuit having higher output voltage.

One method for reducing switching transients arising in the input circuit (and which is as effective for SCR as for diode) is the classical one of providing condensers across primary and/or secondary of the power transformer (here, C_2 and C_3). Transients can be reduced even further by increasing the capacity of these condensers, but this gives rise to 'ringing', ie. shock-excited resonance of condensers with the inductance of the transformer. It can be avoided by a damping resistance in series with each condenser, R_4 and R_5. Optimum values depend on the magnetising current of T (see Miniwatt Digest, July 1962), but typical approximate values might be as follows :

Output	C_2	R_4	C_3	R_5
LT (eg.Fig.1)	0.05	2.7K	1.0	200 (carbon)
MT			0.01	20K
HT			0.002	100K

Condenser values are in µF, resistances in ohms. The effectiveness of this RC method depends on the fact that the lower and medium frequency transients see a lower impedance path through the larger value of C. The minimum impedance imposed by R is less important at high frequencies since these would tend to be bypassed by the distributed capacity of the transformer windings.

Another, and rather interesting method for reducing transients arising in the input a.c. circuit, is to insert a conventional silicon diode rectifier, shown as D_2 in Fig. 1. In that circuit it could be rated at 100PIV, at a current rating from 2A to 6A, depending on the maximum load to be drawn. In this instance, the SCR PIV rating could be reduced to 50V without loss of reliability; the cost of the additional diode is likely to be greater than the amount saved by using the lower rated SCR, but the increased safety for the more expensive SCR is well worth it. In addition, the financial saving does become significant when HT SCR's are used.

Consider, now, two possible configurations for the diode-protector circuit. One

(continued, P. 5)

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FOR SALE: Collins- 7553 comm. Receiver-as-new. £350 or near offers. -Heathkit- "Apache-SB 10". Combination in-built power supply. Input- 180 watts, 10-80 mx SSB, AM, CW,
(this advertisement is continued on P.4)

(Advertisement continued from page 3)

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S.E. Widgery, 39 York Str. West, Ballarat, VIC.

ELECTRONICS ASSOCIATES... 76 View Str., Hobart Tasmania.

Waterproof.

Recently a diode was salvaged from the washing maschine at 76 View St, where it had been cleaned quite thoroughly for several weeks. We are proud to report that it meets all tests satisfactorily, including stability. Even so, we won't put it back into regular stock-- it will be incorporated into a new Diode/SCR Tester that will reduce testing time and increases reliability. This instrument incorporates several useful designs we have been pondering, and its components include several 1500V/0.4A diodes which are cheaper than alternate methods.

Why not use 400mA diodes?

We usually use 400mA diodes for our own designs, because normal applications rarely require the 750mA ones. If you follow our example, you will save money. A 400mA diode will comfortably deliver a full 400mA to a resistive load-- no current derating necessary for that, and 300mA to a condenser input filter. In Full Wave or Bridge that means 600mA... who needs m ore? PIV safety factor is vitally necessary, but not so for forward current. It is unnecessary to pay for current that you will never use. For the benefit of those reading the EEB for the first time, our current stock of 400mA diodes is as follows..

500V (small stock)=	4/6 ea.	1000V	= 9/9 ea.
600V (plenty)	5/9	1200V	14/-
800V ''	7/-	1400V	20/-

and of course they are of the same high quality as all others we sell, and similarly are guaranteed, tax paid, and post free. MINIMUM ORDER = ten diodes, any assortment. If you don't want ten of these, send for our free catalogue for a wider selection.

SCR's

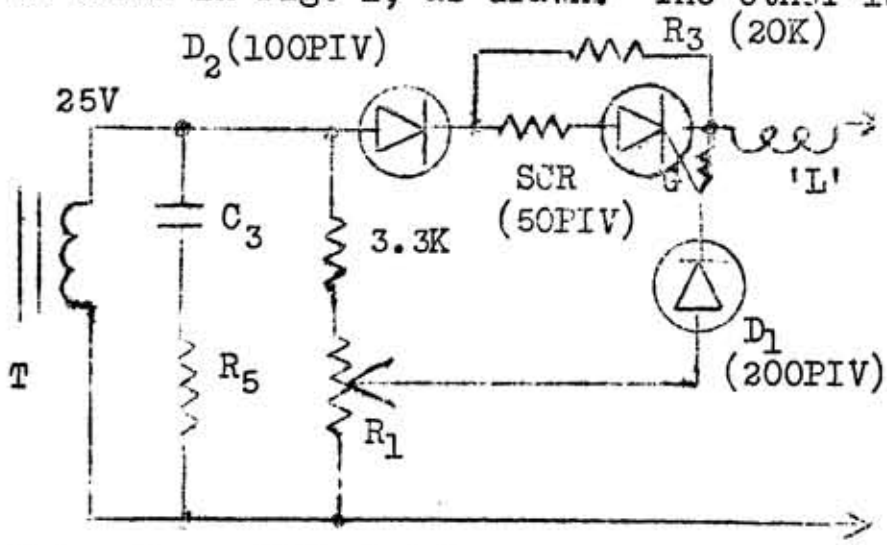
We are pleased to announce that we have a stock of Silicon Controlled Rectifiers now, and have finished testing them. We are satisfied with their performance (which is more than can be said for the surplus transistors we have tried so far), and present them for sale. We obtained only a small lot, but if you like them, we shall get more. Silicon Controlled Rectifiers are like Thyratrons, but better (in our opinion). Typical characteristics..Absolute Maximum PIV Rating limited by PIV or V_{BO}, Maximum Average Forward Current = 4.7 Amps (25°C), Nominal Gate Current to fire= 3 to 10 mA, Maximum Gate Voltage to fire = 1.6V. Individual technical characteristics are provided for every SCR we sell. Owing to their relativelly high cost, you are well advised to design your circuits so that transient reverse overvoltages are suppresed, to use the suppression PIV safety factor. Limit forward surge current by a series resistor, as for a diode of comparable current rating. Useful technical information and techniques can be found in various issues of the EEB, in Mullard's 'Technical Communications' and 'Outlook' (cf.'thyristors') and in Philips 'Miniwatt Digest'. A wealth of useful material is found in the G.E. Silicon Controlled Rectifier Manual, and in the G.E. SCR Hobby Manual.

Silicon Controlled Rectifiers.

50 PIV =	£0.18.6 ea.	500PIV =	£2.15.0 ea.
100	1.5.0	600	3.1.0
200	1.14.0	700	3.10.0
300	2.1.0 (no minimum for SCR's)		

(continued from P. 2).

is shown in Fig. 1, as drawn. The other is Fig. 3, here below. By inspection of Fig. 1 it can be seen that a reverse transient generated by the a.c. supply will be developed across D_2 and the R_1 network in series, and will appear almost entirely across D_2, since the resistance of D_2 is several thousand times that of R_1 and the 3.3K resistor. Only the back voltage appearing across the 1K+3.3K will be applied to SCR, and this is negligible. Therefore the load of bearing the transient is placed upon D_2, which is easily rated to handle it.



Note : Here, PIV of SCR need be only slightly greater than a.c. peak supply voltage.

Fig. 3

On the other hand, a reverse transient generated by a motor load is applied across the 1K+3.3K in series with the SCR, and therefore appears primarily across the SCR. This requires C_4 to bypass the transient, since D_2 is of no use in this instance.

By inspection of Fig. 3 it can likewise be seen that a reverse transient generated by the a.c. supply will be applied to D_2, but now in series with the SCR itself. In Fig. 1, we could in fact dispense with R_2 and R_3, because the value of R_1 + 3.3K is so much lower than the reverse resistance of D_2 or SCR, and it is necessary only to ensure that D_2 have sufficient PIV rating. In Fig. 3, however, R_3 must be used to provide a high leakage path for current from transient overvoltages. This results in the greater part of the transient being developed across D_2, as in the Fig. 1 ckt. Now the reverse transient developed by a motor load is also blocked by D_2, and C_4 is no longer necessary; we have eliminated a condenser in favour of a resistor, and have made D_2 perform a double function. D_1 protects the gate, in the same manner that D_2 pro tects the anode of the SCR, therefore D_1 must be rated for at least 100V.

The idea of protecting the SCR by a HT silicon diode in series, is a simple and effective method for reducing the SCR PIV safety factor requirement to a bare minimum and has the advantage that it is both cheap and effective. It ought to be similarly possible to protect four (or more) diodes of a bridged rectifier by inserting a single diode in the common a.c. line, where the added diode is rated for PIV sufficient to attenuate transients appearing across the others. If we have time, we shall test this idea and let you know about it.

Unfo rtunately both of the circuits Fig. 1 and Fig. 3 suffer from the effect of forward transients (eg. back EMF) from a motor load. These do not affect the cathode circuit (because the SCR is robust in the forward direction), but do develop a positive bias on the gate. This can cause 'hunting' at low motor speeds (in absence of 'L'), and tends to maintain firing even though R_1 is turned down. It can be minimised only by turning R_1 down slowly. This reduces the effectiveness of the variable gate voltage control system. In the next issue of the EEB, we shall show how control can be maintained more smoothly and effectively by phase shift methods, using constant gate voltage.

There are a few more minor points we might mention about transient suppression, but we are running out of space, and will probably mention them next time. A few very useful references to semiconductor theory (simple) and practice are : Silicon Controlled Rectifier Manual (General Electric Co, 1961), SCR Hobby Manual (G.E.), 'Power Rectification with Silicon Diodes' by M. Dayal (Mullard, Ltd., 1964), Selected Semico nductor Circuits Handbook Edited by S. Schwartz (Wiley, 1961), 'Firing Requirements for Silicon Controlled Rectifiers', Mullard Tech. Comm. 6,Mar'62.

EQUIPMENT EXCHANGE BULLETIN

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CONTENT.

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Editorial.

We are required to place the fastening staples at the left hand margin of this publication. We realise that this promotes tearing, but we have no choice in the matter. You can avoid tearing by folding each page at the margin as you turn it.

Please tell your friends about the EEB. We cannot afford a suitable advertising campaign, and we are depending on you to spread the word. If you like our articles, tell others about them. If your advertising was effective, let others know about it.

In reference to the matter of advertising, we are puzzled. There has been considerable interest in the EEB. We have received compliments on the technical articles. We have received unsolicited reports that the advertisements actually worked, and the advertisers were well and truly pleased. We have had a flood of subscriptions. There is only one trouble: few advertisements. The subscription fee pays only for the postage and some of the materials. The articles are donated. Advertisements are necessary if this enterprise is to continue, so that we can justify the considerable time devoted to it.

It is your part to support the EEB. Surely the cost of advertisements is not prohibitive. Surely you must have something sellable in the workshop or attic. Surely you must want something else to clutter up the attic. It doesn't have to be electronic. It doesn't even have to involve money. 'EXCHANGE' is part of our title. How about good recipies exchanged by the YLs?

If you appreciate this publication, please support it.

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SILICON CONTROLLED RECTIFIERS. Part IV. — by R. L. Gunther and R. A. Reynolds.

More about Transient Suppression for SCRs and Diodes.

A more expensive, but more effective method of reducing output transients from inductive loads, is simply to place a zener diode across the load (with cathode going to the + terminal) in place of C_4 of Fig. 1 in the previous issue of the E.E.B. In this circuit it could be rated from 30V to 45V, if a 50V SCR is used. An alternative method

uses an ordinary silicon diode (eg. PIV 50V in Fig. 1) across the load (same polarity as zener), and another in series with the load itself. This is simply using the same method for suppressing output transients as we have described previously for input ones. Either the zener or the conventional diode pair are more effective and appreciably smaller than the condenser (C_4), and have the not inconsiderable advantage of reducing 'hunting' when a motor load is used. This provides a further saving of space and cost by eliminating 'L' of Fig. 1.

The circuit of Fig. 3 would have seemed altogether superior to that of Fig. 1, for inherent output transient protection, but for a matter of efficiency which we shall discuss in the next issue: by placing a full wave bridge rectifier network between transformer and SCR (of Fig. 1), circuit and transformer efficiency is increased appreciably, and output ripple frequency is doubled (therefore easier to filter, if d.c. is desired).

It is also possible to protect semiconductors from input reverse transients by using a zener diode in parallel, instead of the series diode. In this event, however, the zener must not be subjected to a pulse exceeding its own maximum current rating; this is usually a few times its nominal continuous current rating. This stipulation requires that the internal impedance of the voltage source be sufficiently great to limit the zener current to the safe value for the highest transient to be encountered. If the source has a low impedance, as in an LT supply, this may be impractical economically, but can indeed be used in certain kinds of circuits, for example one design of a transistorised ignition system:

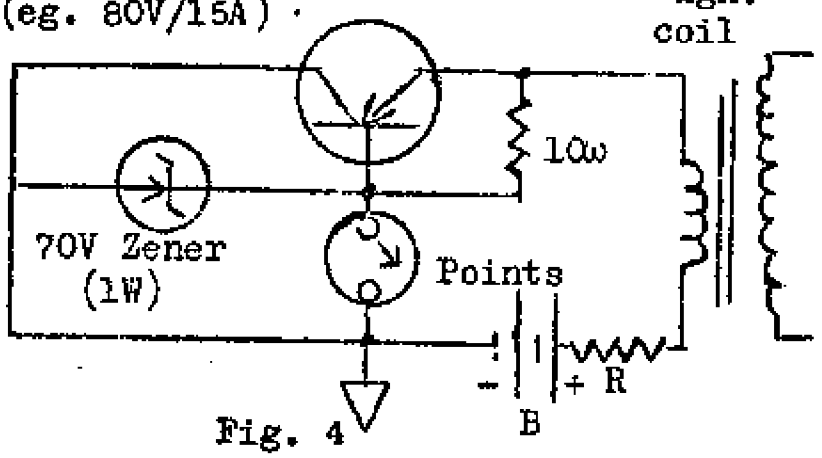

Fig. 4

In Fig. 4, this clever arrangement ensures that a transient voltage exceeding the zener value allows the zener to conduct through the base of the transistor. This allows the transistor itself to conduct a considerable current, and this damps out the transient. When the magnitude of the transient voltage falls below the zener voltage, the transistor stops conducting. The time during which the transistor conducts is so short compared to the time of a normal operating cycle, that the normal function of the system is undisturbed, but a large amount of transient overvoltage power has been suppressed by a zener of modest size (eg. 1 watt).

We might say a further word about the PIV ratings of D_2 and SCR, in event of your applying this design to an HT circuit. In Figs. 1 and 3, we chose a value of 100 PIV for D_2, though this is about twice the normal diode safety factor in this circuit, because of the violence of the SCR switching action. A smaller safety factor would probably be adequate, b t we were cauticus, and the higher PIV did not cost much more. The PIV rating of the SCR itself in either Figs. 1 or 3 would not have to be more than the drop across the R_1 network or R_3 (viz. only a few volts), but for the fact that V_{BD} (cf. EEN, Vol. 1, No. 1) must be sufficient to ensure that the SCR does not fire until the gate so dictates. Therefore the minimum value of PIV rating of the SCR must be a bit greater than the Peak Voltage of the a.c. supply, but a small margin of safety (eg. 20p.c.) is adequate in this instance, though this will depend on the degree of nominal variation of your mains supply (which can be considerable). For HT, the resistance of the R_1 network or R_3 should be increased in proportion to the SCR PIV rating, but make certain that sufficient wattage is used

We realise now, in case you hadn't caught it, that our hypothesis about a diode being able to protect other diodes was impratical as proposed, since it would require at at least a bridge configuration, and that would be no advantage. If anyone has any ideas about this, we should like to hear from them. If your letter is technically suitable, please indicate whether we could have permission to publish it in these pages. There is, at present, no reward for publication other than the Glory. Later perhaps something may develop, if the EEB shows a profit.

There is one more type of transient suppression system, useful for very low impedance circuits, and particularly valuable for 3-phase networks. It simply places a Bridge Rectifier across the line, and the output of the Bridge goes to a large electrolytic condenser. The condenser is thus placed automatically across the line on each half cycle, presenting a very low impedance to voltage peaks above the nominal value. Electrolytic condensers, however, are notorious for their high inductance, and it seems to us that this idea should be approached with caution, and with use of high quality electrolytics. Perhaps a suitable combination might be to use a large electrolytic bypassed by a low-inductance paper condenser. For the most part, electrolytic bypassing can best be applied to high power engineering design where special methods are required to ensure reliable operation.+

The one situation for which we have no obvious solution is the existence of extremely high voltages appearing on the mains during severe lightening storms. What transient-suppressing system could withstand 4KV on the mains for several hundred milliseconds? (it has happened in Hobart). Any suggestions?

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ADVERTISING

+ See GE's SCR Handbook for further details.

Advertising Continued.....

If you own a tape recorder, the Australian Tape Recording Society will aid you in this fascinating hobby. A.T.R.S. will open it's 'Pre Recorded Tape Library' soon from which members may hire commercial and home recordings at low costs. Write now for details... 'The Secretary, Australian Tape Recording Society, Box 9, P.O., Crow's Nest, N.S.W.

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(We have seen sample copies of the above . They are of excellent quality..... The Editor.)

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DID YOU KNOW???????? by C. Pallaghy.

Have you a bottle of Hydrofluoric Acid in your workshop? Have you treated it with only casual precaution or are you aware of its potential DANGER to yourself and to others?

Hydrofluoric Acid is commonly used in workshops for glass etching. It is an acid having unusual physiological properties and therefore is highly dangerous to users unaware of its true nature. Most of the common acid burns are treated by first giving the burned area a thorough wash with tap water and then rubbing bi-carbonate of soda into the burn to neutralize the remaining acid. This is fine for acids such as Hydrochloric, Sulphuric, etc., but it just won't do for Hydrofluoric Acid, which penetrates deep into the skin. In this form, the fluoride combines with substances in the surrounding flesh, killing the cells and then moving on to furth[illegible] regions until your arm literally 'drops off'. This process may take several weeks, but it is inevitable unless the proper treatment is applied straight away or at least as soon as possible.

The correct treatment must involve the instantaneous removal of the fluoride ion by chemically combining it into an inert form and usually this is done by injecting a 10 percent solution of Calcium gluconate completely around and into the burn. At the same time, you must realize that we are by no means qualified to give medical advice on this matter and you must consult your own Doctor for the appropriate treatment. Also, this is in no way related to fluoridation of tap water.

Unfortunately too few people (and doctors) know the correct treatment, as Hydrofluoric Acid is not as commonly used here as in overseas countries. So don't let anybody fool you by saying that an alkaline paste is good enough.

The greatest danger, of course, is that weak solutions of the acid are potentially more dangerous because contact of it with the skin causes no pain (i.e no immediate pain) and is therefore just wiped off and neglected.

How do I know about it? ... By painful experience. Fortunately I was aware of the correct treatment.....And YOU?.... at least you know now.

E Q U I P M E N T E X C H A N G E B U L L E T I N

March 5, 1965 Issued twice monthly Vol.1, No.5

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Send to: E.E.B., P.O. Box 177, Sandy Bay, Tasmania, Australia.

BACK ISSUES are available at 5d each, while they last. We have had to start charging for the postage, because we get tired of spending money. Please send stamp or largish brown envelope, with address. All subscriptions start with the current issue.

CONTENT.

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Editorial.

It appears that our Editorial appeal in the last issue of the EEB had some results, and we are grateful. Time will tell whether it will have long range significance. We are certain that eventually the number of subscribers to the EEB will provide a good supply of source and patronage for advertisements. Understandably enough we are impatient to build this publication to that level, and your continued help will be appreciated.

The greatest single requirement is for us to obtain even more new subscribers, and we should appreciate your giving the fullest publicity to our activities. If we have a sufficient number of subscribers, advertisements will follow automatically. The next most important need is to obtain good technical articles. You can help with that too. If you have an idea, jot down the main details, and we can work it up into passable English. If you can also write it up yourself, so much the better.

If you have not verified your idea experimentally, PLEASE state that specifically -- there will be others who will want to try it out. If you have done experimental work on it, please furnish all details -- working voltages, resistances, waveforms (if available), etc. Your project does not have to be earth shaking, and the article does not have to be a literary effort. We do not have to accept it either (hi), but it is quite likely that if you found something to be interesting, so would others. Let's hear from you, and of course we always welcome comments on published articles, particularly if they are of printable technical calibre.

Our efforts so far have resulted in a sufficient number of projects to fill our pages for a while, and we shall pad them occasionally with interesting excerpts from other publications (with permission, of course). Our own interests run heavily on the side of semiconductor theory and practice, but your contributions can be on any hobby or electronic subject. We shall pay you with Gratitude and Fame, and maybe someday even with Money, if we ever see any.

Editorial (continued)--

We are required to staple these pages on the left hand margin. You can avoid tearing by folding each page at the margin as you turn it.

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SILICON CONTROLLED RECTIFIERS. Part V. -- by R. L. Gunther and T. Ohsberg

A more efficient constant-phase voltage control circuit.

There are two principal methods of controlling the firing time of a Silicon Controlled Rectifier: 1) The gate is in phase with anode, and the angle of anode current flow is controlled by the magnitude of the a.c. gate voltage -- as discussed in Part II of this series of articles. 2) The a.c. voltage on the gate remains constant, but its phase is altered with respect to the phase of the anode voltage -- This will be discussed in Part VI of this series.

Each method has its advantages. No. 1 is more simple, but is subject to interaction with output load (viz. 'hunting'), and cannot control the output over the entire cycle. No. 2 is more versatile, but requires more circuitry, and adjustment for optimum performance. We must emphasize that either method of control has no relationship to the question of transients, and any SCR circuit must be well protected from them, as discussed in Parts III and IV of this series.

We have finished experimental work on the phase-control system, but thought that we ought first to present an improved version of the constant phase circuit, for the sake of completeness, and because it can be a useful power supply in its own right. The improvements result in higher efficiency from the power transformer, lower output ripple, and the elimination of feedback interaction with the load. In applications where control of power is not required over the lower part of the cycle (cf. EEB, Vol. 1, No. 2), this is certainly the most effective circuit.

The half wave circuit of the Part III article is made into a full wave bridge by adding two rectifiers at the input, and two diodes are added at the output:

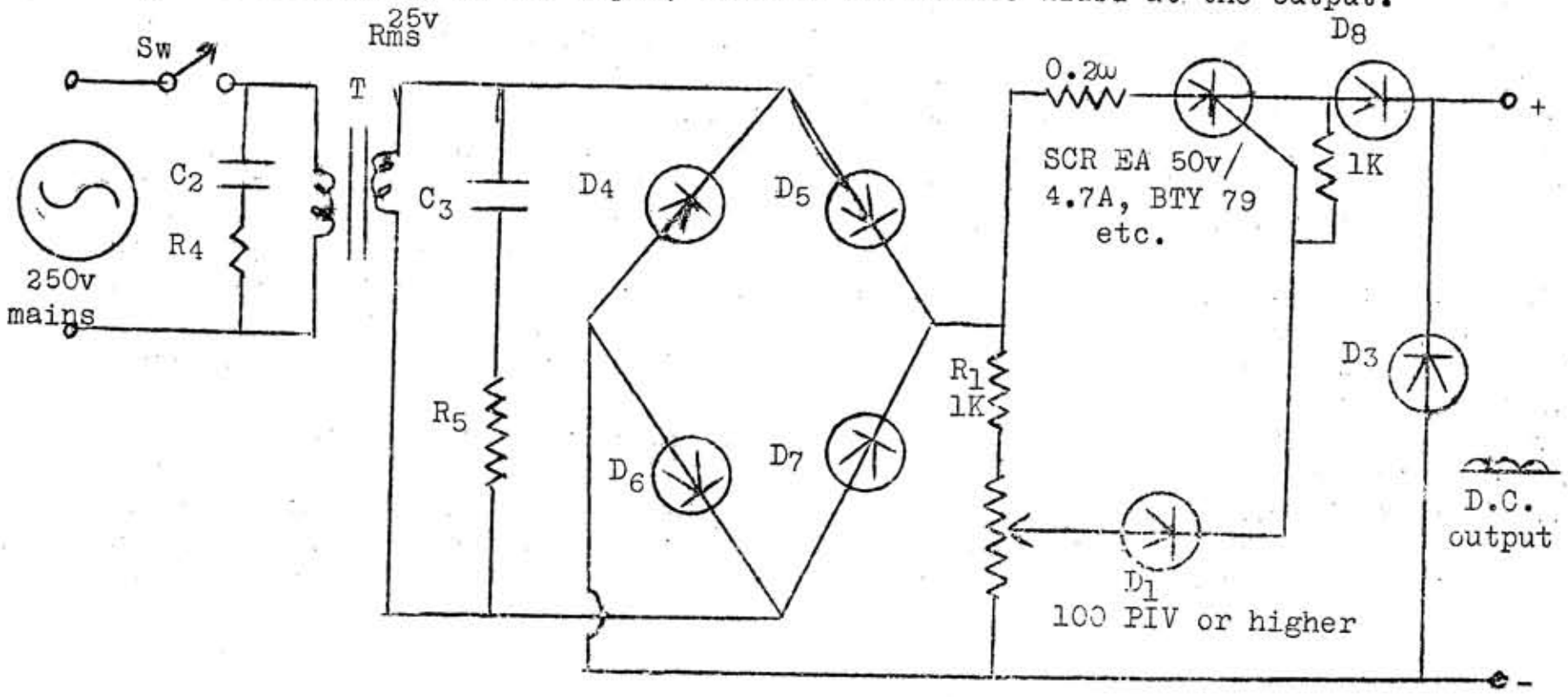

Fig. 5. The improved power supply

(See Part III, EEB Vol 1, No. 3, for discussion of values for C_2 C_3, R_4, and R_5)

The transformer now delivers useful power to the SCR on both halves of the a.c. cycle. Not only does this increase d.c. ripple frequency to a more easily filterable 100 cps, but it also reduces transformer core saturation. The transformer is then able to deliver 50 percent more actual power than it could supply to the half wave circuit. Diodes D_4-D_7 still protect the SCR from transients (cf. Part III, article), and should have the same PIV rating. 100PIV would be best in this circuit, but 50V would probably work if the transformer voltage is not over 25V RMS, and if C_2 and C_3 have suitable values. For a 3 Amp output, 1-1/2 Amp diodes could be used, of the type not requiring heat sink. For greater than 3Amp output, Stud type diodes must be used, requiring heat sinks. The use of reverse-polarity types for D_4 and D_6 would reduce the number of heat sinks required from 3 to 2. Or, mica washers could be used with one (suitably large) heat sink, though this is not recommended for loads drawing the maximum rated diode currents. If more than about 5 Amps are required, a larger SCR would have to be used, or more than one 4.7A unit (to be discussed in this series).

Theoretically the gate is now protected as well as the anode, but D_1 is retained, because of the danger of prohibitive gate voltage (viz. over 0.25V) when anode is neg. owing to the possibility of excessive leakage through D_4-D_7 on the reverse cycle. As an added advantage, output control can now be maintained over a larger output current range than previously, because both input cycles are controlled. These advantages override the relatively minor problem of the necessity for output transient suppression when working into an inductive load. As we described in Part IV, this can be most effectively accomplished by D_3 and D_8, which can be rated at 50-100V (silicon, not germanium) in this instance. D_8 protects the SCR from output commutating transients, and D_3 eliminates 'hunting' in motor loads. We have examined this circuit on a high speed oscilloscope, and find that D_8 is appreciably more effective than C_4 for suppressing load transients, and that D_3 is more effective than 'L' (Fig. 1, previously). The diodes are also smaller than their reactive equivalents. Both D_3 and D_8 could be replaced by a single 30-45V Zener in place of D_3. HT Zeners are now available in Australia; Mullard/Philips OAZ and BZZ series go up to 26V, and may be used in series. Electronics Associates have Zeners up to 1000V.

If the supply is to be used only for non-inductive loads, the output diodes can be omitted. But, if they are included, it can always be used as a general power supply, without wondering whether you did protect it for all types of loads. If it is used as a general power supply, it is wise to state clearly on the front panel what are its voltage, current, and load-type limitations.

For application to HT, the PIV rating of diodes and condensers would be increased in proportion, as well as the value of R_6. Note, however, that for HT, R_6 will have to be rated at 5-10 watts. Since Fig. 5 is a derivative of Fig. 1, no equalising resistances (R_2,R_3) are necessary, for reasons discussed previously. The PIV of the SCR in this circuit should be at least 20 percent greater than the nominal peak voltage of the transformer secondary, and greater than this if mains voltage varies appreciably in your locality. The penality for inadequate voltage rating of the SCR, however, is merely prefiring; it is very robust in the forward direction, and is protected in the reverse.

If the SCR will always feed only a resistance load, the 0.2 ohm anode resistor may be omitted, as may D_8 and D_3 or C_4. If, on the other hand, if the load is capacitative (eg. for filtering d.c.), the minimum value of the surge resistor (0.2 ohm in Fig. 5) should be increased according to the formula:

$$R_{surge} = \frac{\hat{E}_s}{I_{surge}} - R_s - R_p(E_s/E_p)^2$$

where $\hat{E}_s$ = peak value of the secondary voltage (=1.4 x RMS), I_{surge} = 50 Amps for a 4.7A SCR, R_s = d.c. resistance of secondary winding, R_p = ditto for primary, E_s = RMS voltage

of secondary, E_p = RMS voltage of primary. If it is not practical to determine all parameters, an approximate value may be obtained from : $R_{surge} \doteq E_s/35$. Note, however, that a larger value of R_{surge} is kinder to the SCR, but worsens voltage regulation. If the latter characteristic is not primarily important, it is not undesirable to make the surge resistor larger (but not smaller) than shown. This is particularly important when running the SCR directly from the mains, because their impedance is very low (assume $R_p = 0$, $R_s = 3$ ohms).

One caution is necessary. It is imperative that only silicon diodes be used for all of the diodes in the circuits shown in this series of articles on SCRs. The design of the circuits depends on this, and suitable transient protection will not be obtained with germanium or selenium metal rectifiers.

Some technical references to material discussing SCR applications were given in Part III of this series, and eventually we shall publish a whole page of them. The best American ones can be obtained from the General Electric Co., and the local ones from Mullard, Philips, and the Library or Bookshop.

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DID YOU KNOW ???????? by R. L. Gunther

In reference to the discussion on Hydrofluoric Acid in the 'Did You Know?' section of the last issue of the EEB, we might mention that it is also hasardous to use fluoride preparations to etch quartz crystals for frequency changing. Unless you are competent to use the most meticulous possible techniques of chemical manipulation, it is safer (though more difficult) to grind crystals mechanically with the appropriate abrasive powder. If you do grind them, however, ensure that the surfaces are washed clean (and dried) before reassembling into the crystal holder for the frequency measurement.

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A D V E R T I S E M E N T S

FROM THE ELECTRONICS ASSOCIATES, 76 View St., Hobart, Tasmania.

We continue to expand. In accord with our desire to bring you more types of components (even though we are doing all right with diodes), we are buying bits and pieces from the U.S. and British surplus markets, hoping to find some good bargains. Most of it is junk, alas, and some lessons have been expensive. We have, however, found some good items as follows :

1) Silicon Controlled Rectifiers. 4.7Amps, 50V to 700V. 18/6 to 70/-.
2) Varicap Diodes. 47pf at 0V, 12pf at -4V, PIV= 50V. £1 per pair (misprint in last advertisement). Lovely for sweep generators, FM, automatic control, frequency doubling, remote control. Control frequency with a potentiometer !
3) Zener Diodes. 5.25V, 6.4V, 9.4V at 2.25W (18/6), other ratings up to 1000V.
4) High Power Transistors. Finally. 2N174 : 150W, 80V, 15A, β=80 (1Amp), F_α=10kc/s. Excellent for transistorised ignitions (we have the Zeners and diodes too): 39/-. 2N174B : Same, but 90V rating (BV_{ces}): 41/-. 2N236B: 25W, 60V, 5A, 16/6. Others coming; we'll sell them if they are good.

These are available under the same conditions as for our diodes: tested thoroughly, guaranteed to conform to specifications, sales tax paid, and post and exchange free. We have obtained a relatively small quantity of each item. If they sell, we shall obtain more. If they don't we won't. Very simple. S.A.E. for Diode Catalogue, and our usual Technical Information Sheets. Pls say that you saw this advert in the EEB.

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SELL.. 50 watt (EL34) Hi-fi power amplifier (i.e. would need preamp). Real bargain £20. Collaro mono tape deck with Nova amp. Excellent deck but some motor noise. £30. Power supply for same (280v. at 100 ma. - 6. 3 2A) £3. 10. 0. Grundig TKI transistor tape recorders. Two. One needs mic. repair. Both good order. £25 , the pair. Altec-Lansing 12" biflex speaker. Fabulous performer, new- £25. 0. 0. Home Constructors... Presently making Radiotronics 75 watt transistor stereo amplifier, and preamp. to suit; I would welcome enquiries from others interested in doing likewi se.
Murray - 55 Harcourt Str., Hawthorn, VIC. 82 6157.

TAPE RECORDER OWNERS !

Have you thought of joining an organisation designed for the pleasure of such an interest ? The EEB is your introduction to the Australian Tape Recording Society, a non-profit making organisation operated from N.S.W. A.T.R.S. now has members in five states and will soon offer a library of 'ATRS' and commercial 'Pre Recorded Tapes', and at present offers a 20p.c. discount on 'Scotch' brand tape, 40p.c. discount on 'Triton' brand recording tape and up to 50p.c. discount on tape recording supplies, a 'Purchase/Repair Advisory Service', monthly membership news and listing, and exclusive ' Newstapes' regularly. Write now to the... 'Hon.Secretary, Australian Tape Recording Society, Box 9, P.O., Crow's Nest, New South Wales'.. for details and membership applications.

NEED ANY DUPLICATING ? The Colour Duplicating Service provides a service to all organisations at reasonable rates for seven-colour duplication. Our approximate prices are based on 5/- initial cost and 1/2 or 1d per copy (depending on the size of paper). Detailed Price Lists are obtainable from the Director at.. 'Colour Duplicating Service', Box 9, P.O., Crow's Nest, New South Wales. '[illegible].S.' is a subsidiary to the Australian Tape Recording Society.

FOR SALE.. Long Playing Records, slightly shop-soiled condition. Jazz-modern and traditional; Clasical, popular etc. Many hundreds to select from. Ten inch 6/- ea. or six for 25/-. Twelve inch 8/- to 15/- each. All post free. A large number of second-hand records are also available. Send for lists to R. Meincke, Box 77, P.O., North Essendon, VICTORIA.

TRANSISTOR IGNITION.. Complete-ready to install- including Ro-Fo coil. Fitting instructions supplied. Unit uses 100V-15Amp transistor. Beautifully built in aluminium box. Price-12V-Negative earth £18/-/-. 12V-Positive earth- £18/10/-. Post free anywhere. Descriptive literature free on request. MEECO, Smith Str., Naracoorte, S.A.

WANTED 'Minicam' Battery pack 'M' or 'D' for minicam electronic ringflash, or information regarding conversion of other lightweight battery power packs for use with Ringflash. C.Pallaghy, 24 Beddome Str., Sandy Bay, TAS.

WANTED.. Aboriginal handcraft pieces, for souveniers. R.L. GUNTHER, 76 View Str., Hobart.

WANTED.. Electronic photoflash tube(s) or units. Tube must be in workable condition. Tony Ohsberg, 92 Cascade Rd., South Hobart, TAS.

EQUIPMENT EXCHANGE BULLETIN

March 20, 1965 Issued twice monthly Vo. 1, No. 6

SUBSCRIPTION. 3/- for 24 issues, sent to all Australian subscribers by Air Mail on the fifth and twentieth of each month. Foreign goes by Sea Mail.

ARTICLES ARE SOLICITED for the EEB. We prefer articles on electronics subjects, but any good hobby treatment will be considered. Copyright is that of the author. Although each article has been carefully prepared, we can accept no responsibility for errors. Opinions expressed in 'Letters' and other contributions are those of the author.

ADVERTISING. First 20 words, 2d each. Words thereafter, 1d each. Call sign or name free. For advertisements appearing more than once, 10 percent may be deducted from the total cost. Special rates are available for half pages. Underlining is 1d per word, borderlines 3d each, and large lettering 2d per letter. All advertisements must be prepaid. Please write clearly or type. Receipts issued on request only. Deadlines for articles or advertisements are the first and fifteenth of each month.

Send to : E.E.B., P.O. Box 177, Sandy Bay, Tasmania, Australia.

CONTENT.

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CORRECTIONS to Vcl. 1 No. 5: In Fig. 5, the potentiometer should be labelled 'R_1' and has a value of 1K. The resistor above it (in series with it) is R_6, and is 3.3K for the voltages shown. Sorry about that.

BACK ISSUES are available, for 5d each, or large brown stamped self-addressed envelope.

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THE PROBLEM OF HT DIODES.

-- by C. K. Pallaghy

The only difficulty in using HT diodes to protect SCR circuits, is the fact that HT diodes are either rare or expensive when rated for high currents. Admittedly they are cheaper than SCRs, but it is still money. The fact is that one does not need to use protective diodes if SCR PIV safety factor is sufficient, and if reasonably effective capacitative transient suppression is used. On the other hand, even one series diode will protect an SCR, and adequate voltage and/or current ratings can be built up by using diodes in series or parallel. Four diodes in a bridge will allow better transformer efficiency and higher output ripple frequency (cf. EEB, SCRs, Part V), but are not necessary if neither of these characteristics are required. For simple motor control, a half wave circuit is quite effective, particularly when operating directly from the mains.

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DID YOU KNOW????????

-- by R. L. Gunther

DANGER ! 250V 50cps is lethal. 330V d.c. isn't much better. If you take a.c. power directly from the mains, do so with only one wire from the 'active' pole. Run the other wire to a pole you know to be earth or 'neutral'. Then there will be no problem of accidental polarity. NEVER rely on the polarity of mains sockets. Sometimes they are wired backwards, alas, and you never know whether they can be trusted. The obvious answer is not to trust them.

Use pilot lamps on diode power supplies, to ensure that you know when they are on. Neon lamps are more reliable than incandescent ones. On equipment open to the public (including children), door interlocks and key switches should be considered. Use a bleeder resistance to discharge power supply filter condensers (and to improve load regulation), but never depend on it. Alwaysshort filter condensers with wire or screwdriver before working on the supply-- even though you might not receive a dangerous shock, your involuntary reaction could sweep delicate equipment off of the bench, ruining hours of your work. A friend once got a jolt from a TV set, and with that one hand THREW the set across to the other side of the room!

When you work on power circuits, turn the power OFF. Never rely on an SCR to turn off the power, for various reasons, not the least of which is that a transient might turn on the SCR, and turn you off. And of course, always work on potentially live circuits with one hand behind your back or in your pocket. If you think that that makes you look silly, think how much sillier you will look flat on your face.... Unplug the mains plug; mains socket switches have been known to be wired into the 'neutral side'. It is enough to make a man cynical.

If a transistorised circuit works from a mains-connected power source, unplug the power supply from the mains before applying soldering iron to the set. Don't learn this the hard way. Transistors can be expensive.

The G.E. SCR Hobby Manual (P. 17) says " Even a 6V automobile battery can be dangerous since it can supply enough current to burn up a ring or watch band, and the skin underneath it... Be sure your circuits are insulated, and watch (out for) the usually electrically hot heatsinks."

Do not think that LT can be 'perfectly safe', even for ordinary skin contact. We know of one instance in which an experimenter was electrocuted by a 1.5V battery! The current flowed through his heart via punctures in his skin. It requires only a few milliamperes to damage the heart. Do not depend on the normally high resistance of dry skin to protect you.

By the way, teach the family the techniques of artificial respiration. Lest you think that this is morbidly dwelling, it could save your life, as it has for other electronics experimenters. Electric shock usually doesn't kill you immediately, and the precious time spent by the wife running about looking for Help could be spent in saving your life.

ADVERTISING

FOR SALE.. Long Playing Records, slightly shop-soiled condition. Jazz - modern and traditional; Classical, popular etc. Many hundreds to select from. Ten inch 6/- each or six for 25/-. Twelve inch 8/- to 15/- each. All post free. Alarge number of second-hand records are also available. Send for lists to R. Meincke, Box 77, P.O. Nth. Essendon, VIC.

WANTED.. Command receiver, 3 - 6 Mc/s or 6 - 9.1 Mc/s. Peter Dann, 8 Canterbury Rd., Camberwell, VIC. 82.6714

WANTED.. Modulation Transformer; 100 watt rating with multiple impedance tappings. VK5ZFA Chris Skeer, Hatherleigh, via Millicent, S.A.

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The Hon.Secretary,
Australian Tape Recording Society,
Box 9, P.O.,
Crow's Nest,
New South Wales.

Dear Sir,

Please send, at your earliest convenience, full details regarding your organisation at no obligation to myself.

I own/will be purchasing, a " " tape recorder.

Yours faithfully,

(Signature).....

(PRINT NAME).....

(EEB)

-----cut here-----

MAIL THE ABOVE COUPON NOW FOR DETAILS OF THE AUSTRALIAN TAPE RECORDING SOCIETY.

AT THE MOMENT, A.T.R.S. OFFERS 20% DISCOUNT ON "SCOTCH" BRAND AND 40% DISCOUNT ON "TRITON" BRAND MAGNETIC RECORDING TAPE. ALSO UP TO 50% DISCOUNT ON ALL HOUSEHOLD GOODS, INCLUDING TAPE RECORDERS AND CAMERAS. At the moment, this is only available to N.S.W., A.C.T. and Queensland members. NUMEROUS OTHER SERVICES ARE ALSO AVAILABLE TO MEMBERS. SEND THE COUPON N O W!

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FOR SALE.. Marconi CR100 RX. 6 bands. VAR. SEL. PROD. DET MIN. TUBES etc. £40 BC. 312 RX with XTAL FILTER £20 or exchange for TRIBAND BEAM. Phone 47.1o73 M. Marschall, 2 Parker Str., Preston, VIC.

WANTED Aboriginal handcraft pieces, for souveniers. R.L. Gunther, 76 View Str., Sandy Bay, TAS.

FROM THE ELECTRONICS ASSOCIATES. 76 View Street, Hobart, Tasmania.

== On Making New Stock: After having been bothered by Customers about stocking other items than silicon diodes, we decided to try transistors and other components, as described in the last issue of the EEB. If we had any doubts about the effectiveness of the advertising in these pages, it is now dispelled. In the past fortnight we have sold out our small trial stock of 2N236B transistors, and a dent has been made in the stock of 2N174 transistors, with one firm asking anxiously whether we were prepared to sell the entire stock remaining. This is worrisome, because it means quite definitely that we shall have to put in a reasonable sized stock of transistors, and that means

ADVERTISING (continued)

going through all of the problems we encountered with diodes: the most reliable supply, the lowest prices, and the most efficient methods of testing. Now, you may well ask 'so what are they complaining about? They are making money'. Well, not entirely so. We do this as a hobby, and it is not a simple one; as for money, most of that has gone back into new stock. We are bemused by this consideration: if a business is successful, it is expanding, and if it is expanding, one must constantly reinvest profits into it. No doubt this means that we won't see much of that money until we get out of the business. Oh well.

Our initial activities with transistors will involve high power units, because these are not always readily available here at a good price. In addition to the 2N174, for which we are ordering more stock, we have already ordered 2N1038 and 2N1040 transistors, which ought to handle several Amperes at 40V and 80V respectively, though exact figures will have to await meticulous testing when the transistors arrive. We also hope to obtain some 2N1046, which are rated to handle 12Amps at 100V, up to ten megacycles! We shall, however, believe that when we see it. They ought to sell very inexpensively indeed, and we hope you will like them, even if they only work to 5mc/s. Then, there will be some VHF transistors, to perhaps 150mc/s or more, some general purpose NPN transistors-- which can be very useful when combined with PNP in various complementary symmetry configurations. And perhaps we shall play a bit with 'sun battery' photocells, and inexpensive 50μA meters. Watch the pages of the EEB for announcements about these items, particularly in view of the fact that we are not likely to advertise many of them in the national journals until we have a good stock of any given item. We have, however, made arrangements for mentioning the 2N174 in the April adverts, so we had better put in a larger stock of them!

== <u>On Selling HT Diodes</u>: Normally our HT high current diodes are obtained by culling from the lower rated units. The big surplus dealers don't have time to be careful, so we benefit, and so do you. We could not afford to buy the HT high current diodes at the usual price, and experience shows that you wouldn't buy them. A new situation, however, has arisen. After the SCR articles were published in the EEB we received several requests for HT 3 Amp diodes. Our supply was quickly exhausted, which only shows that we have more technical enthusiasm than business sense. We are embarrassed, but the only thing that we can do is to offer to buy the higher priced HT diodes for you if you want them, and reduce our profit margin to suit. We are, therefore, prepared to order the following diodes for you, if so requested:

400PIV/3A = 8/-, 500PIV/3A = 10/-, 600PIV/3A = 12/-, 400PIV/10A = 30/-, 500PIV/10A = 34/-, 600PIV/10A = 38/-. PIV should have the usual safety factor, but Amps are 'working'.

We shall wait a month until all special orders are received, and then send for the diodes by air, and they ought to be available about three weeks subsequently. If you are impatient, you can pay about 10 percent more for the privilege of rapid delivery..... It would all be much easier for us if you built LT SCR circuits, for trains, small motors, battery chargers, etc! We hope that many circuits for same will be published in the EEB in the near future.... By the way, a few people have mentioned to some of use that it is a pretty smooth idea to write articles for the EEB, to sell more SCRs, etc. We do disagree. Those of us who prepare those articles put a tremendous amount of work into them, including not a little original laboratory research. We do it, because we enjoy it; there are a lot easier ways to make money!

== <u>On Selling Old Stock</u>: In May we shall be placing the following advertisement in the national magazines, and you might as well get first choice: 50PIV/1.5A = 3/3 ea., 50PIV/35A = 26/- ea., 200PIV/10A = 15/- ea., 200PIV/20A = 20/6 ea., VHF Point Contact (germanium) diodes = 2/6 each. The other items will be listed as per our regular Catalogue. We shall be advertising our inexpensive 50μA meters, and we hope that our shipment of same arrives before then.... Our Catalogue plus Technical notes are available, of course, in exchange for a largish S.A.E. Please put 'EEB' on it in the lower left hand corner. Thank you.

TAPE RECORDING IN GENERAL

by David James

In this modern age, about forty percent of Australians either own, or have operated a tape recorder. Thirty nine percent of these persons enjoy recording, and maintain it as either their main hobby or just another "pastime". The other one percent just couldn't care less !

For a person buying a tape - recorder, there are many aspects to be considered, and ask yourself these questions:- "What do I want the tape-recorder for ?", "How much am I prepared to spend ?", "Will I go into the expense of Stereo?" "Am I likely to make tape recording my major interest ?", and many, many others. The above, and other questions will be answered in future editions of the EEB. Other items featured will be: the type of machine to buy, the money to spend, the brand of tape to use, the type (and quality) of microphone to use, recording indoors and outdoors, unusual sounds, sound - effects, mixing, dubbing, cine and tape syncronisation, slide and tape syncronisation, tape recorders in industry,, faults in tape recorders (...and repairing them), etc. etc.

Tapes and tape recorders are linked with hundreds of modern-day machines. Computers use magnetic tapes on which to store information for data processing machines. The spools used on these machines are quite large and travel at hundreds of inches per second.

There are quite a number of tape-recorders at present on the Australian market; and to mention just a few (if I may); "Philips"; "Grundig"; "Akai"; "Sony"; "National"; "Telefunken" "AWA - Robuk"; "Elizabethan"; "Ferguson"; "Collaro"; "Tandberg" "Brenell"; "Uher"; "Ampex"; "Revox"; "Audivox"; "Pye"; "Truvox"; "Optacord"; "Fi-Cord"; "Vortexion"; "Classic" and "Ferrograph". If your recorder wasn't mentioned---I'm sorry !

Prices range from £10 to £500 and include from a small battery portable to a full stereophonic, waist-high machine.

The most common tape-brands are: "Philips"; "Scotch"; "B.A.S.F."; "R.C.A."; "EMItape"; and "Agfa".

In future issues, I will describe the best methods to obtain satisfaction from your machine, or if just buying one, the brand and type to buy to suit your requirements.

If you now know nothing about tape recorders, tape recording or tapes, please don't take the "plunge" before the next issue of the"EQUIPMENT EXCHANGE BULLETIN".

EQUIPMENT EXCHANGE BULLETIN

April 5th, 1965

Issued monthly

Vol. 1, No. 7

SUBSCRIPTION. 3/- per year, sent to all Australian subscribers by Air Mail on the fifth and twentieth of each month. Foreign goes by sea mail.

ARTICLES are solicited for the EEB. We prefer articles on electronics subjects, but any good hobby treatment will be considered. Copyright is that of the author. Although each article has been carefully prepared, we can accept no responsibility for errors. Opinions expressed in 'Letters' and other contributions are those of the author.

ADVERTISING. First 20 words, 2d each. Words thereafter, 1d each. Special rates are available for half pages. Call sign or name free. For advertisements appearing more than once, 10 percent may be deducted from the total cost. Underlining is 1d per word (except for the usual capitalised heading), borderlines 3d each, and large lettering 2d per letter. All advertisements must be prepaid. Please write clearly or type. Receipts issued on request only. Deadline for articles or advertisements is the first of each month. Send to : E.E.B., P.O. Box 177, Sandy Bay, Tasmania, Australia

BACK ISSUES are available at 5d each, while they last. Subscriptions start with current issue, and all others must be considered as back issues.

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CONTENT.

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Editorial. Much work goes into producing this publication twice a month. We do enjoy it, but it also costs money. When we started the EEB, our idea was to provide an advertisement sheet that appeared often and regularly, informally produced, and with a circulation sufficient to ensure advertisement results. The EEB has, however, developed into a technical publication in its own right. It is also evident that the Australian advertisement market is not nearly as productive as the American one (where advertisement sheets succeed). It appears that a vast subscriber roster will be required for modest advertisement activity here. The low price of advertisements in the EEB is not discouraging anyone, and we know that the advertisements in the EEB have had a good response. The difficulty seems merely to be that we do not buy or sell things very often.

We cannot continue to depend on the principal support of our present two main advertisers ; we can only operate successfully if we receive many advertisements for each issue from individuals. With our present activity, and with our present circulation this means that we must change to a monthly publishing schedule. We appreciate the response you have made to our appeals, but that cannot continue indefinitely. With a monthly publication, we shall no longer have the same advantage of frequent appearance, but we shall retain the advantage that the (still inexpensive) advertisements or the articles can be accepted until 5 days before issue. This makes matters frantic for us, but reduces long waiting periods for you. Another benefit of a monthly schedule will be to present more material in each issue, and we can therefore reduce serialisation.

EQUIPMENT EXCHANGE BULLETIN

5th. April, 1965.

Please remember..... The EEB will appear once monthly henceforth.

Editorial (continued).

We can say this : When we get a circulation large enough to produce a favourable financial basis, we shall either return to a fortnightly schedule, or will be able to pay some money for articles. We shall, however, cross that bridge when we arrive at it.

In forthcoming issues we have planned or have prepared articles on the following subjects --

SCR phase shift power control
The design of high current power supplies
Surge resistor design considerations
More about transient suppression
Half wave vs. full wave
Semiconductor bibliography
Voltage current relationships in rectifiers
SCR with a.c. output
Tape Recording
Transistor circuit design
Linearising non-linearities
Applications of zener diodes
All about heat sinks
A novel emergency power source
The use of constant current diodes
Model Railroad control and power
A special d.c./d.c. converter
Variable transformer control.
Diode testing-- plain and fancy
Meter protection
SCR battery charger
VHF transistor applications
Applications of Varicaps
The use of Zeners in heater voltage stabilisation (are you interested in the mathematical work we did for this?)
Unusual applications of silicon diodes (please let us have any special ideas you might have on this subject. We might have overlooked them).

If this list appears to lean heavily on semiconductors and power supply, that happens to be our interest. If you have an article you want to present on any technical subject, from workshop hints to laser technology, please send it to us in any state of literary elegance, and we can add to the above list. We can't pay you anything at present, but we could probably provide advertisement space.

The subscription rate will remain at 3/- per year. Present subscribers will receive the full remainder of their 24 issues. The new arrangement becomes effective on April 31st -- oops, April 30th, but new (not renewal) subscriptions received before that date will still receive 24 issues (viz, two years) for their 3 shillings. Tell your friends..... but not too many !

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'LETTER TO THE EDITOR'

Sir,

An article was published in an overseas journal recently, describing how a simple power supply could be built around the BY100. I wrote, objecting that the BY100 is a lovely diode, but it does seem inappropriate to use it for an application where a 50V diode (eg. OA605) would suffice.

A reply was received relating that the author of the article believed that the extra safety factor obtained with the BY100 was worth the few extra shillings of its cost.

I suppose that that is true on the face of it, but the BY100 has a transient peak PIV of about 1200V, and my tidy soul rebels at the idea of using a 2400pc safety factor. Thus :

1) For someone who does not realise the factors involved, it can result in additional expense, and this choice ought to be the perogative of the constructor, not the author.

2) The use of unnecessarily large safety factors is sloppy engineering, and it can also lead to hazardous ambiguities.

Consider a filament winding, rectified by a half wave diode followed by filter condenser, or two diodes in a voltage doubler. In either instance each diode sees twice the peak voltage of the supply when the diode is back biased. For a 12V (RMS) winding, this value is abo ut 34V. What should be the PIV rating of the diode? Neglecting 'crest working' and similar considerations, let us just consider the absolute maximum PIV rating for transient overvoltages (which can occur from a variety of causes).

The RCA Transistor Manual specifies that if a rectifier circuit is capacitatively protected against transients, a maximum-PIV safety factor of 1-1/2 to 2-fold ought to be employed, and if no suppression were installed, the safety factor ought to be 4- or 5-fold over the nominal reverse peak voltage appearing across the diode. Therefore the diode PIV rating in the above example ought to be 50V if transients are suppressed, and perhaps 200V if they aren't. I know this rule works, at least for the capacitatively protected circuit, and have built several power supplies designed around a 1-1/2 safety factor, with reliable results under a variety of conditions.

If no transient suppression is included in a rectifier circuit, how much safety factor is the unwary constructor to assume, providing that he has not seen the RCA publication, or equivalent? 500pc, 10000pc?? Would an OA91 (PIV max = 115V) he has found in his parts bin suffice? The question will be decided by his knowledge, prudence, and financial affluence. If he uses capacitative suppression (even though it did not appear in the original article), it will work (with load limited to 50mA, resistive). If he doesn't, the diode will most likely short, placing the electrolytic (and the load) directly across the transformer. This is not suitable treatment for either component.

If an indeterminate safety factor is assumed, and if it is potentially inadequate, it might take some time for sufficiently large transient to appear. You can be certain that this will occur when a W1 calls CQ on 2 metres, or when you are showing the Boss your HIFI.

If an adequate safety factor is assumed, and it is excess, it can be wasteful and expensive, particularly if several components are involved. 304TH valves are obtainable in Australia for less than £2, but would you use one of these 300 watt plate dissipation valves in place of a 6A3 or 6AS7? It is 'safer', but one doesn't use the large bottle. It is unnecessary.

This problem can become acute at HT. Given an 800V c.t. secondary (RMS) winding, how many BY100s do you use in a bridge rectifier circuit? If you want to be really 'safe' use 5 in each leg, particularly if money is no object. 1120 nominal peak volts appear across each leg, plus transients... The prudent constructor, however, simply places a 0.02µF condenser across the primary of the transformer (or more elaborate networks. See EEB, Vol.1 No. 3) and uses a 50PIV OA605 (or equivalent) on the 12V circuit, and two 1200V BY100s in each leg of the 800V circuit mentioned above. He knows that his circuit will be reliable, and he has followed good design procedure -- and incidentally he has saved money.

If, on the other hand, you want to stock your parts box exclusively with 400V or 1200V diodes which can be used on LT circuits without fussing about with details, that's lovely, but know what you are doing, and why.

Yours faithfully,
(s) R. L. Gunther
Hobart, Tasmania

PSEUDO- TUNNEL DIODES. -- by Tony Ohsberg.

In the course of testing a large number of diodes, several were found with the peculiar reverse characteristic shown in Fig. 1. Obviously these devices exhibit a negative resistance in the region AB. This is the result of temperature breakdown of the PN junction. This, together with the shape of the characteristic, distinguish it from the usual Esaki tunnel diodes, which obtain a negative resistance from the tunnelling of electrons through the junction. Another important difference is the fact that the former has a high impedance (high voltage, extremely low current) while the latter is a low impedance device.

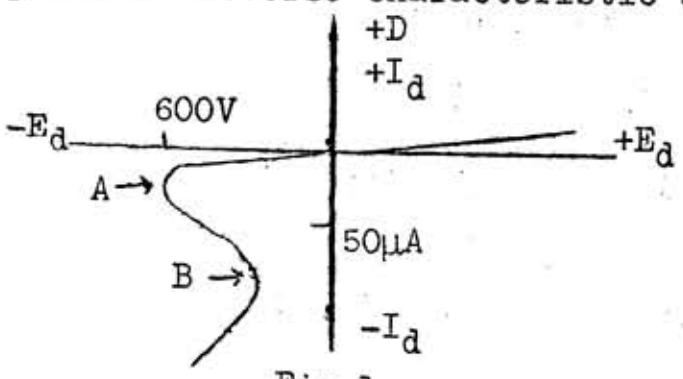

Fig.1

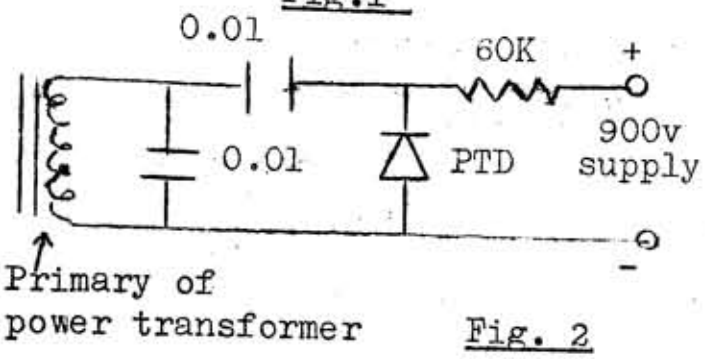

Fig. 2

Several laboratory applications have been investigated. The first was a simple oscillator with a frequency of approximately 51 kc (the upper frequency limit due to the capacitance of the junction) according to the circuit in Fig. 2. The resistance of the tuned circuit is effectively paralleled with the negative resistance of the diode. This results in an infinite resistance (or a + or - resistance if the values of both resistances are unequal...), giving the circuit the properties of the elusive 'ideal' tuned circuit. When the current is applied, oscillations build up in the circuit instead of dying away as they would with only positive resistance in the circuit.

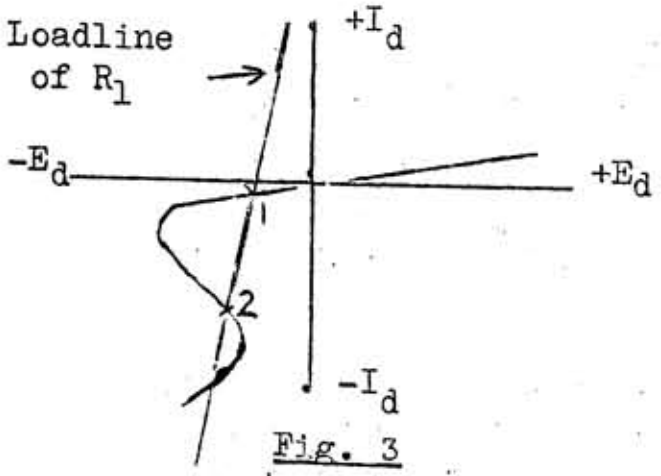

Fig. 3

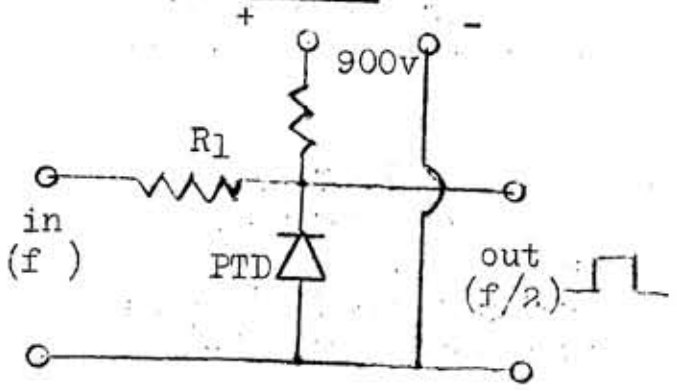

Fig. 4

The second application was a bistable flip-flop, using the fact that these devices have two stable operating points on the one resistive load line (cf. Fig. 3). The device is switched alternately between these two points by the application of a voltage 'input' pulse through R_1 (Fig. 4), and acts as a frequency divider, but delivers no power (viz., must drive a high impedance). Maximum input frequency is about 20kc, using a Top Hat Pseudo- Tunnel Diode. A Stud type PTD was available, but was not used; Studs are typically much higher capacitance devices (across the junction), and would therefore likely be limited to a maximum usable frequency of some hundreds of cps.

Points A and B (Fig. 1) change in voltage (increase) with temperature, though stable operation was observed in the circuits of Figs. 2 and 4. This requires, of course, that the operating power be very low. If forward current is passed through a Pseudo-Tunnel Diode, the temperature instability phenomenon often disappears, and the diode reverts to the conventional type. Therefore it is evident that for successful operation of a PTD, one must avoid excess reverse currents, and avoid forward currents altogether. The former requirement is easily met by suitable series limiting resistance, and the latter by the use of d.c. power of the correct polarity.

A PTD phenomenon was also observed (but not investigated) in the reverse characteristic of a Silicon Controlled Rectifier, with gate shorted to cathode.

TAPE RECORDING Pt II

Tape Recording in general.....by David James

The first thing to do when purchasing a tape recorder is to decide exactly what you want it for and how much your pocket can afford. If you intend to "go in" for high-fidelity, it would be useless buying a small dicatation machine. Alternatively, if you wished a dictation recorder in your office, it would be useless buying £300 worth of stereophonic recorder. You may determine the price-brackets as follows:- Under £20; £20 to £50; £50 to £100; £100 to £150; and £150 and over.

In the "Under £20" class you would find lower quality battery-operated portable recorders. Tapes recorded on these will not play back on any mains-operated recorder. These machines are quite useful for people just wishing to record his/her friend's voices, play them back and put the recorder in a cupboard for a few weeks. The smaller and cheaper the recorder, the more battery power it will use. These recorders generally use small torch, "penlite" and/or 9volt transistor batteries. Power consumption of these recorders rates between 10 and 20 volts.

Most of the larger recorders with mains operated driving and amplifing systems incorporate accessories such as tone-control, input(s) for radio, pick-up and perhaps an extra microphone, output(s) for headphones, extension loud-speaker, auxiliary amplifier etc. Some machines even incorporate a built-in electronic mixer which enables the operator to feed both speech and music from two or more sound sources and blend them to desired volumes or dfade in or fade out as required.

There are hundreds of domestic and industrial tape recorders on the Australian market, ranging from the battery portable to the stereophonic machine. It would be wise to consult your local dealer regarding your recording requirements or write to the author at the address in the advertisement on the reverse side of this page.

Monaural recorders would be the better to commence with due to their simplicity in operation, lower cost and simple design. A reasonable mono recorder would cost between £30 and £60 and would feature numerous accessories. The most essential with a mains-operated recorder is a recording level indicator, (i.e. "magic-eye" or VU meter), microphone input, safety record system and a simple cooling system (i.e. motor-driven fan).

Advanced monaural machines would cost between £60 and £140 with a luxury model or two at over this amount. These recorders include more than the recordist could wish for:- Tape counter, selection of speeds, selection of tracks, fast forward/rewind, mixing facilities, echo effects, copying from track-to-track, listening to one track whilst recording on the other - with or without transferring signals, "superimpose" facilities, remote control, automatic stop, automatic start, larger frequency response, pause button, Public address system etc. etc. The most common speeds are one and seven eighths ($1\frac{7}{8}$), three and three quarter ($3\frac{3}{4}$) and seven and a half ($7\frac{1}{2}$) inches per second. Others are 15/16, 15, 30 inches per second.

CONTINUED NEXT EDITION--------

ELECTRIC TRAINS.

We are preparing a short article on the requirements and peculiarities of model electric train power supply. If you have any ideas on this subject, please let us know about them, and whether we can use your name in the Article. None of us play with these devices, but we have seen various communications from those who have, and there is much that can be said on the subject. What happens when the tracks are shorted (as often happens)? This could be catastrophic for rectifier diodes. Would the answer be to use a higher supply voltage, with an extra series resistor to bring the output back to normal? But this worsens output voltage regulation, and would tend to slow the train on hills. On the other hand, this is the way that real trains behave, and perhaps it is not undesirable in a model?

PEAK CURRENTS. -- by R. L. Gunther

Recently I read that selenium rectifiers are still used in certain battery chargers, because garage men like to short the output of the charger to see whether it is on, or is working properly. If you do this without adequate current limiting resistance in series with silicon rectifier diodes, output will drop to zero, and will stay there. Garage-men please note.... Selenium metal rectifiers are definitely more resistant to overloads of peak currents and reverse voltage, than are silicon diodes, and if you have plenty of room, there is no reason why you should not use them. I look ruefully at a box full of gigantic selenium rectifier units in my junk box, each of which is rated for two whole amperes (at 18 volts). What to do with them now? I suppose that I shall make a battery charger with one of them. Does anyone have any other ideas?

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ADVERTISING

FROM THE ELECTRONICS ASSOCIATES. 76 View St., Hobart, Tasmania

You may have noticed some delay in receiving semiconductors ordered from us. We are truly embarrassed about this. It arises from the fact that we are building an elaborate new tester for semiconductors, to meet our expanded needs, and to incorporate several ideas we have been considering for a long time. The old tester has been crippled while the reconstruction was progressing, and the construction had to occur in 'spare' time, of which there isn't much at present. The project has taken about a month, and is nearly complete. The problems we have run across could fill many pages of technical articles in the EEB, and we even succeeded in destroying 14 HT diodes at one time. That hurt.

In any event, please do realise that since we are not set up as a regular 'business', you may occasionally have to encounter delay. Ordinarily, however, we shall do our utmost to avoid it.

In reference to transistors, we have again verified the fact of our having a poor sense of business timing. We cautiously offered HT power transistors for sale, when we (finally) found some reliable ones. The response was overwhelming. We now have back orders. Normally we should order diodes by air, to fill this type of demand, but the big transistors are too heavy for this unless the customer pays extra. Therefore we beg your indulgence in this matter as well, and assure you that more 2N174 transistors are on the way, and ought to be here by the beginning of May.

We had to be rather cautious about transistors, because it is difficult to gauge the market for any kind of semiconductor. We have been offering zener diodes for some time, with meagre results. Therefore we are not replacing most of our zeners. We shall keep some for our own use, because these devices are uniquely valuable for voltage regulation. We are not very concerned about the fact that the Varicaps are not moving rapidly either, because we enjoy playing with them ourselves, and have many ideas for remote control, frequency sweeps, and frequency multipliers which we want to build.

In the next issue we shall discuss 'Do it Yourself', in which we present several cogent arguments in favour of letting us lose money for you.

A.T.R.S.

FOR JUST A FEW POUNDS PER YEAR, YOU CAN JOIN AUSTRALIAS' NEWEST, MOST HELPFUL TAPE RECORDING ORGANISATION. NO LIMIT TO THE TAPE RECORDER YOU OWN.....BE IT A £5 BATTERY PORTABLE OR A £500 STEREOPHONIC BROADCAST MACHINE.

TO BE EXACT, THE FEES OF A. T.R.S. ARE ONLY ONE POUND FIVE SHILLINGS PER YEAR PLUS A ONCE-ONLY JOINING FEE OF ELEVEN SHILLINGS.....THE LOWEST IN AUSTRALIA.

VERY SOON, A.T.R.S. WILL OPEN AN EXCLUSIVE 'PRE-RECORDED TAPE LIBRARY' FROM WHICH MEMBERS MAY HIRE TAPE RECORDINGS, BOTH COMMERCIAL AND HOME OF THE ENTERTAINING, EDUCATIONAL AND INSTRUCTIONAL NATURE. A.T.R.S. ALSO PAYS FOR THE RIGHTS TO ANY RECORDING THAT YOU HAVE AT HOME WHICH IS ORIGINAL, REASONABLE QUALITY, NOT PREVIOUSLY COVERED BY COPYRIGHT AND IS YOUR OWN PERSONAL PROPERTY.

EVERY MONTH MEMBERS RECEIVE A COLOUR-MAGAZINE..."MEMBERSHIP NEWS" AND RECORDED "NEWSTAPES" REGULARLY. STARTING SOON, A.T.R.S. WILL PUBLISH A PRINTED TAPE RECORDER DIRECTORY ENTITLED "TAPE RECORDING NEWS" AND IF PROVED SUCCESSFUL, WILL BE ISSUED QUARTERLY. (You may lodge Classified Advertisements or Tape Exchange Listings now if you wish.....special reduction to those who act now !) THIS MAGAZINE, PRINTED ON GLOSSY PAPER AND SOLD FOR A FEW SHILLINGS, WILL INCLUDE ARTICLES OF INTEREST TO THE RECORDIST, ADVERTISEMENTS, TAPE EXCHANGE LISTINGS, CLASSIFIED ADVERTISEMENTS (Rates available on application) ETC.

IF YOU WOULD LIKE A COPY OF THE APRIL EDITION OF "MEMBERSHIP NEWS", THE MONTHLY PUBLICATION, PLEASE COMPLETE THE COUPON BELOW.

WHEN ENQUIRING ABOUT A.T.R.S., BE SURE TO MENTION THE 'EEB' OR USE THE OTHER COUPON PRINTED BELOW.

"MEMBERSHIP NEWS" COUPON

A.T.R.S. Box 9, P.O., Crow's Nest, New South Wales.

Please send me the APRIL.....edition of the above. Name and address attached.

To Australian Tape Recording Society, Box 9, P.O., Crow's Nest, N.S.W.

Please send mo full details regarding membership in A.T.R.S.

Name _____

Address _____

WANTED .. Two Gruner 9075 relays, February-June 1963 Radio Control Models and Electronics. Reply by mail to R.P. Singe, 29 East Crescent, Hurstville, N.S.W.

WANTED... to buy or borrow Handbook or circuit 3bz transmitter. ARB receiver to control box connecting cable 16 Pin. VK3QJ , V.N. Tuohill, Care Post Office, Lakes Entrance, VIC.

TRANSISTOR IGNITION. Complete ready to install - including Ro-Fo coil. Fitting instructions supplied. Only high quality parts used. All Aluminium construction. Price.. 12 Volt Neg. earth £18/-/- ... 12 Volt Pos. earth £18/10/-. Post free anywhere in Australia. Descriptive literature free on request. MEECO- Smith Str., Naracoorte, S.A.

TRANSISTORS for sale. i) 2N702, NPN, VHF, Diffused mesa silicon. Maximum parameters at 25° C. : 600mW (not 50mW!), 80V, 30mA, β from 14 to 25, $f_{\alpha b}$ 100mc/s, miniature TO-18 hermetically sealed case. For the remarkable price of 12/6 each, first-come first-served. Nine in stock. Please note that these are NPN, and must therefore be connected with polarity reverse to the conventional PNP transistors. This also provides the possibility of simple direct coupling in d.c. amplifiers, and for complementary symmetry configurations.

ii) 3N35, NPN, VHF, Grown-diffused silicon tetrode transistor. 125mW, 50V, 20mA, β 40 and 80, $f_{\alpha b}$ 150mc/s. Only two in stock. 19/6 each. Typical RF amplifier circuit furnished with each order for tetrode transistors.

iii) Transistor sockets, for ordinary low power types. 1/3 each, if ordered with other merchandise; a few dozen in stock, to see whether you like them. We don't like to solder to transistors, do you? It is much neater, safer, and easier to cut the leads short, and plug in the transistor, just as a valve. Improves high frequency response too. These sockets have four pins, and can therefore be used with tetrode or triode transistors, or with diodes.... We have some other transistors which have just arrived, but have not had time to test them yet (working too hard on the diode business). Full details in the next issue of the EEB. We have definitely sent for more 2N174 HT Power Transistors, and will send for some 2N250 (similar AT1138A) soon, and ask you to be patient with us.

A word: you rarely get something-for-nothing in this world. These transistors are 'surplus' either because they are industrial or military seconds or overstock. We test them as thoroughly as practical, but are not in possession of the same test equipment as the manufacturer. The transistors work well according to casual needs, in accordance with the specifications we supply (individually) for them, but if you need the highest quality and best reliability, you would probably be advised to obtain commercial components at the usual prices. There, we've said it! We may not get rich, but we try to be reasonable.

We have some lovely, uncomplicated diodes in stock too, various ratings, highest quality. All of our merchandise is guaranteed, tax paid, and post free. Send a SAE. Electronics Associates, 76-E View Street, Hobart, Tasmania.

WANTED.. Walkie Talkie. These advertisements work. I asked for a walkie-talkie, and received an excellent offer. Unfortunately, however, the post office lost my letter during the Christmas period and the opportunity vanished. I also received several offers of low frequency walkie-talkies. I am grateful to the people who offered these , but I am only interested in the 27mc/s type. I want a pair and they must be inexpensive. They do not have to be in the best working condition, but all the original parts must be there. R.L. Gunther, Physics Dept., Box 252C, G.P.O., Hobart. TAS.

EQUIPMENT EXCHANGE BULLETIN

May 1965 Issued monthly Vol. 1, No.8

SUBSCRIPTION. 3/- per year, sent to all Australian subscribers by Air Mail on the first weekend of each month. Foreign goes by sea mail.

ARTICLES ARE solicited for the EEB. We prefer articles on electronics subjects, but any good hobby treatment will be considered. Copyright is that of the author. Although each article has been carefully prepared, we can accept no responsibility for errors. Opinions expressed in 'Letters' and other contributions are those of the authors.

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BACK ISSUES are available at 5d each, while they last. Subscriptions start with current issue, and all others must be considered as back issues.

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Editorial. For the benefit of those who have not heard it before, and for those who have read our May adverts in the national magazines, we hasten to repeat that we are now on a monthly rather than fortnightly publishing schedule. The technical format and the advertising copy will both benefit, and the volunteers who bring this Bulletin to you can relax somewhat..... We have had several communications from readers who are considering making technical contributions. This pleases us greatly, of course, and we urge those authors not to delay their composition. Don't be reluctant; if copy is imperfect, it can be improved, but if it is put off, it will merely stay in the drawer, benefiting no one.

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CONTENT.

Please say you saw it in the EEB!

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'LETTER TO THE EDITOR'

Sir,

Firstly, may I congratulate you on a wonderful and informative publication. I have had many replies to the advertisements lodged by this organisation, and I felt that it was about time I converted my feelings into words and put the words on paper.

Secondly, I realise your handicap with the former fortnightly publication dates, and my full support goes into the fact that you are converting to monthly publication. I hope that all other readers realise that this publication is operated on a part-time basis. The publishers do not receive the money for their own pockets; it supplies ink, paper,

LETTERS (continued).

postage, research, copy and many other aspects of the publishing business.

It is our duty, as readers and possible advertisers, to publicise this publication to the best of our ability. A little advertising on your part will cost you little, if anything and will guide this magazine to popularity

Take a copy of the EEB to work. Surely some of the 'fellers' would be interested in receiving good technical information as well as the opportunity to lodge cheap advertisements to readers all over Australia.

On this last note, I remain, Yours faithfully,

(s) D. James
Secretary,
Australian Tape Recording Soc.
Crows Nest, N.S.W.

((Believe it or not, we also have readers in New Zealand and in America -- Ed))

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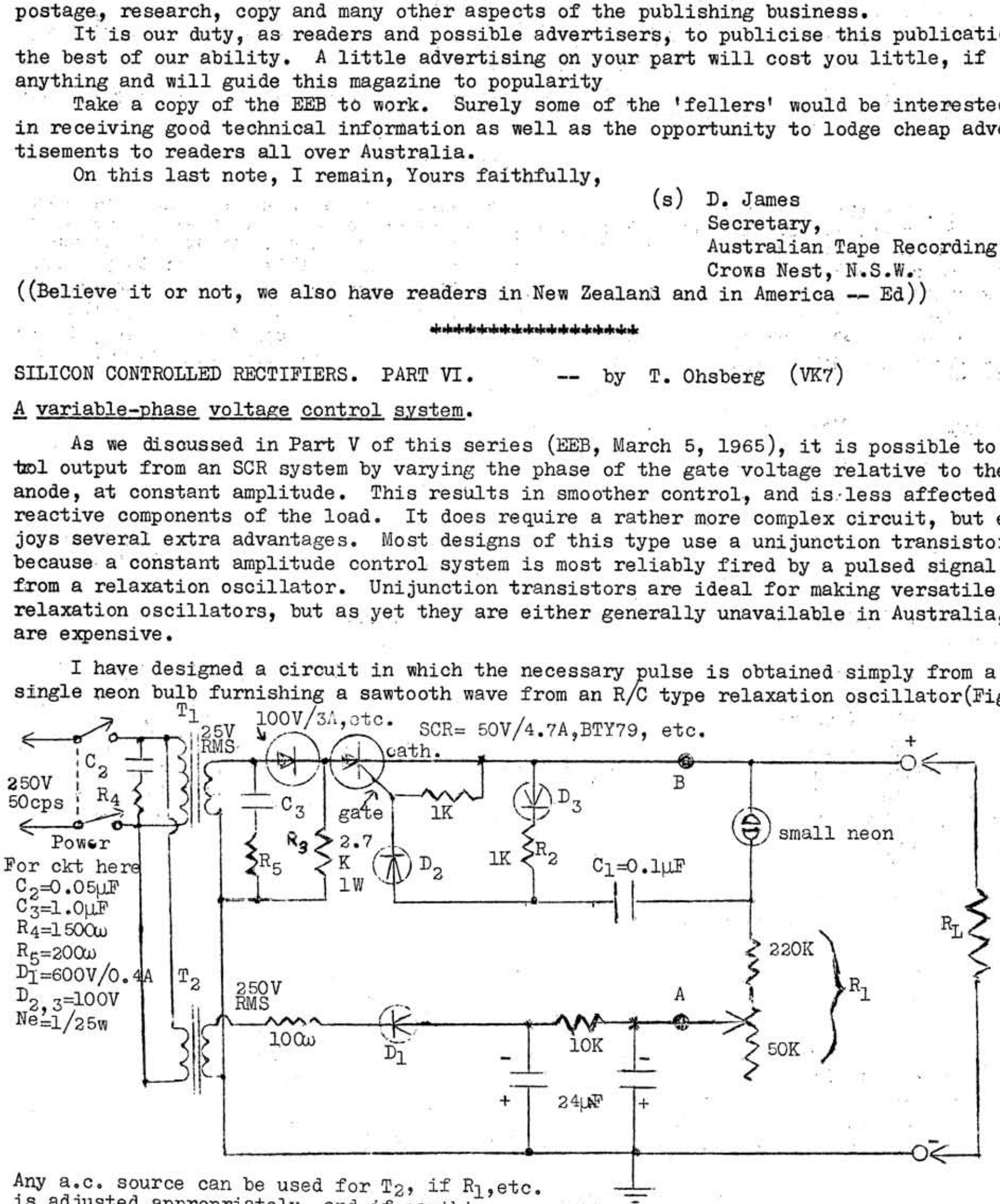
SILICON CONTROLLED RECTIFIERS. PART VI. -- by T. Ohsberg (VK7)

A variable-phase voltage control system.

As we discussed in Part V of this series (EEB, March 5, 1965), it is possible to control output from an SCR system by varying the phase of the gate voltage relative to the anode, at constant amplitude. This results in smoother control, and is less affected by reactive components of the load. It does require a rather more complex circuit, but enjoys several extra advantages. Most designs of this type use a unijunction transistor, because a constant amplitude control system is most reliably fired by a pulsed signal from a relaxation oscillator. Unijunction transistors are ideal for making versatile relaxation oscillators, but as yet they are either generally unavailable in Australia, or are expensive.

I have designed a circuit in which the necessary pulse is obtained simply from a single neon bulb furnishing a sawtooth wave from an R/C type relaxation oscillator(Fig.6).



Any a.c. source can be used for T_2, if R_1,etc. is adjusted appropriately, and if earthing connections are made safely.

Fig. 6. The variable-phase control system.

SCR/VI (continued).

One interesting advantage is obtained from this circuit. The output voltage is automatically regulated quite closely over a wide range of output currents. With slight modification, the output voltage can also be maintained constant with variation of mains supply voltage. The result is a fully stabilised variable power supply handling considerable amounts of power, and of more simple design than usually found in systems providing similar characteristics. Operation is as follows:

1) Phase control permits supply to be fully regulated.

2) The frequency of the relaxation oscillator (Ne, C_1, R_1) is dependent on the voltage between points A and B, which is equal to the potential difference between A and earth, minus the output voltage. Thus if the output voltage falls, the oscillation frequency increases, firing the SCR earlier in the cycle.

3) The condenser, C_1 charges through D_3, and discharges through D_2 and the SCR gate.

4) The low impedance of C_1, when discharging, develops 2V across 500 ohms, and that satisfies the voltage and current firing requirements ofmost 4.7A SCRs. If more than about 4mA of gate drive is required, C_1 can be increased (but use only high quality paper or other non-polarised type), while R_1 and R_2 are decreased in proportion.

5) A condenser cannot be connected directly across the output for filtering, because the firing circuit relies, to some extent, on an a.c. output to synchronise the firing pulses. The circuit of Fig. 7, however, will not affect the firing system, though it will worsen the loadregulation somewhat.

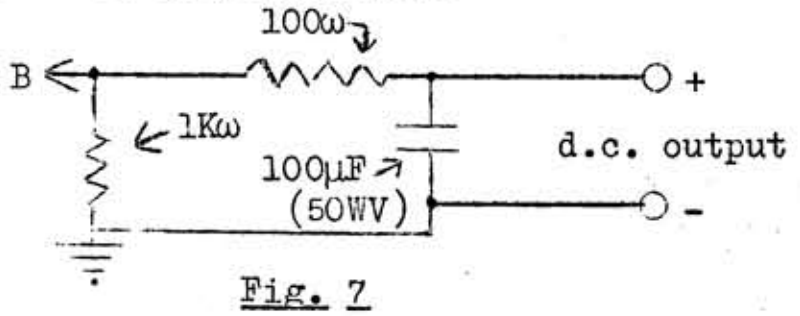


Fig. 7

6) Provided the mains line voltage is constant, the supply is regulated, due to the constant voltage firing characteristic of the neon. The supply can be regulated with respect to both mains voltage and output current variations, by regulating the high voltage supply associated with D_1, thus: (Fig. 8)

7) Relevant waveforms are shown in Fig. 9.

8) Load regulation is indicated in Chart I. Please note that all voltages here indicated are average, as read on a VOM Multimeter. Peak (or approximate output to a condenser input filter) would be about π times higher.

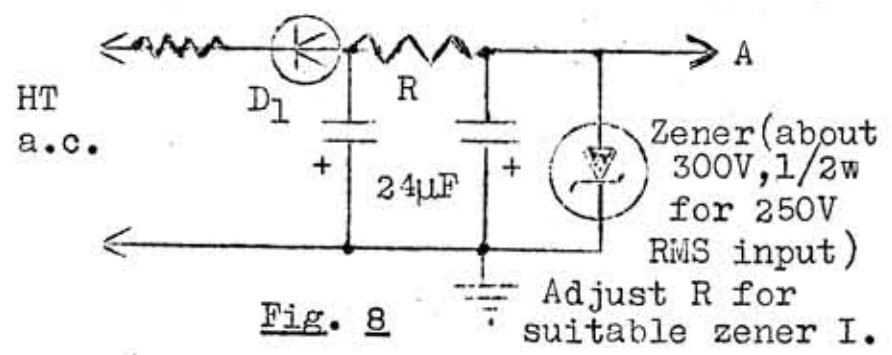
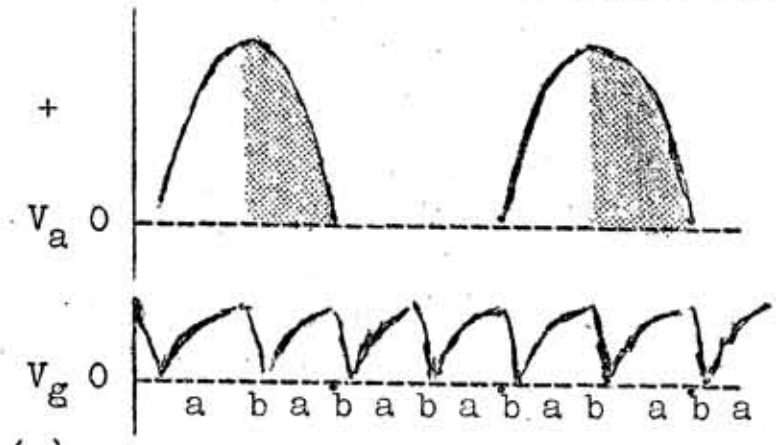


Fig. 8

9) The circuit of Fig. 10 was tried, and output was then full wave (ie. 100cps pulsating) and measured output (ref. No. 8, above) was 195V at low load, or 173V at high load (eg. 1.5A). Note that if one side of the output is to be earthed, an HT transformer of suitable power rating must be employed.

In Fig. 10, as in Fig. 6, the PIV rating of the SCR is protected by diodes (see previous articles for discussion of this), but in this instance, the average value of output is greater, and if d.c. output is desired the higher frequency of ripple is easier to filter. The one disadvantage is the requirement for HT high current diodes. For LT, you might use the BYZ13 (200V/6A) or equivalent,



(a) C_1 charges through D_3

(b) C_1 discharges through D_2

Shaded area signifies SCR firing time.

Fig. 9

SCR/VI (continued)

with 100PIV sufficient for a 25V (RMS) secondary. For operation from the mains (or 250V RMS), BYZ11 (600V/6A) or equivalent ought to be sufficient, as long as C_2 and/or C_3 are included for transient suppression.

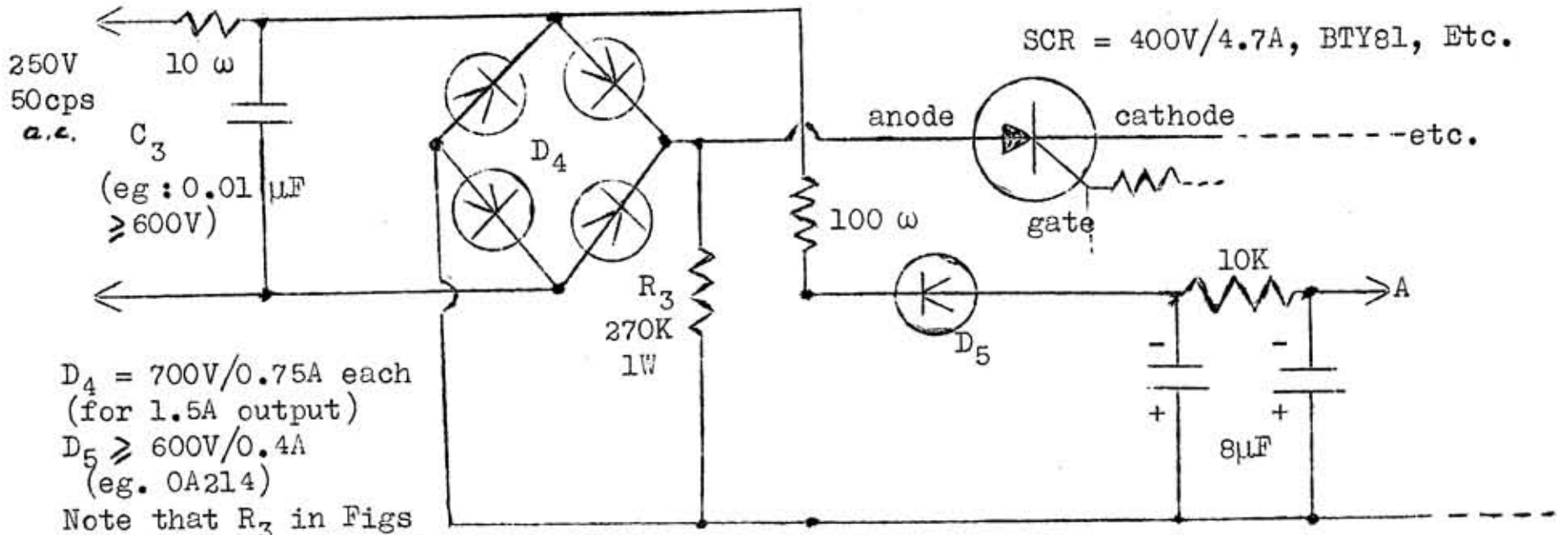


Fig. 10. The mains-operated system.

If HT diodes are scarce, or economically unfeasible, one alone can be used in the half-wave type configuration (cf. Fig. 6). If the HT diodes are unavailable, they could be omitted entirely in favour of the simple half wave SCR configuration, but in that case, it would be essential to provide sufficient SCR PIV safety factor, at least 2 times, preferably 3 times the nominal peak voltage from the a.c. supply... The capacitative transient suppression is essential for SCR circuits, and has been discussed in Part III of this series. If it is not desired to bother with R_4 and R_5, C_2 should be reduced to about 0.01μF, and C_3 to about 0.1μF for LT or 0.002-0.01μF for HT. By the way, I have just found an error in the circuit 'Fig.1' of Part III (EEB, Feb 5, 1965). The values of C_2 and C_3 shown in the figure are suitable if the resistances in series with them are zero, but when the resistances are inserted, the values given on P.2 of that issue ought to be used.

The reason for using the resistances in series with transient suppressing condensers is to reduce 'ringing' which would produce excessive voltages from shock-excited resonance of condenser with transformer winding. This extra resistance also allows the capacity of the condenser to be increased, providing better transient suppression. Consider Fig. 11. It can been seen that at about 5kc/s the impedance of C and 10C + R is about the same, but it is 1/10th as much at 50c/s. Above 5kc/s, the distributed capacity of the transformer would swamp out excess transient signal. Thus, better transient suppression is obtained at the frequencies at which transients are likely to be generated. The relationship between R and C presented in Part III is reproduced here for convenience, as Chart II, at the end of this article. The general rule for this situation might be : Use the formula of Miniwatt Digest, July 1962, or the values of Chart II when resistance is to be added, and optimum protection is to be obtained. If the resistance is omitted (eg. when inexpensive components are used), reduce the capacity of the C tenfold.

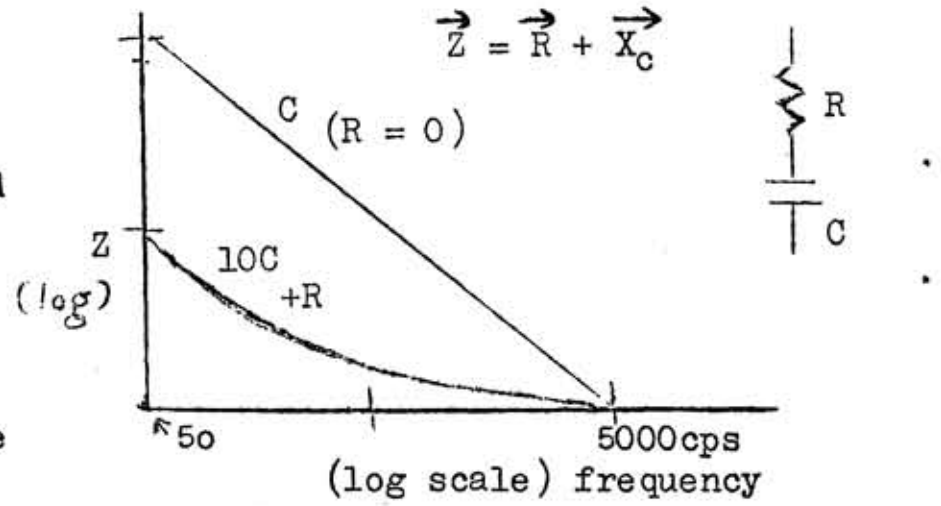


Fig. 11

SCR/VI(continued).

Chart I: Load regulation.

a) Secondary voltage = 25V RMS.

Load	Output (avg)
10mA	11.52V
1 Amp	11.40
4	11.31

b) Secondary voltage = 250V RMS.

Load	Output (avg)
10mA	112V
500mA	111
1 Amp	110.6
1.2	110.6

Chart II. Transient-suppression parameters.

Output	C_2	R_4	C_3	R_5
LT	0.05	2.7K	1.0μF	200(carbon)
MT	μF		0.01	20K
HT			0.002	100K

Please note that these are approximate values, and although they are not critical, optimum ones depend on transformer magnitising current. If it is known (and it can be measured simply by measuring the a.c. current of the transformer primary with no load on secondary), it is not difficult to use the formula given in the Miniwatt Digest, July 1962.

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SILICON CONTROLLED RECTIFIERS. PART VII. -- by R. L. Gunther (VK7).

While we are talking about transient protection, I might recall that it is possible to apply an input peak voltage in excess of the PIV of an SCR, when the SCR is protected by diode(s) as discussed previously. This can apply when the V_{BO} (forward breakover volt.) is sufficiently high. I have tested several SCRs, and in some of them the V_{BO} was appreciably higher than the PIV rating. This can be very convenient, because the SCR's cost is related to its PIV rating, but by using this concept it is possible to use the SCR at an apparently ridiculous voltage. We have tried this, and it works. An SCR with a PIV of 50V, and a V_{BO} of 450V was used in a simple control circuit (eg. Fig. I, Part II of this series), with a 600V diode in series with its anode. An a.c. supply of 250V RMS was applied, and the SCR worked admirably. Nice, eh? All that is necessary is for you to be able to determine the V_{BO} of any given SCR you may have, if it has not been explicitly furnished by the supplier. Then the peak input voltage you can apply to a diode protected circuit using that SCR will be about 10 to 20 percent lower than the V_{BO}, with the PIV rating of the SCR being irrelevant owing to its being taken up by the protecting diode. (which must be silicon, not germanium). The safety factor for V_{BO} is considerably less than that for PIV rating, because the SCR is relatively unaffected by forward breakover. Consider it this way: you can think of the gate current having the function of lowering the working forward breakover voltage. At $I_g = 0$, forward breakover is the rated V_{BO}. At higher gate currents, it requires less anode voltage to break down the SCR junctions in the forward direction (see Part I of this eries for technical background of this). Therefore, as long as the forward current is limited to the considerable value specified for the SCR, the SCR will be unharmed by unexpected forward breakover. The 10-20pc indicated is suggested only to take care of variations in mains voltage, which can be considerable for periods up to 6 cycles.

It is not difficult to test the V_{BO} (at I_g=0). Simply connect the gate to cathode, and connect the SCR to a power supply as shown in Fig. 12. V must be direct current, so that the PIV is not affected. Increase the applied voltage while watching voltmeter, M_2. The voltage read just before M_1 jumps upward is the V_{BO}. R should limit the SCR current to less than the full scale deflection of the meter, M_1.

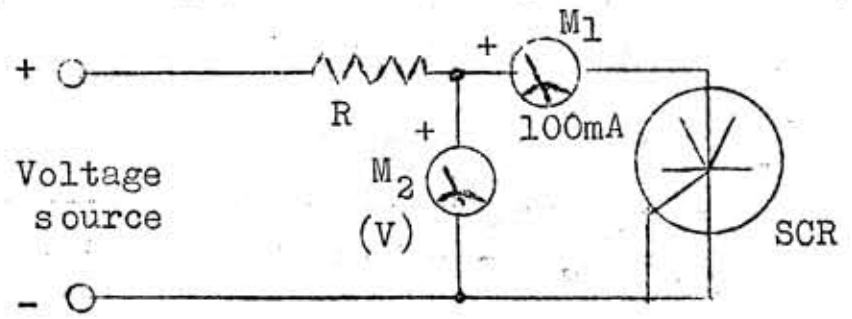

Fig. 12

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Next month we must MUST start the Bibliography!

TAPE RECORDING. PART III

-- by David James (VK2)

What will the recorder be used for ?

As you know, there are thousands of uses for all makes and types of tape-recorders but you will have to decide upon several of the uses for which you will demand of your recorder. This decision is entirely up to you !

If you require high fidelity or stereo, be sure to purchase a more advanced machine- the best your pocket can afford. Remember, you can always buy better quality equipment after using lower quality when you can afford it. For just the long playing time of 'pop' music for parties etd. it would be wise to purchase a lower priced machine (perhaps incorporating four tracks.....i.e. the tape is run through the recorder four times - twice in each direction - with each using one quarter ($\frac{1}{4}$) the width of the tape).

Most recorders incorporate the general speed of $3\frac{3}{4}$ inches per second (i.p.s.) and some others incorporate the following:- 15/16, $1\frac{7}{8}$, $7\frac{1}{2}$, 15 and 30 i.p.s. These speeds must be used in accordance with the recording requirements. The slower speeds of fifteen sixteenths and one and seven eighths inches per second should only be used for speech, minutes of meetings, dictation etc. while three and three quarters inches per second is the general purpose speed and can be used very successfully for speech and with reasonable quality in music. Seven and a half inches per second is ideal for high fidelity music while fifteen and thirty inches per second would produce professional quality. Most recording studios use 15 or 30 inches per second. For the use of tape corresponding it is advisable to use tape recorders with speeds of $3\frac{3}{4}$ ips and with "capstan drive". On the larger machines, the movement and speed of the tape spools does not govern the actual speed of the tape passing the production heads - with "capstan" drive, the tape speed is maintained at constant speed while the speed in rotation of the spools varies. Tape will pass through the production gap of a large recorder without the aid of the turning spools. The spools rotate only to provide a means of tidy winding. On the battery-operated portable recorders the tape speed <u>is</u> governed by the spool rotation. Thus a tape recorded on a mains-operated recorder cannot be replayed with success on a battery recorder and vice-versa.

Why does the higher speed give better results ?

Look at it this way.....A car moves slowly along a road with an abnormally fast leak in the radiator; water pours onto the road in large patches. If the car was travelling at a faster speed, the water would pour onto the road in smaller "drops". The tape recorder operates in much the same way (only not with water). The signal passes from the recording head onto the tape and, in short, the more room it is given to cover, the better and clearer the playback.

There is nothing more I can tell you about this aspect of tape recording but should you be in doubt you may wish to contact me at Box 9, P.O., Crow's Nest, N.S.W. If you have any points that I have left out, I would be grateful of the advice so that I may correct them in the next publication.

Next edition, a note on Tracks.....

MODEL TRAINS.... A letter to the EEB regarding overload protection .

By Brother Julian C.P., Holy Cross, Sepelts Rd., Templestowe, VIC.

An overload breaker was made up by removing the series and load winding from an R.B. 106 Type Lucas Control Box and substituting with a series winding of 18 Ba S wire This coil was connected in parallel with shunt winding and contacts, then by setting the adjustment for the points to open at a load of 5 amps the armature will remain attracted by the parallel shunt winding until the load circuit is opened and/or the short is located.

A second method is to use 12 or 24 volt globes, one or more in parallel to obtain current draw equal to max. output of power source. This arrangement will give the operator the full power available and prevent damage to the power pack in case of short circuiting.

.....

ADVERTISEMENTS

TYPOGRAPHICAL ERROR..

I (the Secretary of the Australian Tape Recording Society) would like to advise all readers of a typographical error on my part which was published in our advertisement of April 5th. The advertisement appeared on Page 7 and was included in the second paragraph. The announcement stated that fees were £1.5/- plus 11/-. This was incorrect and should have read... £1.5/- per year plus a joining fee of One guinea.

The publishers are in no way to be blamed for this error. We have again altered the arrangement of fees which will be described with your query.

We regret any inconvenience caused. (Signed D. James)

WANTED.. UM3 'Woden' Modulation Transformer or similar, and Modulation Transformer from 522 transmitter. P. Garde, (VK3ZDF), 154 East Boundary Rd., Bentleigh, VIC.

TRANSISTOR IGNITION.. Complete ready to install - including Ro-Fo coil. Fitting instructions supplied. Only high quality parts used. All Aluminium construction. Price.. 12 Volt Neg. earth £18/-/-.... 12 Volt Pos. earth £18/10/-. Post free anywhere in Australia. Descriptive literature free on request. ALSO....

TRANSISTOR IGNITION KITS.. Make your own. Transistor, diode and zener already mounted on heat sink. Ballast resistor already adjusted. Only the easy work left for you to do. Complete with Aluminium cover, coil, assembling and fitting instructions.
12 Volt Neg. earth £15/-/- ... 12 Volt Pos. earth £15/10/-.
Also available 6 Volt Neg. earth (for V.W. or FJ Holden). Unit uses three transistors No special coil needed. Use your old coil. Price. Kit £14/-/-. or built ready to install £17/-/-. All units post free.

MEECO- Modern Electronic Equipment Co. , Smith Street, NARACOORTE, S.A.

FOR SALE... Your advertisements - so be in it !!!

(Advertisements continued next page)

ADVERTISEMENTS (continued)

MORE FROM THE ELECTRONICS ASSOCIATES (Hobart): We have heard that there is another firm in Australia called 'Electronics Associates'. That could get confusing. Does anyone know any specific details about them? Please let us know; it could save us some embarrassment, since we are only 'small potatoes'.

=More about Stock. 10A Diodes: None, and no more contemplated. They move too slowly, and are not sufficiently competitive with material offered by the Honourable Competition. Please do remember, however, that OA31 is Germanium, therefore not suitable for protecting Silicon Controlled Rectifiers. Stay with the BYX and BYZ series for that purpose.

20A. Everything below 400V is gone, not likely to be replaced, because this was a lucky accident, and replacements from surplus would cost about twice as much. Several still available from 400V (for 25/-) to 600V (37/6).

35 and 50A. All gone. No more. But we have a pretty one at 100 Amps, for welding, or for charging 8 accumulator batteries at a time. A mere 67/6.

VHF Transistors. 2N702, 150mc/s (according to the book; we are building a vhf oscillator to verify this, and will have it completed by the time you order), 80V, 30mA, 600mW. Price 10/3 to clear for a different kind of transistor. The 2N702 is NPN silicon, and nice not only for medium power VHF, but also anywhere an NPN transistor is applied, such as the protection circuit in the 'Reader Built It' Dept of April RT+H Mag, or wherever useful in simplifying direct coupling, with low temperature effect. Individual characteristics are supplied with each transistor, of course.

3N35. 150mc/s NPN Silicon tetrode, with ckt. 13/10 ea.

4-pin Transistor Sockets. Very useful, but be careful of the leads. 1/3.

General Purpose transistors. Believe it or not, we have not found enough time to finish testing these thoroughly, since we mentioned them last month. We shall not likely continue to supply them (though we shall sell the ones we have), because it takes just as much work to test one as to test any kind, and profit is negligible. Live and learn. They have to be tested for voltage, leakage, gain, stability, and freq. response!

Power Transistors. Sorry, the 2N250 (medium) and 2N174 (high) power transistors have not yet arrived. Takes forever. Due later this month?

Did our frank discussion about surplus transistors last month scare you? Good. If a man has no illusions, he can't be disillusioned, and it pleases us to be honest. But don't overlook the fact that we are perfectionists, and that we compare quality with commercial material used for exacting work. You can, however, be certain that if we offer a transistor for sale, we have tested it throughly, and that it conforms closely to specifications. It will serve all normal experimental purposes admirably. It is simply not recommended for industrial use, since obviously it was found inadequate for that purpose by the manufacturer.

Silicon Controlled Rectifiers. Available from us at horrendous prices, but still a lot less than what you might pay over the counter. Owing to still better contacts (truly!) our 4.7Amp ratings 500V and below now cost 10-25p.c. less than before, and we have just received some of the most beautiful SCRs we have ever seen: 10 Amperes (actual) avg fwd current, 350PIV (£2/5/0) to 550PIV (£3/12/0). Finally, SCRs are available in Australia for a price within the reach of every experimenter. Well, nearly everyone.

VHF Germanium Point Contact diodes, halfway between OA90 and OA91, with a very high back resistance, and rated at 50V/50mA maximum. Only 2/6 ea, in lots of 25.

We also still have our old standby, equivalent to OA90, for 2/3 ea., in lots of 25.

We also still have Zeners (unfortunately; what a headache, everyone wants a different value), Pseudo-tunnel Diodes for the adventuresome (see April EEB), and 60μA meters(32/6). Write for details before ordering the meters. No more Varicaps, sorry. Use the BA102.

=Do it Yourself. We had a lovely little article prepared for this issue, but because (for some unaccountable reason) Charles has received some other advertisements for the EEB, there is no more room. We were going to describe what you will encounter when you send abroad for surplus semiconductors yourself. We invite you to try it, indeed, but only because we have a malicious streak in us. Results for the unwary can be simply appalling.£££££££££££

ADVERTISEMENTS (continued)

DO YOU OWN A TAPE
RECORDER ?

THERE ARE HUNDREDS, PERHAPS EVEN THOUSANDS OF USES FOR THE DOMESTIC TAPE RECORDER.

PRE-RECORDED MUSIC, SPEACH TRAINING, TAPE CORRESPONDING, LIVING LETTERS, SPOKEN FAMILY ALBUM, WEDDINGS, PARTIES, DELAYED RADIO LISTENING, TELEVISION SOUNDTRACKS, SOUND TRACKS FOR AMATEUR FILMS, COMMENTRY FOR SLIDES, NATURE STUDY, OVERCOMING SPEACH SHYNESS, VOICE CULTURE, SOUND EFFECTS, SOUND EFFECTS FOR AMATEUR DRAMAS, TALKING BOOKS FOR THE BLIND, LIVE CONCERTS, DICTATION OF LETTERS, TELEPHONE CONVERSATIONS (ON NON-PMG 'PHONES), and many others.

IF YOU HAVEN'T YET ENTERED THE WONDERFUL WORLD OF TAPE RECORDING, SEE FOR YOURSELF, THE WIDE RANGE OF TAPE RECORDERS AT YOUR LOCAL DEALER.

IF YOU ARE A "VETERAN", YOU MAY WISH TO JOIN AN ORGANISATION DESIGNED ONLY FOR ONE THING -- TO CATER FOR THE TAPE RECORDIST.

THE AUSTRALIAN TAPE RECORDING SOCIETY OFFERS THE UTMOST IN TAPE RECORDING ENJOYMENT....WITH DISCOUNTS ON TAPE AND EQUIPMENT OF UP TO 40%, MONTHLY MAGAZINE, PRE-RECORDED "NEWSTAPES" FOR MEMBER'S INFORMATION AND A FUTURE 'PRE-RECORDED TAPE LIBRARY' WHICH WILL INCLUDE COMMERCIALLY MADE AND HOME RECORDINGS FOR HIRE ONLY TO FINANCIAL MEMBERS.

FULL INFORMATION FROM THE HON. SECRETARY OR MAIL THE COUPON BELOW:-

---

(Address).....
.....
.....
State.....
Date..../...../1965

The Hon.Secretary,
Australian Tape Recording Society,
Box 9, P.O.,
Crow's Nest, N.S.W.
Australia

Please send full details and copy of the latest issue of the monthly journal (delete if necessary) to the above address.

Yours faithfully,

.....
PLEASE PRINT (OR TYPE) YOUR NAME HERE

FROM THE ELECTRONICS ASSOCIATES, 76 View Street, Hobart Tasmania: All items post free.
=Catalogues. Sorry, we cannot send our Catalogue to customers automatically every month. We have had several requests for same, but we are not set up for it, not to mention the fact that we keep prices low by keeping costs down. On the other hand, if you send us an SAE, we'll be happy to stuff it with the latest Catalogue, and any revisions to the Tech. Notes (please specify), anytime. However, since said Cat. and Notes have been growing in bulk, you will increase reliability of the post by providing a largish envelope.
=Stock. 0.4A and 0.75A. At present out of 500V through 800V, but still have economical silicon diodes in the 50-400V and 900V-1400V ranges, and even a few up to 2100V! The 400V/0.75A are particularly attractive at 4/9.
1.5A. Still a good supply of 50V (at 3/3), and a few 200V.
3.0A. None in stock. Small shipment probably later this month. More in September.
6.0A. None. We are negotiating to get some HT ones at a good price. July?

EQUIPMENT EXCHANGE BULLETIN

June 1965 Issued monthly Vol.1, No. 9

SUBSCRIPTION. 3/- per year, sent to all Australian subscribers by Air Mail on the first weekend of each month. Foreign goes by sea mail.

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BACK ISSUES are still available at 5d each, while they last. Subscriptions start with current issue, and all others must be considered as back issues.

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CONTENT.

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Editorial. It is a melancholly fact that advertisers disappear from our pages, because their advertisements are successful. At least that is the reason they give us when we ask. On the other hand, commercial enterprises seem to enjoy frequent advertising in our pages, because they are insatible for results. Are there any more commercial enterprises out there, which might be interested in our special rates for effective large advertisements?

Several more people have approached us regarding articles, and we have given them encouragement. We have plenty of copy at hand, but would like to broaden the base of authorship (and subject matter!). But until this happens it looks as though Lee and Tony will continue to turn out more pages from their hot typewriters. We are also most indebted to David James for his interesting series on Tape Recording.

'LETTER TO THE EDITOR'

Sir,

Hot typewriter, indeed! You mean hot soldering iron. Just a note here, in reference to Brother Julian's item on Model Trains on P.7 of the May issue of EEB. An overload

breaker or light globe are good traditional items for protecting ordinary transformer-operated systems, but they can be inadequate for semiconductor-operated power supplies if the magnitude and duration of the short circuit (eg. across the tracks) is sufficient to damage the diode rectifiers in the system. This is simply to say that a semiconductor is more sensitive to momentary overloads. In my opinion it is better to provide essentially instantaneous protection for these items, and this can be done most simply by placing a resistor of suitable resistance and wattage in series with the power source, and then increasing the supply voltage as necessary to deliver required power to the train system... There is a more elegant alternative, using transistor switching. This may be of the triggered multivibrator type, or the simple switch type as described in the 'Reader Built It' circuit on P. 64 of the April 1965 issue of Electronics Australia. All of the components of that circuit are now readily available, and it can be used to control any conventional emitter-follower transistorised power control system. The one mentioned in Electronics Australia used several 2N301 transistors (eg. OC26), though I shall buy a bi of argument about using three of them. But I'll save that for a proper article for the EEB : The design of emitter-follower power control.

-- R. L. Gunther, Hobart, Tasmania

ΣΣΣΣΣΣΣΣΣΣΣΣΣΣΣΣΣΣΣΣΣ

Did YOU Know?????????? -- by C. K. Pallaghy and R. L. Gunther

We continue our discussion of hazards in the laboratory and the workshop (see also EEB, Vol.1, Nos 4 and 5). In addition to those of an electrical nature, there are several chemical ones of interest and importance.

1) Radioactivity. Ordinarily this is no problem to hobbyists, but you should be cautioned that materials that glow in the dark, and X-ray tubes should be treated with respect. The ambitious experimenter who applies several thousand volts to a 'worn out' X-ray tube may be asking for serious trouble unless he familiarises himself first with the hasards of and protection against ionising radiation.

2) Mercury. The fact is simple : the vapour pressure of mercury liquid is sufficiently high to exceed the toxic limit for human beings breathing it in an enclosed space. You may reto_rt that 'I have played with mercury for years, and have never had any trouble from it.' The same argument has been used by those in favour of smoking, radioactivity, and other equally useful vectors. But when the trouble comes, it is too late. The penalty for overexposure is shortened life, at that time of life when it is more important to you. The prevention is simple.

a) Attempt to avoid spilling mercury on surfaces from which it is difficultly recoverable.
b) If you have spilled mercury, clean up all large droplets you can find, and them sprinkle 'Flowers of Sulphur' liberally on the affected areas, rubbing it into cracks, etc. Then clean up the sulphur with a broom, but not water. In a few hours the sulphur can be cleaned with soap and water if desired, but it is harmless.
c) If you have spilled mercury at some past time, but do not know its location, and/or it is impratical to give it the sulphur treatment, ensure at least that the room is reasonably well ventilated, particu_larly in winter. Ventilation can be made to other rooms. It need not be to the outside directly.
d) Do not let children play with mercury at any time. In addition to the toxic vapours there is the real danger that they may get some of it in the mouth.

3) Solder contains lead. Lead is poisonous over a long period of time, particularly if ingested. Be sure to wash hands after using solder, and do NOT put cigarettes down on surfaces which have been in contact with solder. Always provide an ashtray on which to rest cigarettes between puffs. There are plenty of toxic materials around any laboratory, and cigarettes pipe same directly into you if suitable contact is made.

Did You Know???????? (Continued)

4) Organic Solvents. Benzene, acetone, carbon tetrachloride, toluene, xylene, methanol ('methylated spirits'), and most other light organic solvents (eg. petrol, kerosine, petroleum ether, etc.) can be highly toxic. In addition, most other organic substances are poisonous, and we know of one instance in which a small crystal of phenol was accidentally scratched into the skin, with fatal results. 'Carbon-tet' has been used frequently in fire extinguishers, and as a carrier for many kinds of sprays and vapours. It has a distinctive smell, and should always be avoided. It can cause serious damage to the liver and kidneys when breathed or when in contact with the skin. Its direct vapours are poisonous in moderate concentrations. Toluene and xylene are readily absorbed into the skin, and can cause leukaemia. Need we say more? When you must use such substances, ensure that ventilation is plentiful, and avoid direct contact of the compounds with the skin.

As corollary, it is wise to avoid using a fire extinguisher containing carbon tetrachloride. If 'carbon tet' is used on a smouldering wood fire, phosgene can be produced, and this is even more poisonous than the carbon tet vapour itself. If, indeed you are forced to use this type of fire extinguisher, hold your breath, and remove yourself to some other location after using the extinguisher, with deliberate haste.

5) Hydrofluoric Acid. We have already mentioned the hazards associated with this compound, in a previous issue of the EEB, and repeat here the caution that this substance is very dangerous, and should be treated with enormous respect when using it for etching glass or quartz. If you must use it, wear two pair of new surgeon's type rubber gloves, and avoid splashing the liquid at any time. Discard the gloves after each use, after rinsing their outside surface thoroughly in water. If you are so unfortunate to have any fluoride come in contact with any part of your skin, rinse it immediately in running water, and then go immediately to the doctor for subcutaneous calcium gluconate injection (about 10 percent). For your technical interest, the fluoride ion forms a complex with porphyrins in tissue, with progressive biochemical degeneration... which in any event provides a sore which heals only with difficulty.

6) Teflon. Technically this is a part of the hydrofluoric acid discussion. Teflon is a marvelous plastic, being 'poly tetra fluoro ethylene', and it is that 'fluoro' part that causes the difficulty. When teflon is burned (or heated strongly) it gives off hydro fluoric acid fumes, and these can be deadly. Our horrible-example of this is the true case of the workman who was building something, and absently put his cigarette down on a piece of teflon sheet on the workbench. The ash burnt up to the plastic. When he picked up the cigarette and inhaled the fumes, he dropped dead -- just like that! Teflon does make a good bearing surface, and an excellent insulator. We note, however, that a machinist friend recently removed some teflon bearings from a piece o f equipment, and replaced them with roller bearings, because the teflon changed its shape with temperature, hydration, and other conditions. Needless to say, don't use teflon insulation for valve caps or where the plastic could come in contact with a warm valve, resistor, or coil.

7) Miscellaneous. It is not difficult for the ambitious young workshop enthusiast to make gunpowder, DPF (nerve gas), nitroglycerin, etc., o r to obtain fluoride, arsnic, cyanide, aspirin, or old cartridge shells. It is possible to survive childhood, and people do it all of the time. Ensure that you or your children join this fortunate group, by using common sense in handling any of the dangerous things which abound in our technological environment.

8) And that includes electricity.

SWITCH TO SAFETY!

TAPE RECORDING

by David James.

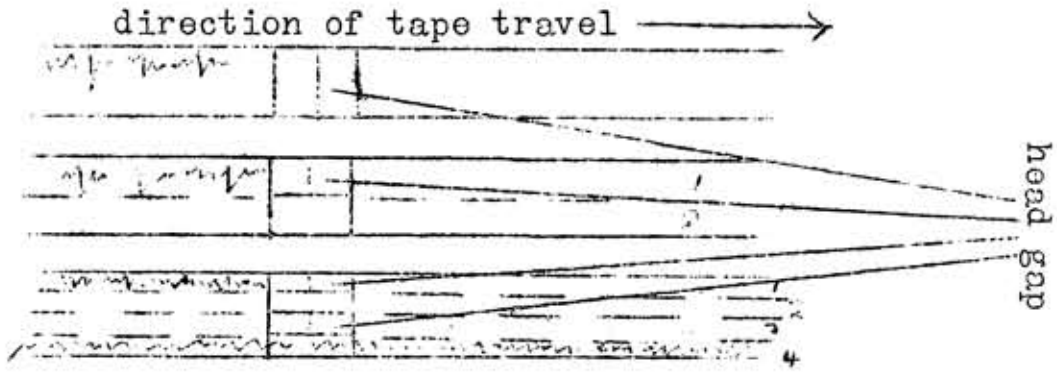
Tracks

The subject of tracks is perhaps the most confusing of all spects of amateur tape recording.
The record/replay head of the tape recorder is arranged as follows for the different tracking arrangements:-

FULL TRACK -

HALF (TWO) TRACK -

QUARTER (FOUR) TRACK -



Tracks could be best defined in the following article by Mr. Peter Clark of Magnetic Sound Industries in Sydney. This article was originally published in the March edition of the A.T.R.S. monthly journal.

"The terms "two track" and "four track" are often quoted in many brochures. Amateur recordists are split into two opposing camps on this question. Some are advocates of the good old two track, and others for the newer four-track method. The first group insists on the fact that the two track system definitely gives better tone quality with greater dynamic range, while the second group can hear no difference in the quality of reproduction between the two methods. I will refrain from taking any side in the argument. Only one thing is certain: The four track system places increased demands upon the recording tape, and it must be extremely supple, absolutely clean, and have a mirror-smooth, specially treated surface."

"The different number of tracks were developed, just as the different speeds, to achieve a way of economising on tape. Broadcasting and recording studios usually employ machines with full track. This track was halved for home recorders resulting in an upper and lower track. This is done by recording on only half of the width of the tape. To use the lower track, the two reels are interchanged, turned over, and recorded over the entire length of the tape a second time. The track width of the two-track system is approximately 90 mils width each track. Recorders which were developed in 1959 have halved the tracks once more, and the tape is used thus for four tracks of approximately 40 mils width each track. This system has quadrupled the playing time of one tape, but obviously, with such an extremely narrow tracks, every particle of dust will be noticeable as a fault in the recording. These particles, although some may be so small that they can hardly be distinguished with the naked eye, will lift the tape away from the sound head and cause a distortion in the reproduced sound."

If you have any query regarding tracks or any other subject of tape recording, please contact me C/o Box 9, P.O., Crow's Nest, N.S.W. Aust. and I will answer your question on this page.

NEXT EDITION, a note on SPEEDS.....

THE DESIGN OF HIGH CURRENT POWER SUPPLIES.

-- by R. L. Gunther

Occasionally there is need for a power supply delivering 20 Amps or more, at low voltage. The design of such a unit is not appreciably different from that of a low current one, but a few precautions are in order.

Even though large diodes can handle high forward currents, there are exactly as susceptible to transient back voltage overloads, or more so because of their high operating temperatures. It is disappointing (and expensive) to see a robust diode perish merely because of a few milliwatts of reverse voltage too much. The prevention is the same as for low current circuits : adequate capacitative suppression plus adequate PIV safety factor. Neither of these are difficult, since condensers are cheap, and generally an increase of PIV rating costs less than an increase of current rating.

The most efficient capacitative suppression can be designed according to the techniques described in our February 5th and May 5th EEB articles. PIV safety factor should be approximately doubled if the diode is run near its maximum current rating. Full wave centre tap configuration is more efficient than half wave, and full wave bridge is more efficient than either because of less core saturation for a given load. The efficiency of a given circuit has to be balanced against the co st of the extra diodes, and the availability of a given transformer.

If you are winding your own transformer, it is easier to add the extra diameter to the wire and to increase core size, when using half wave rectification -- though copper is not cheap. With a store-bought or surplus transformer, you have to determine what power it can supply in practice. This may or may not be the power specified on the box. Modern commercial transformer design can be rather economical of the wire size. A simple but effective method is to load it down with a high wattage resistor only, to approximately its rated (or estimated) load. If it gets hot quickly, reduce load. Otherwise, increase load slowly (eg. 1 hour per change) until the transformer is warm to the touch. For intermittent operation, the load current can be increased 20pc to 50pc above this value. If you like to live dangerously, the transformer can be loaded until you smell insulation, but this is not recommended because the process of overload is regenerative. The current rating obtained from the abovementioned test is about the current that the transformer will deliver to filaments or to a full wave bridge. For a half wave rectifier, assume about 50percent of that current..... If you are winding your own transformer, it is not wise to use less than 500 'circular mills' (viz. the diameter in thousandths of an inch, multiplied by itself) per Ampere of average current load (eg. with resistor load), while 1000CM/A is conservative design. In the Goode Olde Dayes, some transformers were wound with 1500CM/A, but that is long ago and far away.

The Surge Current Resistor necessary in series with the a.c. supply can be calculated according to the March 5th EEB article, and the only difficulty here is the very low value of resistances involved. D.c. resistors less than 1 ohm may most easily be measured by a d.c. resistance bridge, or a length of resistance wire can be measured with an ordinary ohmmeter, and a suitable fraction of length of the wire taken. I have found that resistance wire resistors are the simplest and most accurate method for obtaining low resistances in high wattage. They may be mounted on a tag strip, or wound around a heat resistant power resistor of higher ohmic value (or defunct).... If the transformer can supply extra voltage, and the best voltage regulation is not desired, the Surge Resistor can be made large, and charging current can be regulated by a variable transfo rmer in the primary circuit, or by high wattage resistances (eg. 250V lamps plus a small fixed R for surge).

Big diodes dissipate a lot of heat under load, and their physical size is not that much greater than the small diodes (though their junctions are larger). Therefore they depend very much on the heat sink to carry off the loss energy. Make the heat sink large enough (see manufacturer's specifications), and out of metal heavy enough to carry the heat. Aluminium or copper are better than iron or steel. A commercial heat sink may be purchased, but its only advantage is that it is smaller than a flat piece of aluminium

for a given area. If you need to save space, the aluminium plate can be corrugated or folded, but make bends not too sharply, and ensure that the flat surfaces are vertical during operation of the power supply. Window frame material can make inexpensive heat sink stock; see what else you can find around your builder's supply store. Do not drill the Stud mounting hole too large, and use silicon grease between all metal surfaces at the diode. Mica washers are OK, but I try to avoid using them if maximum current is to be drawn through a diode or power transistor. It is usually easy enough to mount the component on a separate heat sink of suitable area, and then to insulate the whole heat sink from the chassis, using conventional thick insulating material.

If you are running large selenoids, hum can be reduced by paralleling the coil with a large capacity, but remember that you must avoid capacitative values that will resonate the coil at the mains or rectifier supply frequency. And a diode placed backwards across a d.c. operated selenoid will solve all output transient problems, as well as reducing sparking problems in any switches or relays in the d.c. line.

If you are charging accumulator batteries, remember that it is unwise to charge at more than 50 Amps for fear of warping the places, and 35 Amps is still better. Because of efficiency factors, 35 Amps does not take much longer than 50A, and it is better for the battery. Note that 35A from a Full Wave or Bridge is better than from Half Wave, because the peak charging currents from the former circuits are lower, placing less strain on the battery. On the other hand, this consideration is unimportant for 'trickle' charging, or for moderate currents through large accumulator cells. Note too that ordinarily the cells in a 12V battery will be smaller than those of a 6V one, and will therefore stand a smaller maximum charging current without damage.

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4	Feb 20	1	Silicon Controlled Rectifiers. Part IV. More about transients.
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9	June	SEE P.1, THIS ISSUE.	

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ANY tape recordist wishing to attend the First Annual General Meeting of the 'Australian Tape Recording Society' in Sydney should contact the 'Secretary' enclosing a S.A.E. for reply. The meeting will be held in the theatrette of the 'Film Projector Hiring Co.PTY.LTD.', 1st Floor 280 Pitt Street, Sydney, N.S.W. at a date yet to be set. The date and time will be advised with your query. For additional details refer to above advertisement.

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ADVERTISING (continued)

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BACK ISSUES are still available at 6d each, while they last. Subscriptions start with the current issue, and all others must be considered back issues. Lots of paperwork!

CONTENT.

Please help us to get subscribers!

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Editorial. Recently we sent out a copy of our Semiannual Index to several people to interest them in the EEB. In a spirit of whimsy we stated that the EEB was published by the 'Sandy Bay Basement Laboratories.' Lo and behold, back come some cheques made out to the 'Sandy Bay Basement Laboratories'. We looked at each other saying 'all right, why not?'. So here we are, with an elegant name, and a distinctive one--you must admit. We adopt it with all due apologies to W3NL, who maintains a similar establishment elsewhere. If, however, you wish to save effort, you can still refer to us as the 'EEB', and we won't mind.

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MORE UNUSUAL PROPERTIES OF BACK-BIASED SILICON DIODES

-- by R.L.Gunther and T.Ohsberg

I -- Pseudo-tunnel and Noise generators.

Reference: Equipment Exchange Bulletin, Vol. 1, No. 7 (April 5, 1965).

Consider the power supply circuit of Fig. 1. D is a silicon diode whose reverse-conduction characteristics are being studied. R_1 controls the voltage applied to it, and R_2 limits the diode current to a safe value (eg. 100μA). V is a valve (or other sensitive) voltmeter, and A a sensitive microammeter. The typical reverse characteristic is shown as Curve 2 in Fig. 2. Curve 1 is a Zener type response, and gives essentially

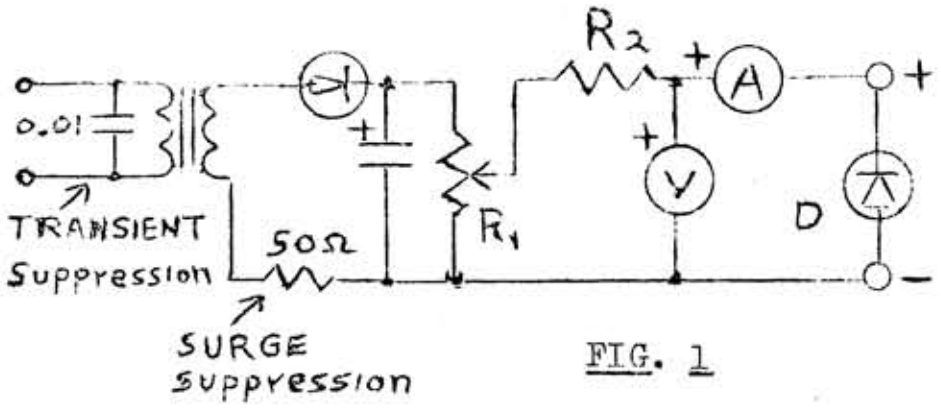


FIG. 1

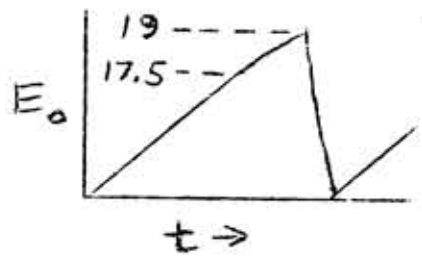
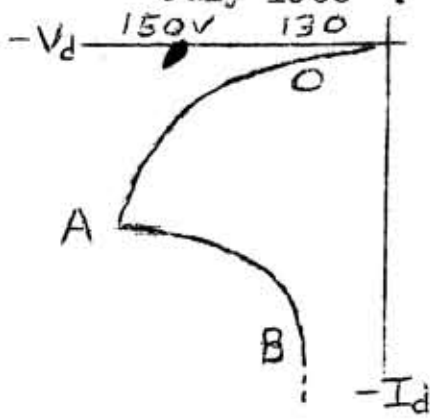


FIG. 6



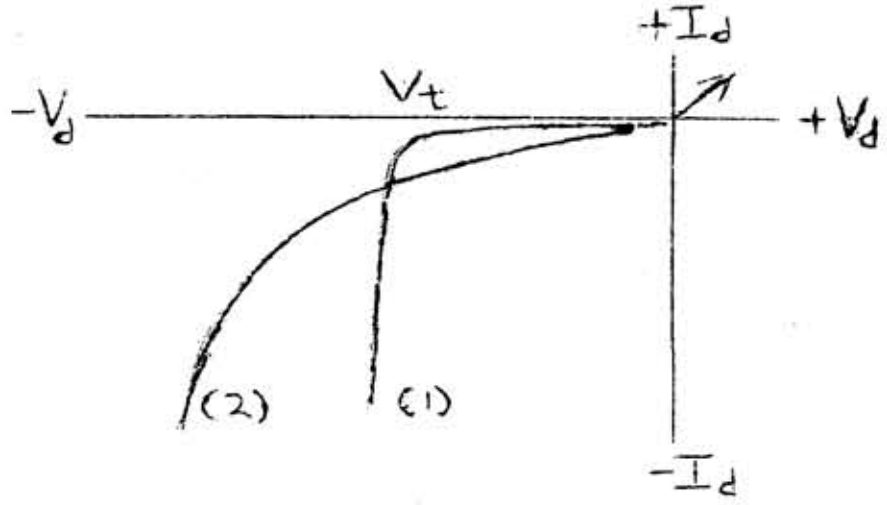


FIG. 2

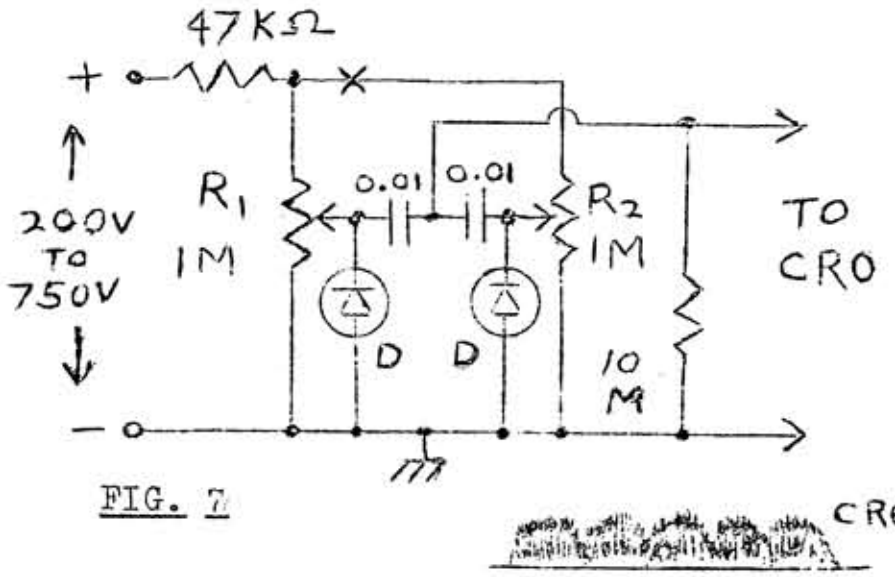


FIG. 7

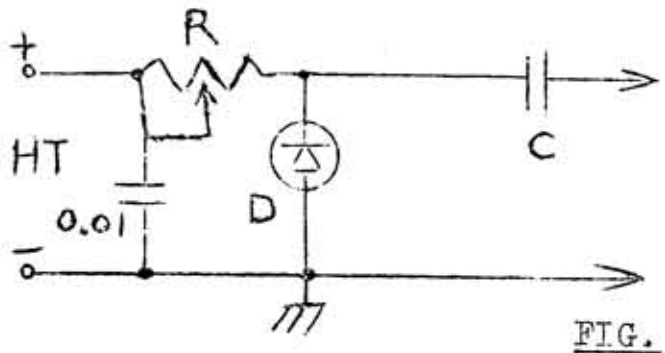


FIG. 3

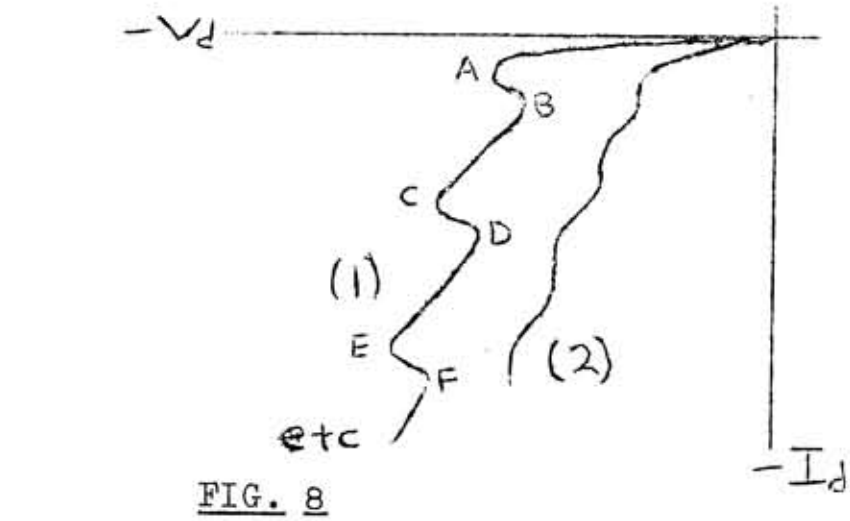


FIG. 8

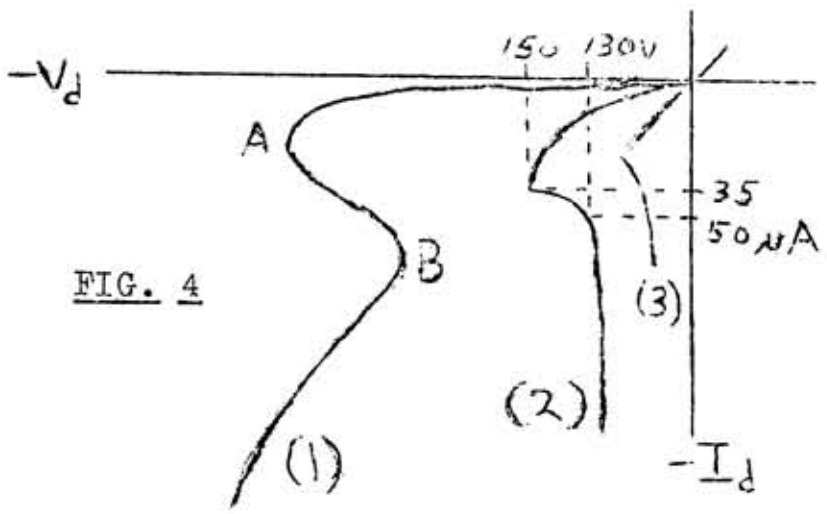


FIG. 4

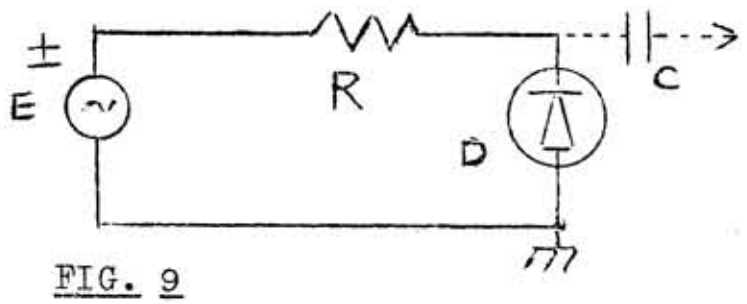


FIG. 9

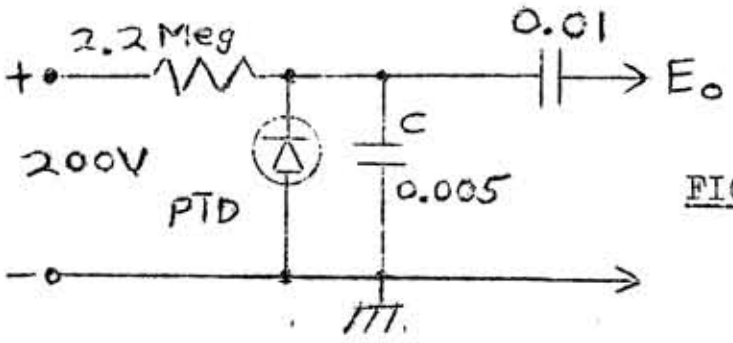


FIG. 5

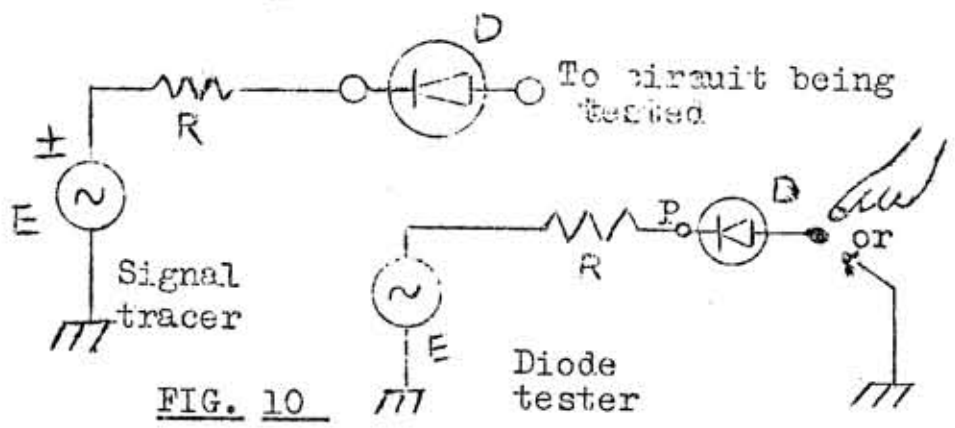


FIG. 10

(Back-biased diodes, continued):

constant reverse voltage over a wide range of currents. The zener response also differs qualitatively from the usual reverse characteristic, in that considerably higher currents may be passed through the back-biased junction without injury to it.ξ

We have noticed that when a small transistorised radio was placed near the power supply, a distinct hiss could be heard when the reverse voltage passed through the Turnover Region (V_t), but only when the curve was of the form of type 1. Unfortunately we cannot consider this a discovery to shake the earth, since it is simply the well-known phenomenon of 'white noise' produced by critically back biased diodes. It is, however, interesting that a signal is produced at (at least) 1Mc/s, in spite of the fact that a typical silicon diode 'Top Hat' will not ordinarily rectify efficiently over 100Kc/s. It is also useful that an ordinary zener diode can be used as a simple noise generator, without the necessity for using elaborate and expensive components for this function. It is even more practical that many ordinary silicon diodes sold for power rectification purposes, have reverse characteristic curves sufficiently sharp to qualify them as noise generators, and even as zeners within limited current ranges.ξ A typical noise generator circuit is shown in Fig. 3, and we have used it successfully as a 'trouble shooting' signal injector for receiver and amplifier circuits. The optimum value for C can depend on load impedance; 220pf is suitable for ordinary signal tracing, while up to 1000pf can be used when the load is a CRO probe -- presumably because of the lighter loading due to high impedance. Although we have only used diodes with Turnover Points 35V and above (up to 700V), any zener diode ought to work, if biased at the correct current, and with sufficient series current limiting resistance. With a large number of silicon zeners, optimum noise output was found to occur from 10μA to 30μA, rarely above 50μA.

Occasionally we also noticed that the signal sent to the radio (placed near the power supply) produced not only a hiss, but also a squeel or whistle. In every instance of this sort, the reverse characteristic was of the 'Pseudo Tunnel' type, described by one of us in the April 1965 issue of the EEB; the characteristics of typical Pseudo Tunnel curves are shown in Fig. 4. It is likely that a relaxation oscillator of some type was set up between the diode operating on the negative slope of the characteristic (AB), and the distributed capacity and circuit resistances. Again it is difficult to explain how the pseudo-tunnel characteristic could function at RF frequencies when the maximum usable frequency of an oscillator employing a PTD was not over abo ut 100Kc/s. It is possible that the PTD was oscillating at a lower frequency, and modulating the white noise signal. If we had time, we could undoubtedly devote a research project to problems of this kind!

This spontaneous behaviour of the PTD suggested that the negative resistance property of the diode would sustain oscillation in an R/C relaxation type oscillator, and such was the case. Fig. 5 was the basic configuration used. The actual shape of the PTD characteristic did in fact vary from one diode to another, with interesting consequences. The PTD having the curve No. 2 of Fig. 4, in the circuit of Fig. 5 oscillated from 10cps to 450cps, depending on R and C (3.3Meg/0.01μF and 1Meg/0.0047μF, respectively); a lower frequency could be obtained, but it seemed to be unstable, possibly owing to heating of the diode in the breakdown mode. An expanded detail of the waveform, and the resulting oscilloscope oscillation waveform are shown in Fig. 6. In region OA, the condenser charges to 150V, and in region AB it discharges to 130V, whence it starts again to charge. The result is the quite remarkable one of a linear sawtooth-type wave, as shown, to about 17.5V, and a relatively sharply bent portion from 17.5V to 19V. It appears that the shape of the exponential PTD charge region just balances the exponential charge characteristic off the condenser, the result being a linear waveform. No doubt a suitable simple discriminator (ie, threshold) circuit could be employed to put this oscillator to use to produce a CRO time base. Curve 3 of Fig. 4 gave a triangular wave (not shown) of amplitude 10V.... One of us thinks that the PTD of Curve 2 (Fig. 4) might be used to drive

ξ This subject will be discussed in more detail in a forthcoming article by one of us.

(Back-biased diodes, continued):

an SCR if used with atransistor and R/C differentiating network, but the other one thinks that it might be difficult to obtain enough drive with a simple circuit, unless the SCR were very sensitive, or unless a typically high sensitivity Silicon Controlled Switch (eg. 3N58) were used. Most PTD's develop a maximum power over their negative slope, of 100µW to about 800µW, for diodes of the 750mA and 2.5A sizes. Most 4.7A SCR's require something over 2mW to trigger them. We did, in fact, have a PTD which developed 10V as a relaxation oscillator, and supplied about 1mW power output, but this was obtained from a 35 Amp silicon diode having PTD characteristics, and was therefore obviously not practical as a source of high power PTD behaviour.

The behaviour of the circuit shown in Fig. 7 is something of a mystery. From the output is obtained an oscillation having the waveform shown, and could be varied from about 700cps to 2.4Kc/s, depending on R_1, R_2, or the applied d.c. voltage. The diodes were strong noise producing type, but did not have to have a PTD characteristic. When a condenser was placed from point 'X' to earth connection (common), the amplitude was decreased for the LF mode, but the white noise remained the same. When the condenser was made larger than 16µF, the LF mode disappeared altogether, leaving only the white noise. Placing a tuned circuit (L= secondary winding (no core) of power transformer, C=0.01µF) at the output produced a reasonably stable output, but was not voltage dependent. The resonant frequency of the L/C used, and the frequency of the LF output component was about 1500cps... Presumably there is some interaction between the junction breakdown processes of the two diodes, developed across the common 47K resistor. Why? As a source of AF this circuit is not too practical, because the frequency of the output is quite variable, if not stabilised by a tuned circuit, though it is fine if you need a white noise generator modulated by indifferent AF.

From time to time after testing a large number of diodes, we came across types showing the characteristic of Fig. 8, in which there could be as many as five different inflection points (ie, the curve changes its direction), some going definitely negative as in Curve 1, others only partly so as shown by Curve 2. The lowest inflection point point might occur around 10µA, and the highest at perhaps 800µA. It is interesting that at each turnover point the diode thinks that it is going into a simple sharp zener-type slope, and a vigorous white noise hiss is produced, which either fades out as current is advanced, or becomes modulated by circuit relaxation (as described above), when the current is passed through the negative slope region. In the case of poorly defined negative slope regions (eg. Curve 2 of Fig. 8), it is possible to hear multiple hiss regions as diode reverse current is increased, even though the negative slope can not be seen as a change in the $-V_d$ reading. It is still a negative slope, however, because it is a deviation from a positive one... We can understand why a simple reversible temperature breakdown characteristic could occur (eg. Fig. 4) ((cf. 'Diodes and Transistors,' by G. Fontaine, publ. Philips)) at the turnover point, but why several of them as the reverse current is increased? Do any of you engineers out there know?

By accident we have also found another intriguing phenomenon. If an a.c. source of voltage is applied as in Fig. 9, and if R is suitable, the diode will produce the usual hiss, modulated at a 25 cycle rate (the reverse voltage is only applied every other half cycle of the 50cps signal). This circuit is even more practical than that of Fig. 3, because the a.c. sweeps through the critical turnover region, and the noise signal will be produced as long as the peak current is greater than the critical current at the turnover voltage (V_t in Fig. 2). This means that the value of R is less critical. If, now, the circuit is modified to Fig. 10, the same white noise signal results (as monitored in nearby transistorised radio); that thing at the right side is supposed to be a hand with outstretched finger. A suitable value for R is 10 Megohms when E is 250V RMS. This gives a good noise signal from zeners up to about 200V rating, and also protects the owner of the outstretched finger. Evidently the experimenter is providing a return path to earth

(BACK-BIASED DIODES, continued):

for the small current necessary to activate the diode. The strange thing about this, is the fact that the noise signal can be obtained from Fig. 10 with diodes rated up to 600V, but not higher, while the circuit of Fig. 9 will not produce noise from diodes above about 200PIV. Where is the extra 300V coming from in the Fig. 10 situation? Evidently it is picked up from the environment, and it is interesting that it is in the correct phase to add to that obtained from the 'active' pole of the 250V Mains used as voltage source, E.

There are several practical implications of this situation:

1) The circuit of Fig. 9 can be used as a general 'signal tracer,' even more effectively than that of Fig. 3. With a 250V 50cps source at E, R = 10 Megs, Zener Diode PIV =36V, C= 500pf, a signal is produced sufficiently strong to drive any stage of a radio receiver, including the audio.

2) The circuit of Fig. 10 could be used safely without a blocking condenser, since the circuit being tested provides the return path. Evidently the tested unit must be earthed, but this is not difficult, since the earthing does not have to be direct, but can have a considerable impedance to true earth without affecting the effectiveness of the signal. If the chassis or common terminal of the power supply is earthed, sufficient leakage is obtained at most parts of the circuit to activate the signal injector. Admittedly this arrangement is not as convenient as a battery-operated transistorised noise generator, but it is simpler, cheaper, and can be made considerably more compact, merely for the trouble of providing a single wire lead to the mains. A value of 10 Megs for R would be sufficient for a wide range of diode voltage ratings, and any diode with zener type characteristics ought to work (see below). PLEASE USE ALL DUE CAUTION WHEN CONNECTING TO MAINS POWER, AND ENSURE THAT THERE IS NO CHANCE OF A SHORT ACROSS THE RESISTOR, R !!!

3) The circuit of Fig. 10 can be used to test whether a given diode has a zener characteristic, or even whether it has a PTD characteristic. A surprisingly large proportion of HT diodes does have a sharp response at the turnover point of the reverse curve, and a few minutes spent on this test system can possibly yield several HT zener diodes from your junkbox This, of course, depends on the size of your collection, but it is still worthwhile making the test on any amount.

To test an unknown diode, simply place a transistor radio with its ferrite antenna adjacent to point 'X' in Fig. 10 (the wire 'X' can be long), hold one electrode of the diode with the fingers of the right hand, and touch the other electrode of the diode to Point 'P'. If the diode has a Zener or PTD characteristic, a strong hiss + buzz will be heard (best to tune the radio between stations). If not, nothing unusual will be heard. If the circuit is used as indicated, ensure that the following precautions be taken:

a) Make absolutely certain that R is a large value, eg. 10 Megs. When it matters, never trust the marked value of a resistor. Always test it first with a working ohmmeter. We have run across mislabelled resistors.

b) Ensure that there is no chance of short across the resistor. Use solid geometry, tag strips, and electrical tape.

c) If you are worried about this, or if you do not think it advisable to use yourself as an earth return, use an earthed wire connected to the test diode instead. In that instance, however, the maximum value of diode PIV which can be tested will be somewhat less than the peak voltage of the a.c. supply. If you are testing HT diodes a complete HT transformer secondary winding should be used for E, and R increased in proportion (eg. 30 Megs for 700V winding). This is ,however, still an appreciable amount of voltage, and even if an earthed (or common) lead is un used in place of the hand, the necessary caution should be observed. We refuse to be responsible for anyone electrocuting himself. These circuits are not appreciably more dangerous than others, but all electrical systems ought to be treated with respect.

Once you have obtained the 'noise diodes', you can do three things with them, depending on their specific properties: use them as noise generators, use them as zener diodes, or use

(Back-biased Diodes : continued)

them as Pseudo-tunnel Diodes. For noise generation, the selected diodes can be used as-is, without further tests, in the circuits of Figs. 3, 9, or 10, though best results will be obtained from the latter two. In order to ascertain whether the diodes are zeners or PTD, the actual reverse characteristic must be tested, and the circuit of Fig. 1 would be suitable. Unfortunately not all diodes giving high noise output from the circuits of Figs. 9 or 10 are zener types, and it is essential to test them before depending on their constant voltage characteristic. For the Top Hat HT type, a dynamic resistance of 100 to 1000 ohms might be suitable, depending on voltage, and a LT type might have a dynamic resistance (= dE/dI) of 5 to 50 ohms. The dynamic resistance acceptable will depend on the voltage regulation requirements of the circuit to be voltage stabilised. In addition to having an acceptably low dynamic resistance, a zener characteristic must be stable. This means that you ought to be able to apply about half the maximum current, and the reverse voltage ought to remain fairly constant, changing only slightly as the diode warms up. If the reverse voltage shows a pronounced tendency to change as as soon as the test reverse current is applied, the junction is unstable, and unsuitable for zener use. Indeed, reverse current should always be applied to any test diode cautiously, and backed off immediately at any slightest sign of instability. This instability will not affect the normal function of the diode as a rectifier, and is merely the illustration of the fact that the PIV rating of that diode is an Absolute Maximum factor. But it precludes the use of the diode as a zener. What is the maximum zener current of a stable junction? It depends principally on the heat the diode can dissipate. The ordinary 'Top Hats' might be rated at about 1/2 watt maximum, and small stud diodes (with heat sink) at 1w to 5 w, depending.

A PTD characteristic is, of course, indicated by a decrease of voltage across the diode, as current through it is increased, or by the existence of more than one 'hiss point' (in nearby radio) as the reverse current is increased, up to perhaps 500μA.

Next month we shall present some experimental results from some noise and PTD diodes which have intrigued us.

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SEMICONDUCTORS REFERENCE LIST. I.

In this issue we present the principal reference works we have found to be of value in designing and building semiconductor equipment. If we have overlooked a good reference, PLEASE let us know about it before the deadline for next issue of the EEB. These are presented more or less in order of our preference, but they are all good.

'Power Rectification with Silicon Diodes' by M. Dayal (Mullard, Ltd., 1964). Magnificent.

Selected Semiconductor Circuits Handbook, edited by S. Schwartz (Wiley, 1961, cf. Ch.8 particularly). This is a book full of simple and practical theory on a wide variety of electronic circuits, plus many practical circuits. It contains some good common-sense ideas we have not seen put together in one place before.

Reference Manual of Transistor Circuits (Mullard, Ltd). Good general reference and circuits, though somewhat dated. More contemporary material found in 'Outlook', etc.

Silicon Zener Diode and Rectifier Handbook (published as two different books by two different publishers : Motolola Corp (Aust = Cannon), and International Rectifier Corp. (Aust = Warburton Franki). Both books (M and IRC) are good, and a basic requirement for those who want to know something about zener diodes and applications.

Diodes and Transistors, by G. Fontaine (Philips Technical Library, 1963). Simple but concise treatment of both subjects. Many graphs in colour, simple definitions.

Transistor Manual (latest edition, published by G.E. Co.). Very very good.

Power Transistor Handbook (published by Motorola). Ditto.

Transistor Manual (publ. by RCA). Not nearly as good as GE's, but worth reading.

--(LIST CONTINUED NEXT MO.)

TAPE RECORDING

by David James

SPEEDS

As I mentioned in an earlier edition of the EEB, you could determine the analysis of speeds in a tape recorder in comparison with a leak in a car radiator.

Supposing a car has a rather abnormal leak in its radiator and is driving along at thirty miles per hour (rather unlikely). On the road you would see the line of water in "blotches". This is much the same with a tape recorder; the tape is travelling at, say, $3\frac{3}{4}$ inches per second and the impulses reproduced by the amplifier are being fed into the record/replay head which, in turn, is causing a disturbance on the recording tape in the form of sound impulses ("blotches").

In this way, the faster the motor car travels, the "blotches" of water will be more spaced out and if the driver reduces speed, say to 15 m.p.h., the line of water will just be one big mess. Exactly the same thing happens within the tape recorder. The faster the tape is travelling, say at $7\frac{1}{2}$ inches per second, the 'more room' the impulses are given and playback is more distinct (i.e. without distortion) but if you reduce your speed to $1\frac{7}{8}$ inches per second, the impulses will be so confined to that little piece of tape that distortion will be quite simple.

For those readers who don't own a tape recorder, the most common tape speeds are:- 15/16, $1\frac{7}{8}$, $3\frac{3}{4}$, $7\frac{1}{2}$ & 15 inches per second. Recording studios usuually use $7\frac{1}{2}$, 15, 30 or even 60 inches per second. The speed of 60 inches per second is generally used for symphony orchestras.

LEVEL INDICATORS

To ensure that you don't over modulate your tape recordings (& under modulate), the manufacturers of all larger tape recorders have employed a level indicating system. The two most common methods of indication are the "magic eye" and the V.U. (Volume Unit) meter. The V.U. meter is by far the most accurate as a small pointer (or needle) swings across a scale marked with numbers (Decibels). On this scale appears a "high", "danger" or "distort" mark which means that when the pointer reaches this mark, you are allowing too much volume when recording and when played back, the result will be distorted. By "distorted" I mean that the recorded signal is too excessive to be handled by the track, the speed you are using or the quality of tape. With the "magic eye" two illuminated neon beams spring together with each unit of volume and if these beams overlap or become too bright, the same meaning as in the above occurs - the recording is distorting.

To give a recording TOO LITTLE volume is just as bad as too much. When you put a record on your stereogram at home, the run in or run out grooves (or even silent parts of the musical arrangement) give out a hissing noise (apart from dust, beer, egg yolk, peanuts, fish oil, the baby's dribble, biscuit, pastry and jam) which is that of the stylus passing over the surface of the disc. It is much the same with tape. This annoying little disadvantage is called "Tape Hiss".

CONTINUED NEXT MONTH.

ADVERTISING:

AUSTRALIAN TAPE RECORDING SOCIETY
Box 9, P.O., Crows Nest, N.S.W.

Copies of our July issue of 'The Microphone' are available by writing to the Secretary at the above postal address and enclosing postage stamps, duty stamps, or the like to the value of 1/6d. This price covers full cost of the magazine & postage. Free literature regarding A.T.R.S. will be enclosed with the magazine for your perusal.

Also A.T.R.S. will be holding it's First Annual General Meeting on July 9th at 7:00 p.m. in the theatrette of the Film Projector Hiring Company Pty. Ltd., 1st Floor, 280 Pitt Street, Sydney. (almost op. Japan Trade Centre) - (near Goulburn Street). All readers of the EEB are invited to attend and bring a friend or two (or even more) and a film of "The Magic Tape" by the makers of "B.A.S.F." recording tape will be shown along with a demonstration of the Brenell range of tape recorders by a representative of RCA of Australia Pty. Ltd. HOW MANY OF YOU SYDNEY & SUBURBAN READERS OF EEB WILL WE SEE THERE ? Free lucky door prizes and a chance to win £10,000 will form only part of the agenda.

For persons who own a tape recorder, A.T.R.S. offers up to 50% discount on recording tape (Scotch, B.A.S.F., Triton, RCA, Sonocolor, etc.) and discounts on certain brands of tape recorders. Up to 50% discount is also available on household goods.

ENQUIRE NOW. The Secretary, Australian Tape Recording Society
Box 9, P.O., Crows Nest, N.S.W.
Australia

FOR SALE: Matador I Electronic Flash Unit. Mains or accumulator power. Guide No. 40-50 with 50ASA colour film. £10. Available only until July 17th. H. Gulline, c/- Physics Department, University of Tasmania, Box 252C, Hobart, Tasmania

ASSOCIATION OF PUBLIC ADDRESS ENGINEERS. If you are interested in, or associated with Public-Address in any way write to APAE, Box 122, Oakleigh, Victoria for full details of membership and benefits.

FOR SALE. 34 watt stereo amplifier with regulated power supply and Leak point one stereo control unit. £50 the lot. R. Bridges, 60 Beddoe Ave., Clayton, Victoria.

FOR SALE:

Halicrafters SX 101 MK - 111A RX. 7 Bands - Amateur Coverage - including 10mc and W.W.V. - provision for 6 and 2 metres - full Band Spread - Double Conversion - VRR - Selectivity 0.5 R/Cs to 5R/Cs - BFO - Product Detector - crystals for upper and lower sidebands and A.M. - crystal Calibrator - Band Switching - noise limiter - NOTCH FILTER - adjustable - AVC on and off - 'S' Meter calibrated in 'S' units and micro-volts etc - a beautiful job - spotless and in almost new condition - complete with 110 to 240V line transformer - matched speaker and case spare set of valves which are hard to get. F.O.R. GYMPIE. PRICE £165.

American National NC-105 RX. 4 Bands - all wave coverage 1600 R/Cs to 30MCs with 100 degree Band Spread - Variable Selectivity - 0.5R/Cs to 5 R/Cs - BFO, SSB and AMSW - Product Detector - noise limiter - 'S' Meter - edge scale - sensitivity control - Audio Control - Provision for H.P. Output for recording of overseas programmes - B/C Band included - Built-in Speaker - 110V to 240V line transformer - in new condition- 1963 Model - JUST from the States. F.O.R. GYMPIE. PRICE £52 . (continued →)

ADVERTISEMENTS Continued--

SB 10. Heathkit SSB Adaptor - modified with 6DQ6 tube - Output 40 to 50 watts - in beautiful condition - almost as new - Phasing Rig - using Upper and Lower SB - DSB and AM - has VOX and Anti Trip built in - requires only VFO and Power Supply to go on the air with SSB. F.O.R. GYMPIE PRICE £52.

Power Supply : R.A. 34F : 240V A.C. 240V AC INPUT. 1000V DC OUTPUT in steps of 20 volts from 0 to 1000V. Two 12.6V AC 10A Windings + one 12V DC for Relays ; OUTPUT = 475mA. All controlled by Thermal O/L Breakers - Micro Switches on doors - Auto Transformer for voltage adjustment - Line Voltmeter - Output Voltmeter. Finger Tip control of selectors. PRICE £35.

Barrie Bestmann, VK4LN, 43 Garrick St., Gympie, Queensland.

FROM THE ELECTRONICS ASSOCIATES: 76 View Street, Hobart, Tasmania.

== Competition! We see that several other chaps have tried their hand at the surplus market. As a commercial enterprise we are properly dismayed, and are marshalling the resources of our sturdy activity to meet the Challenge by providing the same high quality of more types of items. As individuals, however, we are quite pleased. We started this enterprise partly for profit, partly to bring inexpensive semiconductors to Australian experimenters, and we appear to have succeeded at least in the latter instance. We have no fear that we are disturbing the regular commercial market, because you surely realise that most of the tufnover in the electronics supply field comes from industrial and service activities. But we have indeed succeeded in bringing diodes, transistors, and even meters to impecunious experimenters, and have thereby helped to stimulate activity in a multitude of small workshops. Because we are conscientious we have also provided various technical notes to our customers, thereby introducing the casual experimenters to the intricacies and pitfalls of silicon semiconductor practice. We have received many compliments, and we are satisfied. If the Competition (with a lower overhead, no doubt) undersells us on given items, we'll simply switch over to others. If they follow us, you will all benefit... We pause only on one matter : their merchandise is advertised as 'new.' Is this a matter of interpretation? As far as we are concerned, 'new' means something that you buy from Radio Parts, Warburton Franki, etc. Insofar as surplus merchandise is unused, our components are 'new' too, but we shall not advertise them as such. Surplus material originates from manufacturers' surplus, manufacturers' overstock, manufacturers' seconds, and/or military surplus. Most of the time we don't know exactly which is the true source, and you are even less likely to know. All of this means that surplus material must be tested thoroughly, and every single piece must be so tested before it can be sold with good conscience. We believe that such tested items are of high quality and very useful, but we shall not call them 'new.' The Competition will certainly apply these various tests, or it will not stay in business ; well over half of our customers are repeat customers, and indeed this is necessary in the limited Australian market. We have actually sampled the goods of one of the Competition who (which?) has been around for awhile, and we are pleased to report that his quality is uniformly excellent. Therefore, if someone offers low cost semiconductors, etc., there is every possibility that you will be getting good value for money. Obviously the one certain way to know is to sample the various agencies, and we wish you luck. But don't forget to send for our own Catalogue every once in a while too. It has grown to 6 pages, and may possibly have something of value for you.

== Latest News: No more 30V/0.2A silicon miniature signal diodes, sorry. But we do have some 0.3A glass diodes of the same type-- 100V for 1/3, 200V for 1/6 (with discount of nice proportions for quantity orders). These are characterised by very high back resistance, and a frequency limit of 25 megacycles..... Recently we have had to return several lots of transistors we received from suppliers, because they were quite hopeless. It was a nuisance, but we refuse to sell inferior merchandise, and we must state explicitly the technical characteristics of the semiconductors we stock. Unfortunately, one of the rejects

was the type 2N702, and we salvaged only enough of them to fill back orders. This leaves us without a transistor having $f_{\alpha b}$ over 120Mc/s, but with the appearance of the new (new !!) Fairchild VHF low price transistors this will present you no problem. We even have hopes that we can retail the Fairchild units ourselves. We have seen them and their charactersitics, and both are lovely.... We have, however, had good luck with the garden variety cheap low power type of transistor, and you will find details in the Cat. ... For some strange reason we have been flooded with requests for our recently stocked 3N58 Silicon Controlled Switches, and now have a good stock to handle all orders. Our respect for Australian experimenters has risen even higher, and we hope you find the 3N58 as useful as we have. Our Cat. describes them, and the G.E. Transistor Manual devotes an entire chapter to them. We are keeping margin low, to stimulate demand. Price is 21/6, each.... We also have a 2N2646 Unijunction Transistor, and lots of SCR's, as well as the diodes useful in protecting SCR's. Nice HT high current diodes. Cheap..... As of this writing, the big batch of 2N174 high power transistors has not arrived, but we do now have a few 2N1724, being NPN Silicon 85Watts, 7.5Amps 80V, 10Mc/s for 34/6. But don't get excited about that 10Megacycle figure. That if $f_{\alpha b}$, and the maximum frequency you can get from an ordinary Hartley type oscillator using them is only about 3Mc/s. OK for 160Metres, though, and maybe 75 with some stretching..... We still have inexpensive diodes up to 2000V, 100Amperes (but not at the same time !). Plus surprises.

SENDER :

THE EQUIPMENT EXCHANGE BULLETIN
P.O. Box 177
Sandy Bay, Tasmania

TO--

Registered at the G.P.O. Hobart, for transmission by post as a periodical

EQUIPMENT EXCHANGE BULLETIN

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ARTICLES are solicited for the EEB, each of which will provide the author with one year subscription to the EEB, and Glory. Articles can be on any hobby subject, and if they appear to be primarily electronic, that is only due to the fact that the Editors are interested in that hobby, and started out on that subject. If you have any interesting ideas or results, send them in; if necessary we can polish them for publication. Copyright is that of the author. Although each article has been prepared carefully, we can accept no responsibility for errors. Opinions expressed in 'Letters' and elsewhere are those of the authors.

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BACK ISSUES are available at 6d each, except for Vol.1,No.11 which will be 1/-, for obvious reasons. Subscriptions start with the issue published after receiving the remittance. The current issues and all others must be considered as back issues, because bulk mailing rates apply only when posting the entire month's printing.

CONTENT.

Please help us to get ✓ subscribers!

Editorial.

May we please apologise for having missed the August issue of the EEB? We have been terribly busy with work associated with the recent Congress of the Australian and New Zealand Association for the Advancement of Science, and it has quite overwhelmed us. We realise now that we ought to have sent out a brief page explaining what happened, to forestall the dark thoughts of our subscribers, but one day led to another and by the time we realised finally and completely that it was too late, it was too late. As you can see, this issue is twice as heavy, in an effort to make it up to you, and we hope that you will find the material interesting. We'll try to be prompt in the future.

Suddenly the list of subscribers has become long, and several recent searches for individual listings have taken time. Therefore we have reorganised the address labels to include a number after each name, being the order in which the subscription was received. We dislike having to Automate, but must. In ANY correspondence sent to us, please refer to that number, whether it be for change of address, renewal, article,

Editorial (continued):
or Letter to the Editor. We shall be vexed if you don't mention your number. When you resubscribe you get a new number, so always please take it from a current issue.

Enquiry at the Post Office has resulted in our specifying a definite figure for subscriptions to New Zealand and Elsewhere. Until now, we have been placing a 5d stamp on such issues, because they are not included in 'Bulk Mailing.' However, 5 x 12 = 60, and it is impractical to cover that with a 3/- subscription, when more than a few overseas subscriptions are received. We regret the outrageous rate, at least for NZ subscribers, but such are the penalties of national boundaries. Ahem.

We received a note from a correspondent who said that he disagreed with a certain Technical Matter and would possibly 'buy an argument' about it. All right, why not? We invite him to send his detailed rebuttal. The pages of the EEB are open to technical correspondence, and you need only to send it to us.

Back issues requested by a number of people were somewhat delayed, because they had to be reprinted. The back issue situation is interesting. Initially we thought that we should provide them only as a minor service for those who had missed an issue or two, but we have been deluged with requests for them, and the supply becar exhausted. So did we, thus the time lapse, also the raising of charges from 5d to 6d each. It takes as much time to process one back issue as ten ordinary ones, and also we are following the lead of Government and Business in readjusting fees to correspond with the changeover to decimal currency -- to our advantage, of course.

Why make reprints at all after they are exhausted? Because we sympathise with frantic requests, and because they go far toward keeping the EEB solvent!* Any small surplus goes to paying volunteers. Unpaid ones, it seems, are rare. Anyone around Hobart interested in some hard work? We can reward you by public acknowledgement. We hereby reward our Staff: Grateful acknowledgement is hereby advanced to these personages who are responsible for this effort, but you know who does all the work!:

C. K. Pallaghy (not him!)	----- Editor	(Iobject!--CKP)
R. L. Gunther	----- Editor	
T. Ohsberg	----- Editor	
D. James	----- Editor	
R. Reynolds	----- Editor	
J. A. Hill	----- Assistant Editor	
G. van Leuven	----- Assistant Editor	
D. L. Aspinall	----- Assistant Editor	
D. Brown	----- Assistant Editor	
E. J. Watts	----- Assistant Editor	

Want to join our Staff? Send us an article, or help type stencils.

We appear to be doing quite well with articles, and in the 'completed' basket we have ones on simple transistor design, transistorised ignitions, SCR phase control, zeners and meter protection, and a new kind of transistor oscillator. An article on a Proximity Relay was received coincidentally with the appearance of a similar device in Electronics Australia, and the author is now hard at work modifying it to use semiconductor circuitry.

Letter to the Editor

It would appear that the casual Australian experimenter does not often require a very high standard of performance from the transistors he uses. The main requirement seems to be that they shall merely amplify; much less important seem to be gain and frequency response. Voltage and current ratings are not critical either, since most circuits used require only a few volts and a milliamp or two. This would seem to indicate that many will build a circuit if they can put in the specified (and often expensive) type of transistor, or a direct equivalent, but still hesitate

*Our largest advertiser is largely useless (to us), because we use their duplicating machine. They seem oddly reluctant to pay us as well!

Letter (continued):

to modify the circuit to take another transistor with different parameters, or even design their own circuits from scratch. Perhaps the only place they dare use non-specified transistors is in circuits which state 'transistor not critical' and these are, of course, usually low level AF and oscillators. In my experience those who know most about transistors are often those in CSIRO and University labs where transistors with more exacting requirements are needed and where the establishment is willing to pay for them, to be used (and abused!).

This letter is a plea to the casual experimenter to learn more about semiconductor devices. They are fascinating tools, and their operation (as distinct from underlying physical theory) is not at all complicated. Design theory and operation are described well in popular publications by Mullard, Philips, G.E., Int. Rect. Corp., and Motorola. When experimenters feel 'at home' with transistors, SCRs, SCSs, etc, the sophistication of their circuits will increase and they will be able to select components critically for best results from those available within a given price range. This is particularly relevant now with the appearance of inexpensive transistors, whose silicon construction and NPN polarity can be useful in simplifying design and improving performance.

-- R. Maddever
Corio, Victoria

++++++++++++++

MORE UNUSUAL PROPERTIES OF BACK-BIASED SILICON DIODES (continued)

-- by R. L. Gunther and T. Ohsberg

II: Some experimental characteristics.

Here are the reverse characteristics of some of the diodes we have found from some diodes tested according to the methods described in the previous article (EEB, Vol.1, No. 10). Note that RF output was obtained (as picked up on a nearby radio) from 'Stud' types, and that might be remarkable, considering that their frequency limit for rectification is supposed to be measured in hundreds of cycles per second. We did not find any 'noise diodes' in the epoxy type; evidently their reverse characteristic is too gradual (Curve 2, Fig. 1, previous article). After thinking about it, we deduce that the ability of a Pseudo-Tunnel Diode to oscillate at a high frequency need not be inconsistent with the normally low frequency operation of the diode as rectifier. As rectifier, the frequency response is limited by the speed of turn off with reverse bias after conduction, whereas in the PTD mode, the diode never does become forward biased.*

'N'= Noise Diodes which give a hiss in a nearby radio, and 'T'= Pseudo-Tunnel Diodes (PTD) which exhibit a definite negative resistance in the reverse characteristic. These might be represented by Curves (2) and (1) respectively, in Fig. 8 of the preceeding article, when multiple inflection points are obtained. These two curves are really both of the No. (1) type, but in No. (2) the negative resistance is merely sufficient to make the curve pause, without going obviously negative; in practice, (2) does not have enough power in the negative slope to be useful in practical circuits, but it does make a fine noise generator at the loudest noise point. As we described previously, this noise signal can be obtained without critical adjustment, by applying a.c. to the diode... We didn't have any replies to our question in July, about the possible cause of the multiple inflection points in the reverse characteristic; well, is anyone reading our article?

*We have just come upon an article which may be relevant to the subject of PTD function. It is:" Negative-Resistance Diode Handles High Power," by A. P. Schmid,Jr, in Tunnel-Diode and Semiconductor Circuits (see Reference list). See that article for further details. In the same book (p. 139) is an article showing how an ordinary diode can be used as an amplifier, under certain conditions.

More Diodes (continued):

TH = Top Hat metal type, S = Stud high current, M= Miniature glass, R= Reference type

Type	No.	$-V_d$*	$-I_d$*	Fig.8 Curve	Comments
TH	N_1	98V	10μA	2	Dynamic resistance, dR = 18 Ohms at 120V, therefore poor zener, though turnover point is sharp enough to produce noise.
		101	80		
		103	120		
		106	220		
		108	350		
TH	N_2	92	10	1	Tunnel Dip = Slight (stronger a.c. hiss)
		95	50		Appreciable
		108	620		Slight (dR = 6 ohms at 110V)
S	N_3	182	20	2	Very strong a.c. hiss, fair d.c. hiss on each peak
		186	260		
		186+	385		
		187	700		
		188	1200		
	N_4	185	20	2	Very strong a.c. hiss, fair d.c. hiss each peak.
		186	85		

TH N_5 This is the strangest of many strange reverse characteristics we have enccountered, and is shown in Fig. 11: At 150μA the diode suddenly begins to emit a low frequency pulse-type noise (in nearby receiver), which increases to about 800cps at 2100V. Thereverse current rises from only 170μA at 1050V to 180μA at 2100V, the limit of our pwr.

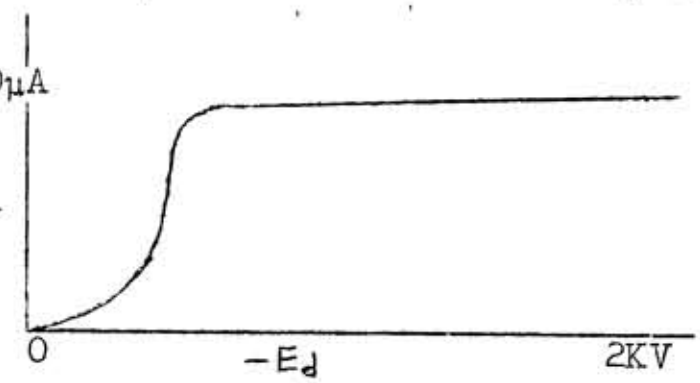


Fig. 11

However, spontaneous curing is also possible. Another diode showed the same kind of strong, rapidly pulsing noise in the nearby radio, beginning at 1360V/2μA, and continuing with increasing frequency to 1420V/60μA, suddenly quieting. The voltage spontaneously fell to a constant 1140V, without our touching the voltage control, and thereafter the reverse characteristic was a good zener type response (viz. Fig. 2, Curve 1) at 1140V. Perhaps there is a clue to the behaviour of N_5. The junction is probably breaking down reversibly, and when it breaks down it starts to reform until the potential across it again reaches the threshold. The frequency at which this happens is the tone heard in the radio, and the steepness of the wave-front is responsible for the very high harmonic content of the wave which allows it to be heard as an r.f. signal. An increase of breakdown freuqency with voltage seems reasonable according to this, but why the decrease, as found in going from peak C to D in Fig. 12, below? We should be interested to hear from someone abt this.

Yet another 'noise' diode had the conventional characteristic of Fig. 2, Curve 1, with a turnover point (V_t) at -940V. The breakdown noise occurred at -2μA, at about 100cps, rising to a rapid hiss at -60μA, but disappearing altogether at -120μA, not to return. We have also noticed that if a noise diode is placed into service carrying forward current in the conventional manner, it may subsequently lose its unique noise or Pseudo-Tunnel Diode properties, although its simple white noise generation will be unaffected, since that depends only on the steepness of the characteristic at V_t.

*Under the $-V_d$ and $-I_d$ listings are indicated the various reverse voltages and currents at which noise peaks are heard for 'N' types, or at which maxima (A), or minima (B) are observed electrically for 'T' type (PTD) diodes.

More diodes (concluded):

and thereafter it is kept to the normal 1V or so (under load).

The existence of the FBD characteristic lends interest to an intriguing possibility. Since the barrier potential is unusually high, the depletion region must be unusually wide, as mentioned above. This means that there ought to be a considerable change of capacity across the junction from OV to the forward breakdown point (which can be +15V or higher), with a higher capacity evident as the voltage across the diode is increased -- a behaviour opposite to that of conventional voltage variable capacity diodes, in terms of the magnitude of potential aplied. Since this thought occurred only while this was being typed, we have not had the opportunity to test it, but we shall. We might mention, however, that any silicon diode with a low leakage (Fig. 2, Curve 1) reverse characteristic can be used as a voltage variable condenser, and you might keep that in mind as a good source of low cost varicaps. The lower the leakage, the higher will be the 'Q', though the total range of capacity variation is not likely to be as high as that of the special diodes chosen for that property. We shall examine this at the same time as the capacity of the FBD junction, time willing.

Aside from the varicap condition, the main practical use of the information in this series of articles on Noise and Pseudo Tunnel Diodes appears to be the fact that it is possible easily to test for selecting them, and to obtain them for noise generators (for testing circuits) or PTD devices (as oscillators or gates).

++++++++++

SEMICONDUCTORS REFERENCE LIST. II.

We have been informed that the Schwartz Selected Semiconductor Circuits Handbook mentioned previously is available in the technical bookshops on the Mainland, in a considerably less expensive edition published by the U.S. Government. This is good news, since this work is a very good one. To continue:

Silicon Controlled Rectifier Manual (General Electric Co., N.Y., Latest Edition). Much practical and theoretical information, including a chapter on transients. Paper.
SCR Hobby Manual (G.E.). A simpler and cheaper version of the SCR Manual. Very practical, though it would be nice to be able more easily to find the characteristics of the semiconductors used, for application to Australian components. Paperback.
The Controlled Rectifier, Vols I and II (International Rectifier Corp). A well Presented treatment of theory in Vol.I and practice in Vol. II. Paperback
Diode Circuits Handbook, by R. Turner (Bobbs-Merrill). For small-signal diodes.
The Transistor Radio Handbook, D. L. Stoner and L. A. Earnshaw (Editors and Engineers, California, 1963 -- the same publisher who puts out the 'Radio Handbook', a magnificent but expensive work of immensely practical value, though less well known than its equivalent by ARRL or RSGB). Practical, for radio amateurs and others. Presents material in the intelligent blend of theory and practice for which E+E excells.
Design Manual for Transistor Circuits, by J. M. Carrol (of Electronics Magazine, U.S.A.) (McGraw-Hill, 1961). Presented in a practical manner with a wider variety of circuits than presented in the usual compilation. If you don't find a circuit elsewhere, try here.
Transistor Circuit Design, by J. A. Walston and J. R. Muller(of Texas Instruments Co.) McGraw-Hill, 1963). Lots of maths, but some nice circuits for a wide variety of functions; component values are specified. Expensive; get it from the library.
Tunnel-Diode and Semiconductor Circuits, by J. M. Carroll (ibid) (ibid, 1963). Includes many fascinating and practical articles on a wide variety of components, including Hall-effect Devices, Voltage-variable Condensers, Parametric Amplifiers, Field-effect Transistors, and unusual applications of SCR and UJT. Also dear.
Handbook of Transistor Circuits (published by Bobbs-Merrill). We haven't seen this,

VOLUME COMPRESSION. Part I: Basic Principles. -- by J. A. Hill (VK3)

As most readers may know, radio transmitters must never be modulated beyond 100%. Best results are, however, obtained by keeping modulation as close as possible to this maximum. To indicate this, Level (or V.U.) Meters are often used. In commercial broadcast stations, Automatic Volume Control units are usually installed between the studio and transmitter, in order to keep the programme level automatically constant as long as the input level is within certain limits. The principle involved is termed 'Volume Compression,' as contrasted with 'Clipping' which literally cuts off peaks, thus causing distortion. Volume Compression can be applied wherever constant modulation or sound level is required without continu ous supervision of a meter. It can be applied to good effect to tape recorders, ham rigs, P.A. systems, etc.

Volume Compression also makes it possible to provide automatic fading for a paging system where background music is required, and where the music must be reduced for announcements. The speech signal from the microphone automatically compresses the music, and the music is restored to its original level when speech stops. How does VC work? Reference to Fig. 1 gives the basic outline.

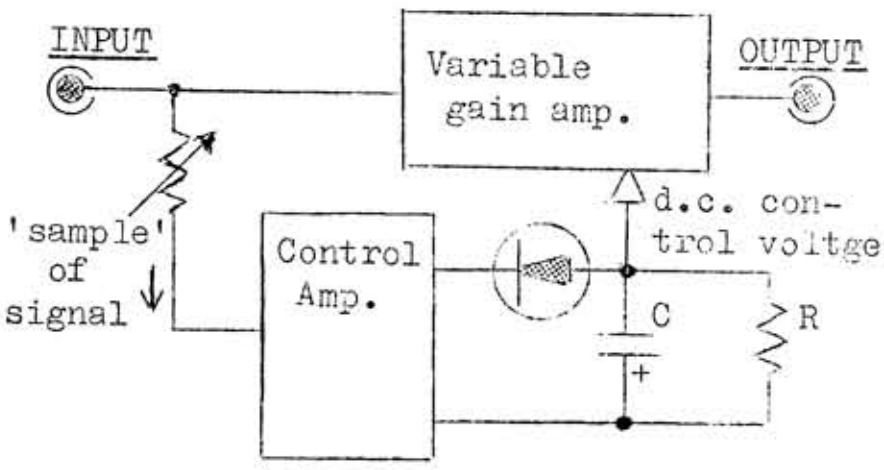


Fig. 1 (Simple Compressor)

Standard Approach. If valves are used, the stage having variable gain is typically a pentagrid type (eg. 6L7) which has the d.c. control voltage applied to grid No. 3. As the input voltage increases, more d.c. is applied to grid No. 3, thus reducing the gain and (if everything is adjusted correctly) maintaining the output constamt. Note that if the diode is reversed, volume expansion takes place -- ie, for a small increase in input level the output level increases greatly.

R and C are chosen to give a time constant of about one second or two (depending on application) so that short soft passages remain soft. This time constant is called the 'Decay' or 'Hold' time. If a large signal is suddenly applied to the input, a short burst of high level signal gets through the compressor. This is due to time needed to charge C, which is called the 'attack time.' Practical compressors must be designed with very short attack times, or a chopping effect will result.

With the arrangement of Fig. 1, critical design is necessary, or it may be found that an increase in input volume may actually cause a decrease in output. To avoid this, the sample signal is generally taken from the output. The 'threshold of compression' is the level above which compression starts (ie, the input level up to which the ratio of input to output is constant) and can be set, if desired, by back biasing the diode.

A further discussion of elementary compressor/expander theory and practice may be found in the introductory pages of the 'RCA Tube Manual.'

Transistor Approach. Unfortunately pentabase transistors are rare, so some other idea must be employed. The variation of base bias provides AGC for most transistorised receivers. In audio work this becomes less practical, because the control voltage is not pure d.c., but contains a distorted portion of the signal. This would be fed into the base of the input transistor, and hence mixed with the desired signal, resul-

Volume Compression, I (continued):

ting in unacceptable distortion. Distortion can be reduced at the expense of attack time, or elaborate distortion cancellation circuitry can be devised. Other factors limit the design of this kind of circuit, however, and another method was sought.

Several ideas were tried, including those shown in the simplfied diagrams of Figs. 3, 4, and 5, and eventually the 'diode' method was chosen and developed.

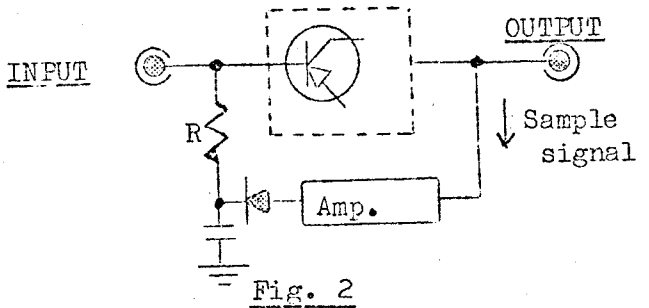


Fig. 2
Base Bias Compression

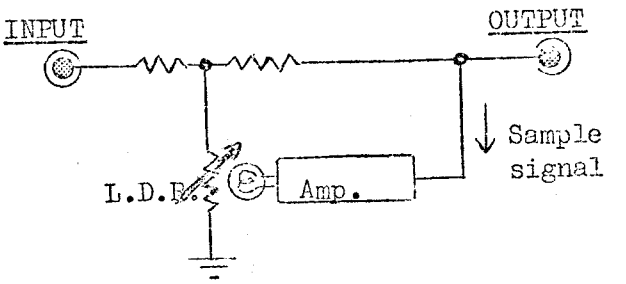


Fig. 3
Light-Depedent-Resistor Compression

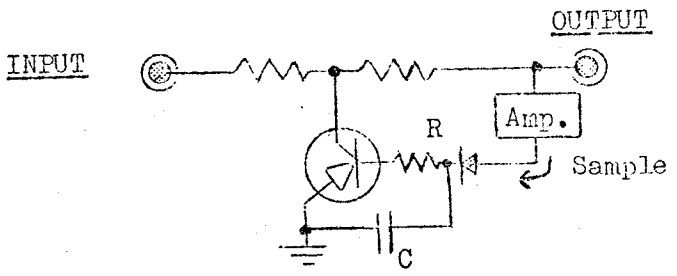


Fig. 4
Emitter/Collector resistance changes with the Base Bias

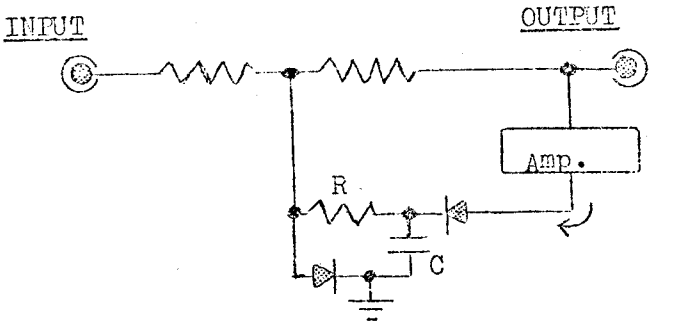


Fig. 5
Resistance of diode changes with forward current.

The diode method of Fig. 5 depends on the reduction of forward resistance with increase of current through a diode. Silicon diodes are best, because their resistance changes more with very low currents, than for other types. The circuit corresponding to Fig. 5 suffered (as expected) from distortion and/or poor attack time due to spurious a.c. on the d.c. control voltage. Trouble was also experienced due to charging and discharging of input and output condensers, which caused unwanted current through the diode and temporary bias change in the following stage -- giving rise to some weird acoustic effects.

To minimise this difficulty, a large number of circuits were evolved and tested, but most had serious defects or resulted in bulky, critical or expensive construction. The arrangement of Fig. 6 was not actually tested (transformers too expensive), though it should theoretically be capable of better attack time, longer hold time, and perhaps even less distortion than the T-pad arrangement of Fig. 7.

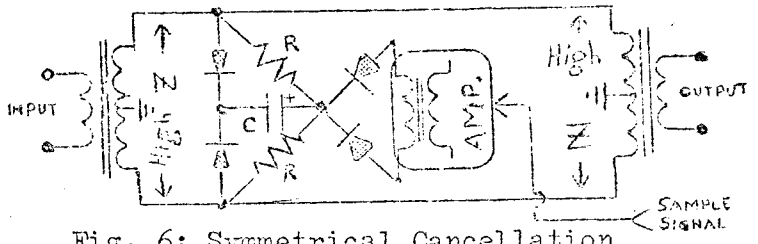


Fig. 6: Symmetrical Cancellation

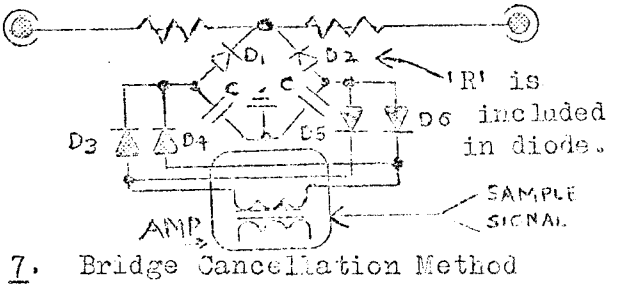


Fig. 7. Bridge Cancellation Method

Volume Compression (continued):

In theory the diodes and capacitors would need to be perfectly matched to provide effective distortion cancellation in the bridge. Experience indicates, however, that special effort is unnecessary. In fact, D4 and D5, or D5 and D6 can be omitted without noticable effect on distortion, although this increases attack time.

VOLUME COMPRESSION. Part II: Practical Designs. --by J. A. Hill (VK3).

Those who are experimentally inclined may like to modify their existing equipment in order to provide compression facilities. In some cases satisfactory operation may be obtained for a dollar or so, though trouble could be encountered. A separate compression unit alleviates these possibilities. One such is here presented, and it is called 'MAVCAT' -- Metered Automatic Volume Compression And Tone control unit.

MAVCAT.

The schematic diagram for this device is presented on P.10. It is self-contained and employs 5 transistors to provide three basic facilities:

(1) Metering of input level.
(2) Volume compression above a predetermined input level (threshold of compression)
(3) Tone controls -- bass and trebble.

It will accept signals from a low impedance microphone, record player, tape recorder, radio, etc., and may be fed directly into the mike or pickup channel of your tape recorder, ham rig, P.A. system, closed circuit radio station, etc.

No critical adjustments are necessary; no test equipment is required, just a little practical experience, a few $s, and that spare weekend ((only one?? --Ed.))

Circuit Description (Left to right, Top to bottom):

1) Input: Low impedance. Volume control before this stage to minimise possibility of overloading TR1
2) TR1: Preamplifier.
3) T-pad compression network -- see Part I, above.
4) TR2: Gain equaliser-- substantially makes up for loss in compression net.
5) Tone Control -- Bass and Trebble controls (see RTV+H, May 1963).
6) TR3, TR4, meter -- Input signal sampled (actually partly compressed). Two transistors provide more than adequate gain to drive the 500μA level meter.
7) TR5 -- Output signal sampled, drives the compression network.
8) 9V dry battery, capable of furnishing 5mA comfortably.

Construction: Most of the components are assembled on a piece of matrix board, as shown in Fig. 9. This fits into an aluminium case, as in Fig. 10. Simplicity combined with servicability and attractive appearance are features of this arrangem

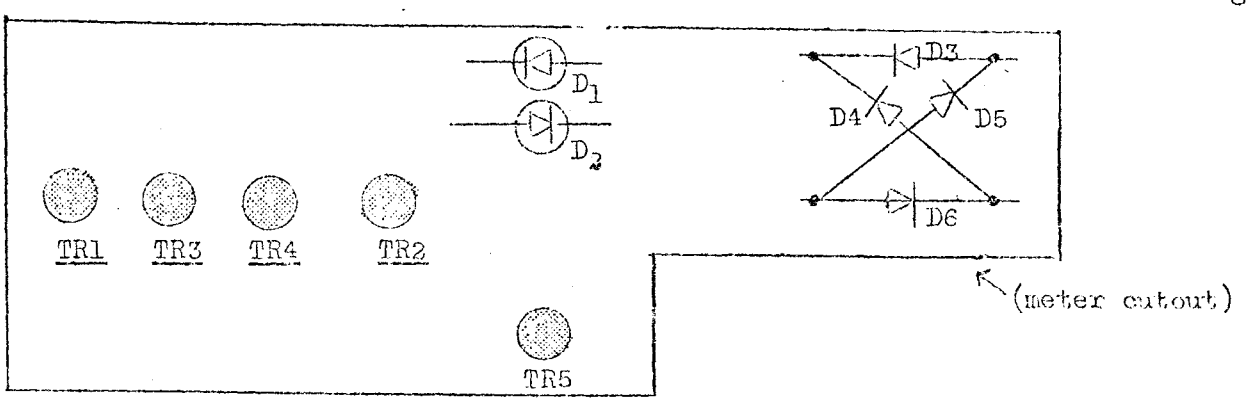
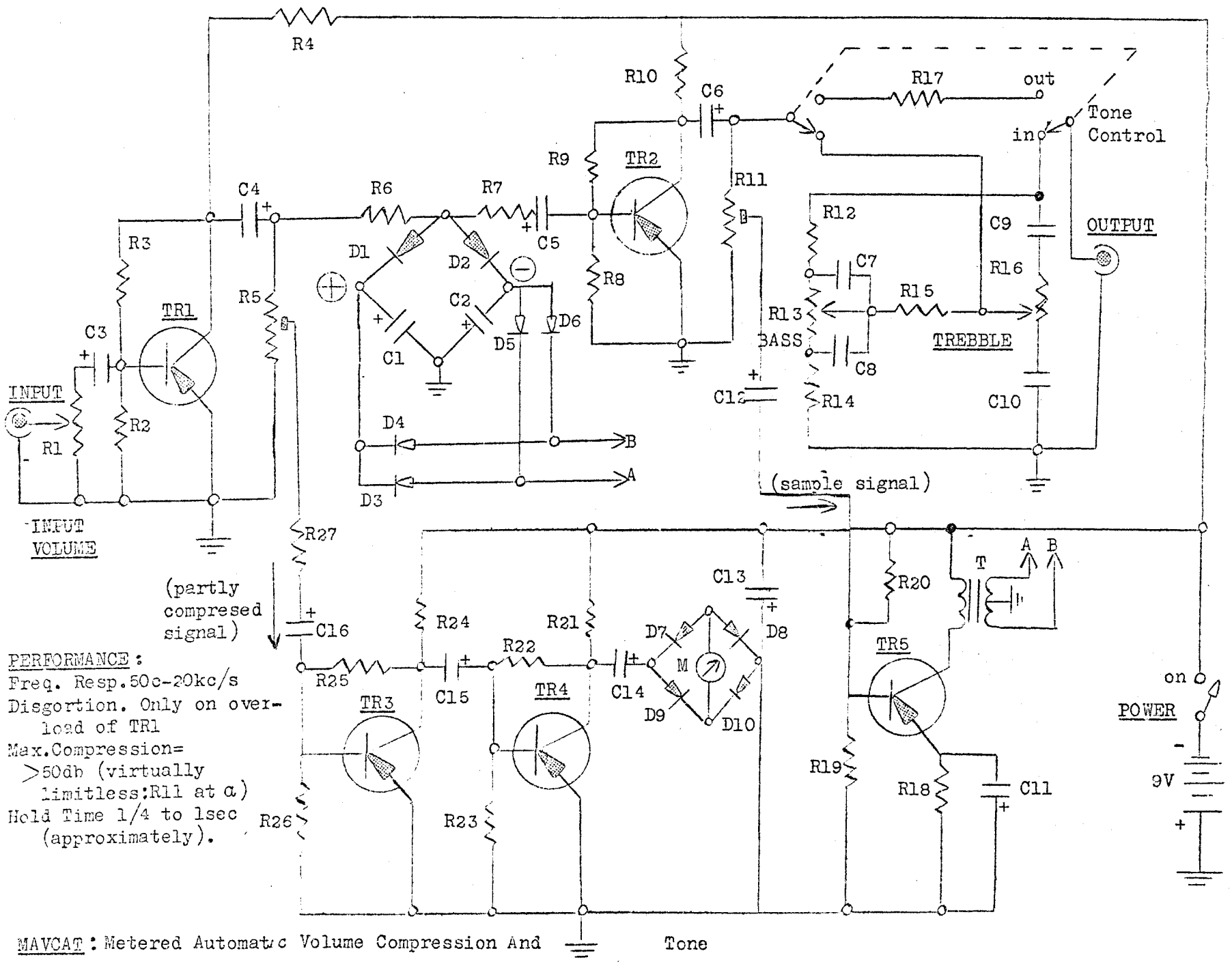


Fig. 9a Layout on Circuit Board



PERFORMANCE :
Freq. Resp.50c-20kc/s
Disgortion. Only on over-load of TR1
Max.Compression= >50db (virtually limitless:R11 at α)
Hold Time 1/4 to 1sec (approximately).

Volume Compression (continued):

Parts for MAVCAT (on P.10): All condensers are miniature LT type, values in µF. All resistors ½W, 5% or 10%, values in ohms.

C1, C2 = 100 (each).
C3, C4, C5 = 50 (each)
C6 = 10
C7 0.1
C8 0.47
C9 0.012
C10 0.068
C11 100
C12 5
C13 250
C14 25
C15 5
C16 10

R1 10K Pot: 'Input Volume'
R2 15K
R3 270K
R4 6.8K
R5 10K Tab Pot
R6,7 12K
R8 15K
R9 270K
R10 6.8K
R11 50K Tab Pot
R12 1K
R13 10K Pot: 'Bass'
R14 680
R15 2.2K
R16 10K Pot: 'Trebble'
R17 See text
R18 330
R19 8.2K
R20 33K
R21 6.8K
R22 270K
R23 15K
R24 6.8K
R25 270K
R26 15K
R27 33K

D1-D6 = Silicon diodes: 30PIV/0.2A, OA200, etc. (larger OK as long as silicon).

D7-D10 = Germanium diodes: P50, G30, OA91, etc.

T = Driver Transformer, type TRD174, or similar (Primary 200 ohms d.c. resist., Secondary d.c. res. 50 ohms each side)

TR1-TR5 = 2N217, OC74, T8G, etc.

M = Meter, 0-500µA, indicates 'Input Level'

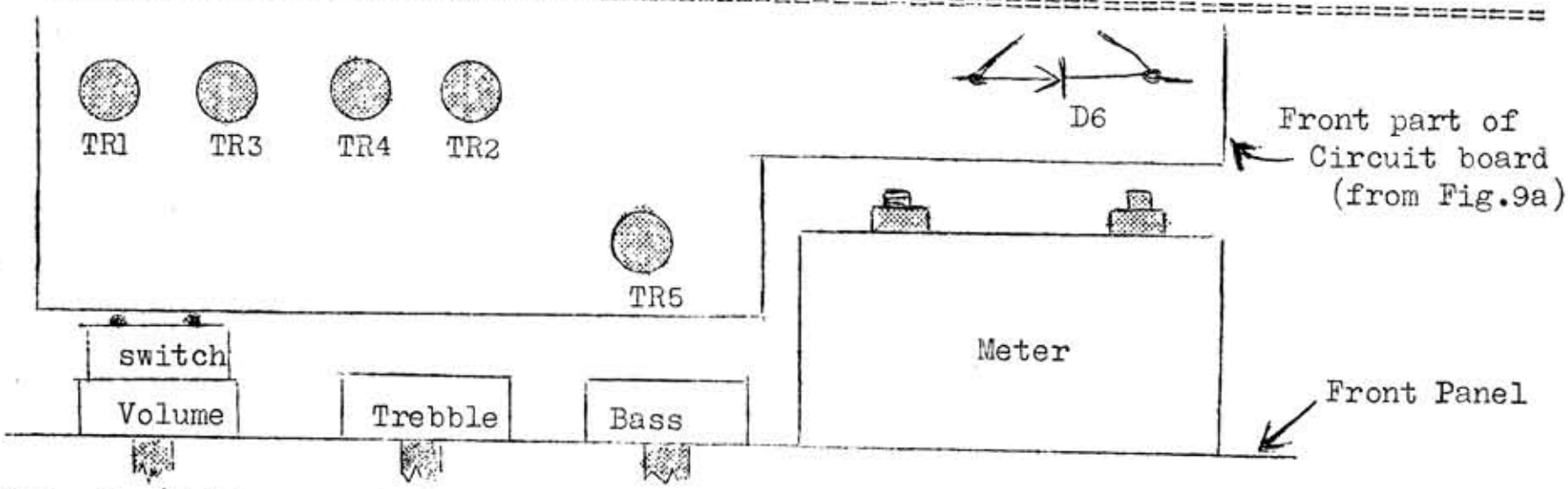


Fig. 9b (Author specified drawing to 'Full Size', therefore we had to break Fig. 9 into two parts because of space; the layout of Fig. 9b is supposed to lie adjacent and below Fig. 9a of P.9, and both are viewed from above --Ed.)

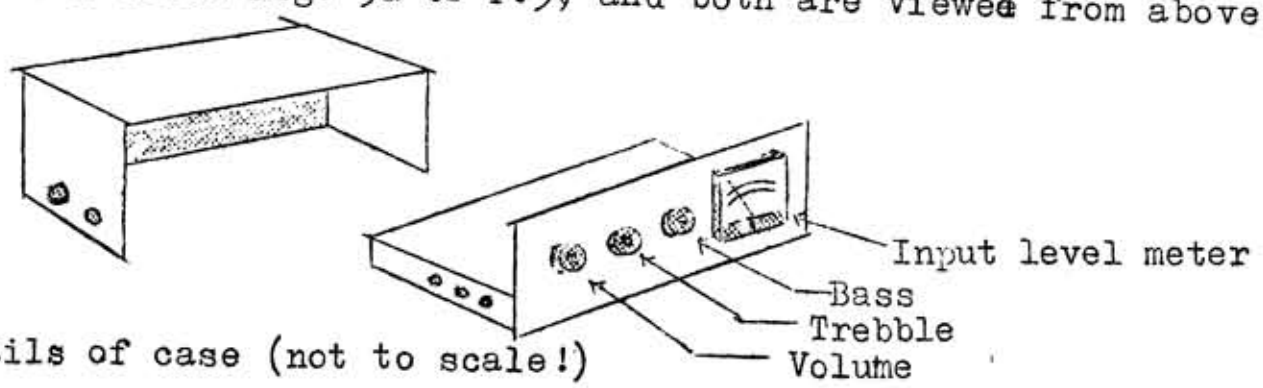


Fig. 10: Details of case (not to scale!)

Volume Compression (continued):

Performance: The following refer to the prototype. Similar units may vary, due to different transistors, though overall performance will be good in any event.

1. Frequency Response. Tone control switched out.
   Below threshold of compression: 40cps to 20kc/s ±1db (approx.), or better.
   High above threshold of compression: peak at approx 50cps.

2. Distortion: 1% or better until overload of TR1
   Negligible distortion in Compression Network
   Square wave response extremely good for PRF's of 100cps to 20kc/s.

3. Input Impedance: Low. Depends on setting of input volume control. In order to reduce loading on high impedance sources (eg. crystal pickup), a 47K or 100K resistance may be placed in series with the input. If this attenuates the signal excessively, an emitter follower transistor stage of conventional type may be included preceeding R1.

4. Output Impedance. Tone control switched in.(DPDT switch in 'down position')
   Nominally low, but may work directly into 500ohm to 5Meg input, assuming adequate gain of following device. For maximum gain when working into a high impedance load, a matching transformer could be employed, or an additional emitter follower stage feeding a common base stage.
   Tone control switched out (DPDT switch in 'up position')
   Medium impedance output. If input of following stage is less than 1K ohm, make R_{17}=1K (see circuit, p.10), or use matching transformer with 10K ohms primary impedance.

5. Noise: remarkably low on prototype. Dependent on temperature and transistors. (editor's note: temperature dependence, and probably noise could be reduced by using silicon transistors, with some slight adjustments in biases possible, owing to the increased voltage drop across base-emitter junctions. If it were necessary to use NPN transistors for this, the polarity of the battery and all electrolytic condensers would simply be reversed, with no other changes necessary. Note, however, that all of the transistors should be of the PNP or of the NPN type; no mixtures, with the circuit as presently shown)

6. Compression. Curve A of Fig. 11 shows the relationship between input and output levels for an ideal compressor. Although MAVCAT's performance is not perfect, it would be adequate for most needs. Perfect compression can indeed be approximated closely, as will be seen in next month's sequel.

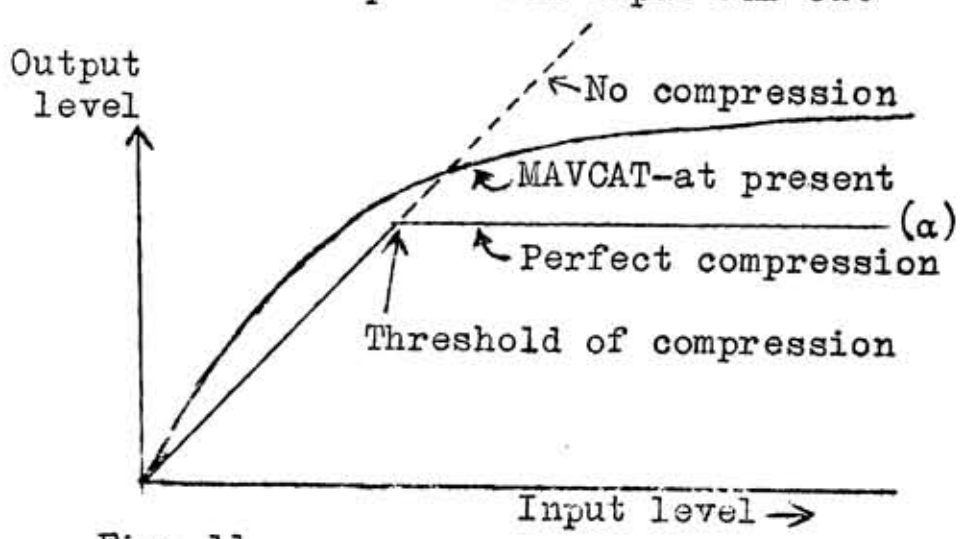


Fig. 11

NEXT MONTH: Compression for the experimenter.

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TAPE RECORDING.

-- by David James (VK2)

The Drive Mechanism.

Every tape recorder has a drive mechanism. This mechanism enables the tape to pass over the recording, playback and erase heads and to be fed onto the takeup spool. There are three common types of drive mechanisms. Those with one motor, those with two, and those with three motors.

Let us start with the three-motor system. Three separate motors are usually found in the more expensive machines and they always include a hysterisis synchronous motor for the actual tape transport to ensure a stable speed always. This motor operates at the one constant speed irrespective of fluctuations in the input voltage. Less accurate motors are used to drive the tape reels independently. Then there is the two motor system which is used in battery portable units. These motors are of very poor quality (compared with an H.S. motor) and are set for the one speed operation. These motors are situated below the reel-table with a direct drive. The right hand motor is used for forward record/playback drive and the left hand motor for fast rewind motion.

The one motor system uses the H.S. motor to drive the capstan and, secondarily, the tape motion. This is a more positive system than that used with the two-motors. This single H.S. motor is usually situated under, and in the centre of, the two reel tables. The capstan is driven by means of a flywheel to the motor whereas the tape transport mechanism is connected by means of belts and bands around the motor spindle.*

It is entirely up to you to decide the type of tape recorder and drive mechanism desired. The two motor system is the cheapest, increasing in price, and then there are the one motor and three motor systems.

The Capstan.

The capstan in a tape recorder is the main tape driving function, and the capstan sleeve is situated to the right of the record and/or playback head. This unit actually pulls the tape past the heads to ensure a constant speed at all times. The supply and take-up spools are rotating merely as a means of emptying and providing a tidy method of storing the tape until such times as it can be rewound onto the original spool.

Not many battery-driven tape recorders have capstan operation, and thus produce a fluctuation in speed.**

To aid the tape in gripping the capstan spindle, a pressure roller is incorporated, in order that the tape can pass between them. In the record and playback modes of the recorder, the pressure-roller presses against the capstan and pulls the tape through.

CONTINUED NEXT ISSUE.

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*Editor's Note: Because of the widespread use of cheap transistorised tape recorders it might be worth mentioning that these units use one motor, only, when they are designed for the greatest simplicity. The speed of the motor is stabilised either by a mechanical governor or by an electromechanical feedback system (using the 'Distler' motor), on the record/playback mode. Rewind function is accomplished by changing the direction of the motor electrically, removing the governing limiter, and/or increasing voltage applied to the motor. The electromechanical ('Distler') system has the advantage of longer useful battery life, but more 'flutter' and 'wow' than the governor-regulated device. Both are rather poor for quality, but they work.

**Ed. note: Capstan regulated battery operated tape machines are becoming more frequent, as the prices of these devices continue to fall. A capstanless recorder is virtually useless for use with other machines, or even with itself, depending.....

ADVERTISING

ASSOCIATION OF PUBLIC ADDRESS ENGINEERS. If you are interested in, or associated with Public-Address in any way, write to APAE, Box 122, Oakleigh, Victoria for full details of membership and benefits.

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post free anywhere in Australia. Descriptive literature free on request.
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SYLTRON (SYLVANIA) 5 inch Service C.R.O. Type 405 and Voltage Calibrator Type 304, with operating manuals. These first class American instruments have had lab. use only, and are in mint condition. Calibrator recently checked by University physics laboratory. £55 for the pair, plus freight; no offers. All spares standard and readily available locally. Apply Factory Manager, A. and L. Adams Pty. Ltd., 14 Myrtle Street, Bayswater, Victoria. (Melbourne area phone 72-91803).

FOR SALE. Electronic Speed Controls for portable (a.c./d.c.) drills, saws, sanders, etc, up to 3 Amp. name plate rating. Controls speed from 0-50 percent of full speed, and closely maintains pre-set speed under varying load conditions. Suitable for countersinking woodscrews into timber without pilot holes. Ideal for sanding off paint, and will not clog discs. Allows reduced speed for portable drills, for longer life of large drill bits.... Attractively housed in hard plastic case with carrying handle. Guaranteed for 12 months. £7.17.6, Post Free in Australia.
ELECTRONIC SWITCHES, P.O. Box 138, Balgowlah, N.S.W.

WANTED. Assembly only from P.A. Horn. At least 3W. Reasonable HF response. LF response, fidelity unimportant. Best offer. David Brown, 81 Faunce St., Gosford, N.S.W.

INFORMATION and ideas on speech/music compression systems wanted. Keep it informal. Please write or send small tape to -- John A. Hill, 31 Devon Road, Pascoe Vale W8, VIC.

SELL or exchange for C.R.O. etc. 2 speed (3-3/4ips, 7-1/2ips) two track Vinson 240V Tape Recorder. Capstan speed control. Two tone leatherette case cover, 5 inch speaker, 2 x 6AU6, 6AR5, 6X4 valves. Nearly new. Sounds good. Only used to get full call. £35. I.P. Cork, VK2BCP, Glen View, Wollomombi, Via Armidale, N.S.W.

HELP! is needed for the grossly overworked Editor(s) of the EEB. Here are the ideal conditions : we need an enthusastic person who is imbued with the spirit and ideals of the EEB, who knows a little at least about electronics matters, who wants very much to help make EEB a success, who can type using more than one (or two !) fingers, who is careful and neat in his work, who can draw electronics diagrams, and who would be willing to prepare stencils on a typewriter at the miserable fee of 2/6 each -- amounting to some 5/- to 7/6 per hour if he is careful. This would likely increase as we received more paid advertisements. It would help if he lived within a reasonable distance of Hobart, but it is not necessary. In any event, he could be furnished typewritten copy and stencils by post, and would return them the same way in a reasonable period of time. Ha. Dreamers, aren't we? If anyone is crazy enough to be interested, please enquire at 'EEB', P.O. Box 177, Sandy Bay, Tasmania. First come, first served!

Advertising (continued).

TAPE RECORDER OWNERS

Join an organisation designed for the enjoyment of such a pastime. The Australian Tape Recording Society offers many features to members including a monthly magazine entitled 'THE MICROPHONE.'

A.T.R.S. plans to open and operate a 'Pre-Recorded Tape Library' of commercial and home recordings to which members will be fully entitled.

An 'Electronic Advisory Committee' will advise you on problems with your tape and Hi fi equipment and A.T.R.S. can arrange the purchase, at discount prices, of selected brands of tape and tape recorders.

Write to the 'Secretary,'
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for full printed literature of the many services offered by Australia's most progressive tape recording organisation.

TAPE RECORDER for sale. Phono Trix, Mk. III, a medium quality tape machine, capstan drive, German made, very rugged construction, metal panel. Distler electromechanical feedback controlled motor ensures constant speed over long battery life (50 hours from four ordinary size 'D' cells), and sound quality is as good as can be expected from any miniature machine in the under £100 class: excellent for voice, poor for music. A transistorised circuit feeds a miniature loudspeaker. A motor is furnished for each of the two speeds: 3-3/4 and 1-7/8ips, and changeover takes about 10 min. A 6V well regulated transistorised power supply is supplied as auxillary, to operate directly from the mains, if desired. Tapes and 3-inch reels interchangeable with any other tape recorder, because of the capstan speed control. Twin-track system -- up to 80 minutes recording time on a reel of long-play mylar tape. Fast forward advance control. Pause control. Rapid rewind. Automatic magnetic erase while recording, can be disconnected for simultaneous recording (hold a dialogue with yourself!) Recording can be monitored. Leatherette case cover. This machine was used for about four years, intermittently, and it is presented for sale because the owner wants to get a good portable machine which will be good for music as well as voice, and which, alas, will cost a fortune.

-- Available in about three months. £25 plus post for the tape machine, and £5 for the special power supply. (TR originally cost equivalent to £80).

Enquire now. P.O. Box 177, Sandy Bay, Tasmania.

Advertising (continued).

FROM the 'Electronics Associates,' 76 View Street, Hobart, Tasmania.

'Useless' indeed! Each month hundreds of readers wait on our every word. What other business do you know which provides so many words per diode?

==A rose by any othername..... It seems that there is indeed another 'Electronics Associates' and that it is a great international organisation. We are also thinking of branching out, but our friends in other States say they are too busy, so we shall stay Hobart-bound. We have grown attached to 'Electronics Associates,' though from the amount of work that gets done by one person, it ought to be called 'Electronics Manager,' but never mind. Our new name will be

AUSTRALIAN ELECTRONICS

and will be adopted formally next month. We should have preferred 'Electronics (Australia)', but someone else seems to have thought of that. Just think what might have happened had we made this decision last year!

Incidentally we are grateful to the firm which originally brought this matter to our attention. They also sell diodes, but they are gentlemen.

'Australian Electronics' might seem to be somewhat pretentious for a home-owned hobby activity, particularly as we shall not continue it indefinitely, but we like the sound of it, and it gives us the opportunity to indicate quite unequivocally the location of the firm. This is not disadvantageous when making arrangements with suppliers in other countries. 'Tasmanian Electronics' might have been a plausible alternative, but you might be surprised to know how widespread is the opinion overseas that Tasmania is inhabited principally by Aborigines and Tigers.

==Meters. We still have some 60μA meters, and lots of 100μA ones. These are really photographic exposure meters, complete and working with photocell, for which we provide a pretty scale plus complete conversion instructions if your interests lie outside of photography. 60μA = 32/6 × 100μA = 30/6. Post free, of course.

The dozen 350mA thermocouple meters (25/6 ea.), 2 inch round, went out like 'snow upon the desert's dusty face,' and we are now faced with the problem of acquiring enough capital to obtain the vast number needed to sell at this price. Maybe by Christmas?

==Silicon Controlled Rectifiers, which we sell at the lowest prices in Australia, can be used to control vast amounts of power. When you buy them from us they can be obtained more inexpensively than most relays, and they are much quieter and more reliable if their ratings are not exceeded. Since even our lowest current type (4.7A) will handle 1000W of power from the 250V Mains, they provide the opportunity of controlling heaters and lights of all kinds, and continuously, too at the simple turn of a pot or illumination of a photocell. The number of applications possible is virtually limitless, but some hints are given in the practical literature on SCRs provided by Mullard, International Rectifier Corp (Warburton Franki), and (Australian) General Electric -- at moderate prices.

==Silicon Controlled Switches. These are PNPN gated diodes, like SCRs, but all three junctions are made accessible. If the SCR is a 'triode,' these are 'tetrodes.' Maximum power dissipation is only 100mW, but it takes only about one microampere to trigger them, compared to several mA for an ordinary SCR. This makes them ideal for a wide variety of applications (detailed in our Catalogue), not the least of which is to trigger an SCR. An SCS+SCR has a firing sensitivity comparable to that of a conventional thyratron, but at a lower trigger voltage, and able to handle much more power than conventional types such as the 884 or 2D21. We are stocking SCSs in order to make available to Australians the latest in semiconductor technology, and are purposely keeping the price low (21/6), to stimulate experimentation. With every order for SCS, we provide a detailed characteristics sheet, plus notes on a few typical ckts. The G.E. Transistor Manual says more, and also lists a large number of US transistors.

'NEWS BULLETIN. For immediate release.'

An organisation has been formed to cater for tape-recorder owners in Australia and overseas. Australia has only a few of these organisations as compared with Great Britai and the United States of America.

The organisation, the 'Australian Tape Recording Society' was opened in July 1964 after months of planning and preparation. The main features of A.T.R.S., as outlined by the Secretary, are as follows :-

- To provide, in the near future, a library of home and commercially recorded 'Pre-recorded Tapes' which members may hire for short periods at reasonable, reduced rates
- Discounts on several famous brands of recording tape are available up to and including 50 percent. Discounts available at the moment are on 'E.A.S.F.', 'Scotch,' 'R.C.A.','Sonocolor' and 'Triton' brand magnetic recording tape.
- Discounts on tape recorders and all household goods are available up to and including 50 percent. Maximum discount on tape recorders at the moment is 25 percent.
- Each month the Society publishes, for its members, a magazine containing news of all club activities, tape and equipment discounts, equipment reviews, classified announcements etc. The magazine is . titled 'The Microphone' and a copy can be secure by sending 1/6d to the address below. Members receive this magazine free of charge.
- The Society will publish, in the near future, a black-and-white, glossy magazine... ... describing technical and commercial details of tape recorders available.
- An 'Electronic Advisory Committee' is present for members' benefit in obtaining detailed information on electronic subjects.
- An attraction to talented teenagers especially will be the offer to record their talent and, if acceptable, a half-hour recording will be made and included in the 'Pre-recorded Tape Library' mentioned above. The recording, if popular among members, could result in the beginning of a show-business career. Good recordings are submitted to record companies and radio stations for review and possible action.
- Another unique feature with A.T.R.S. is the distribution of 'Newstapes' to members. At regular intervals a Master Tape is made up of news items of the Society and members' contributions of recorded material and despatched to members who provide registered postage for the tape to be despatched to the next member.
- Tape correspondence, a method which is popular around the world and a 'Round Robin' system are also featured.

If you would be interested in obtaining additional printed details of the information illustrated above, or you would like to have an audition, please contact the Australian Tape Recording Society at Box 9, Post Office, Crow's Nest, N.S.W. A.T.R.S. membership fees, compared with the services and advantages, are the lowest in Australia.

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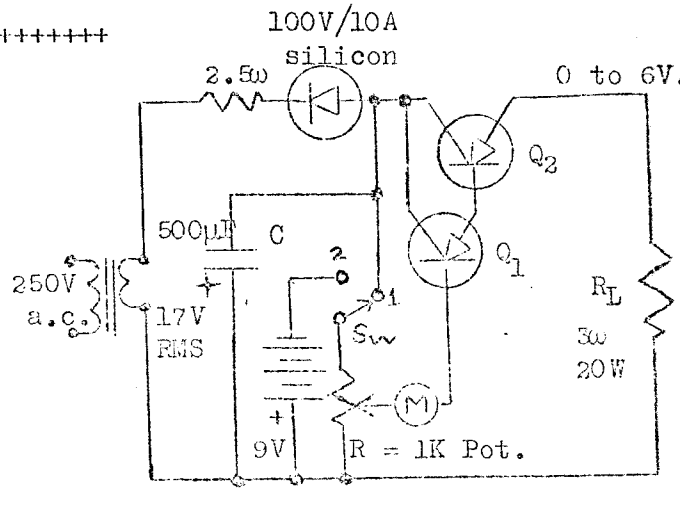
PUZZLE

Q1 and Q2 are high gain power transistors (AT1138 and OC26). The switch is thrown to position 1, and R is adjusted for 6V output. Then the current in the base of Q1 is 100μA. Switch is thrown to Position 2, and R is re-adjusted to maintain 6V output, but the base current of Q1 goes to 4mA. Maddening. Why?

The correct answer will bring a free one year subscription to the EEB for yourself or a friend (preferably a friend, to help spread the word).

Answer next month.



October 1965 Vol. 1 No. 12

EQUIPMENT EXCHANGE BULLETIN

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ARTICLES are solicited for the EEB, each of which will provide the author with one year subscription to the EEB, and Glory. Articles can be on any hobby subject, not necessarily electronics. If you have any interesting ideas or results, send them in. If necessary we can polish them for publication. Copyright is that of the individual authors. Although each article has been prepared carefully, we can accept no responsibility for errors. Opinions expressed in 'Letters' and elsewhere are those of the authors.

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BACK ISSUES are available at 5¢ each, except for Vol. 1, No. 11, which is 10¢. Subscriptions start with the issue published after receiving the remittance. The current issue and all others must be considered as back issues, because bulk mailing rates apply only when posting the entire month's printing.

BLANK PAGES do happen from time to time with our ancient duplicating machine, and sometimes we do not see them when assembling an issue. If you receive an issue with a page missing, please inform us, and we shall be pleased to supply it.

AN IDENTIFICATION NUMBER follows your name on the address label. Please refer to it in any correspondence to us, particularly for renewals or modifications of address. Please notify us promptly of any changes of address, for obvious reasons. And please send yourrenewal without our reminding you; the expiration date of your subscription is indicated on every address label. Thank you.

CONTENT.

Editorial.

We are grateful to the Australian Tape Recording Society for the beautification of the Heading, as above, and next month it will be even better. They do some beautiful colour work too, in case you are interested.

Recently we sat down to compute exactly what the EEB has cost to produce during the past nine months, and to our horror it cost about 6/- per subscriber (therefore about 6d. cost per back issue). If the paid advertisement volume doesn't go up by next Easter, the subscription will. From your favourable comments on the EEB, we think you may be happy to continue to support us for a year for the price of a small transistor.

We wish to apologise to T.W. Salmon, who says that it was he, not Br. Julian who was the author of the note on model trains in the May issue (upon which there was some dissention in the June issue). How did that happen? Never mind.

To our amazement we actually got a Volunteer to help type stencils, as a result of last month's plea. He'll be working for slave wages, but so do we, and we love company. This will simplify matters greatly, allowing us a little time to return to the Workshop, which we ought never to have left in the first place. --RLG.

Editorial (addendum).
Contrary to what everyone else says, 2d = 2¢, or has anyone in Canberra figured out how to charge 1.6667¢ per word?

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Letters to the Editor.

1. Early this month, the family and I went to the Grampians for a fortnight. One unusual feature of this holiday was the perfect nature of the weather, which in the mountains, is usually very bad at this time of the year. Whilst there, we set off for a couple of days touring through the Mallee. The Victorian Mallee had a very bad reputation years ago because farmers did not understand the dry conditions, and farmed by constant cultivation, known as 'fallowing,' leaving much of the cultivated soil exposed to the elements. This allowed the hot North winds to denude the farms of much of the top soil, often sending some of it absolutely free to Tasmania, the Tasman Sea, and an occasional dust cloud to N.Z., whilst southern Victoria had the sun blacked out on many occasions in Summer. All this has changed. The Mallee looks magnificent with the cover crop type of farming. Wise farming has saved the area from ruin and instead of losing the top soil, continuous coverage of clovers or lucerne has built up the soil so richly that it can almost be classed as first class land; and what is most important, no dust storms. All this is still dependent on good rains which the Mallee has been fortunate to enjoy for a number of seasons...

Experiments are proceeding in fine style with my latest transformer, using a ferrite core to reduce the size and weight of my electronic flash, now complete to my satisfaction. After rebuilding the unit, it is my intention to turn my attention to work out the details of a transistorised fluorescent light for my caravan operated from a 12V battery. A bought unit was fitted by me about 2 years ago. It has been such a success that I would like to build a small unit for reading in bed. This would be about 6 watts whilst the bought unit is 15 watts, with a light output better than a 40 watt incandescent lamp... A few tests haven't been very promising, but as yet, I have not read much on the subject, and research has not started in earnest. These jobs will probably cost more than a manufactured one, but who worries, as long as one accomplishes something and has a lot of fun, pleasure, and satisfaction in the meantime.

-- E. J. Watts
North Geelong, Vic.

((We saw something similar in Radio-Electronics perhaps 5 years ago, but it was designed with a long time constant for producing flashes. Why not simply start with a 240V/12V(c.t.) filament transformer used backwards, and a one or two transistor blocking oscillator of the conventional dc-converter design (except that this would put out a.c.). Even though it were only 50 percent efficient, an ordinary 30 watt transistor (OC26, 2N250) ought to suffice, as long as heat sink is adequate. By using a torroidal core, efficiency could be improved considerably; in any event a symmetrical oscillator would likely be more efficient than a single-ended one. -- Ed.))

2. I may have some interesting SCR applications, if I can find the circuit of an SCR relaxation oscillator that doesn't need a series resistor.((Can anyone help him? -- Ed))

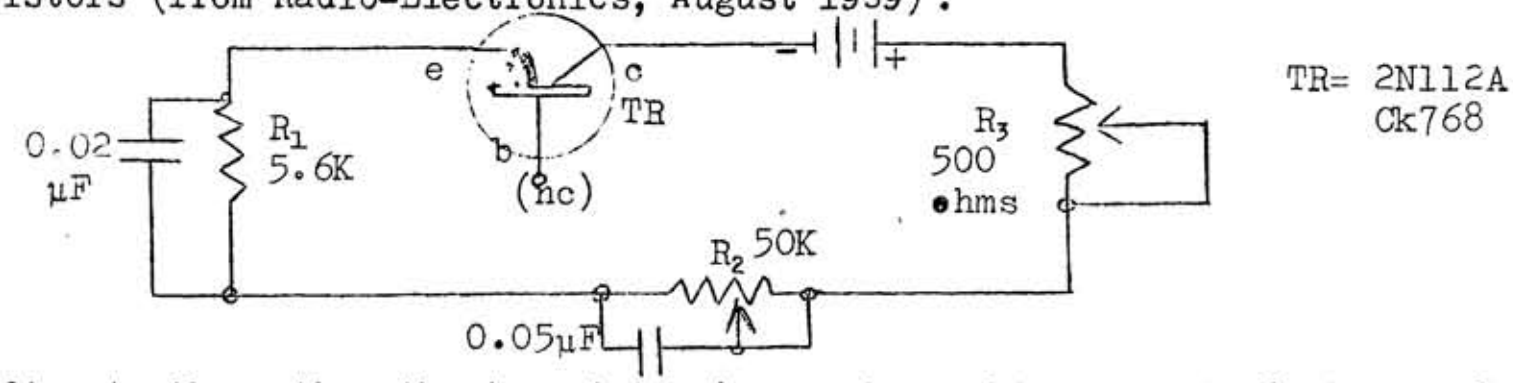
I have a query on SCR function (Reference EEB, Vol. 1, No. 2, p.4). I can appreciate the fact that electrons pass from the NP junction at the cathode, to the gate circuit and to the anode circuit (through a PN and an NP junction), when anode polarity is positive with respect to gate. What about the back-biased SCR, when anode is negative? Then there is nothing to prevent electrons from flowing through the anode PN junction, through the next NP junction, and out to the gate circuit, if the applied voltage is sufficiently high to overcome the barrier potential of the NP junction. The only thing that would stop this would be either a high PIV rating for the middle NP junction, or

Letters (continued).

a diode in series with the anode (as described in EEB, Vol. 1, No. 8, p.5).

I have realised that SCRs would be impractical for SCR keying at high frequencies. The charges around the junction would not have time to reform, and it would not cut itself off. " One dit and you're gone..."

Here is another note on back-biased silicon diodes, or rather not diodes but transistors (from Radio-Electronics, August 1959):



According to the author the transistor 'seems to combine certain features of the reverse-biased diode and of the ionic oscillator... R_1 is a limiting resistor to protect the circuit and transistor. R_2 controls the bias current. R_3 eliminates distortion from the wave and leaves a pure sine wave.' (pure?). To test a transistor for suitability, he left out R_3 but added a voltmeter across the transistor, and brought R_2 down from some large resistance. If, as R_2 is reduced, the voltage drops as the current rises, a negative resistance is shown. Also, however, 'when the circuit is adjusted for sine wave generation and low output (about 0.1V) it is highly sensitive to temperature.' Touching the transistor either causes the oscillation to stop, or the frequency of oscillation to rise markedly. Could this not have big possibilities for ultra-sensitive thermistor-type fire alarms, etc.?

In the same issue, there is a two-valve staircase generator for testing transistors -- very interesting.

-- D. Brown
Gosford, N.S.W.

((Ordinarily we don't prefer to engage in detailed technical discussions, because of problems of time, but this seems to be of some general interest.

((Looking from the anode of an SCR, it is indeed the middle NP junction which should block electron flow when anode is negative. It would certainly require sufficient PIV rating, or the use of a series protective diode, to limit the reverse leakage current to a safe value. But it is not particularly relevant whether the leakage current passes to the gate or cathode. If too much passes, the junction will be destroyed in any event. But we should note that when the anode is negative, so will be the gate, thereby resisting the leakage current in the external gate circuit. It is important, however, to make certain that a diode is connected in series with the gate, to prevent current flowing through the gate-cathode junction when gate is negative.

((One of the junctions of the transistor is back-biased (ie collector-base), but that is normal. It is not surprising that a transistor exhibits negative resistance. In this instance, however, it is likely that the negative resistance arises not only as a result of the 180° phase shift between base and collector, but because of the Pseudo-tunnel Diode characteristic of the back-biased collector-base junction (reference EEB, Vol. 1, No. 7, p. 4; No. 10, p.1; No. 11, p. 3). It is important to realise that the base is still functioning, even though it is apparently not connected. It receives its current through leakage from the collector. If this current is out of phase with collector voltage (because of PTD effect), the base goes negative when the collector goes positive. This results in oscillation, because the base does not 'know' where it is obtaining its current, and promptly acts to control the collector current in the

Reply to Letter (continued).

usual manner. Thus, when the collector goes negative, a positive signal is fed through the PTD (collector-base) junction, and the positive base then drives the collector further negative (by current drawn through R_3), and so forth. It is an interesting idea, and ought to work fine for silicon transistors having sharp collector reverse characteristics, but one ought to be careful when reducing R_2, to avoid damaging the junction. R_2 should be decreased only to that value which gives good stable osc.

((Unfortunately some of the ordinary usefulness of this kind of oscillator is vitiated by its necessarily high temperature sensitivity, and any attempt to stabilise base voltage would eliminate the effect desired. Whether this could be used as a temperature sensing device more reliable and sensitive than a good thermistor is an interesting question, and ought to be investigated. Our own investigation into the behaviour of PTD devices indicates that the characteristic (which depends on cumulative thermal breakdown) can be quite unstable, and in temperature control devices stability is as important as sensitivity. In temperature warning systems (eg. fire alarm), the device might be more practical, as long as the transducer following it was sensitive in the same direction, to an increase in oscillation frequency, or its cessation.

((On the other hand, in rooms having relatively even temperature, the device could be useful as a simple sine wave oscillator. It is not always easy to make a transistorised oscillator having a reasonably good waveform, and one like this might be useful for, eg. impedance bridges, where a good waveform is required, but where its exact frequency is not particularly important. --Ed.))

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VOLUME COMPRESSION (Addendum) -- by J. A. Hill (mostly)

Reference EEB Vol.1, No. 11, p. 7ff.

Fig. 4. Reverse diode.

Fig. 6. Earth centre tap of control amplifier transformer primary. Earth junction of the two diodes at the left.

Fig. 7. Reverse D_2

P. 10 . Reverse D_1

There has been interesting response to my request for information(on the advert. page of last month's EEB). Two circuits of interest, but in my opinion not nearly as satisfactory as MAVCAT. :

Electronic Engineering: Aug. 1965, p. 502. 12 transistors plus rack of auxiliary equipment. Uses principle of my Fig. 4. They use the term 'bottomed transistors.' Poor performance : 3 percent distortion.

QST: Aug. 1965, p. 21. 5 transistors, suitable for ham rigs only. Frequency response and distortion probably poor.

Also see : Audio Magazine: Dec. 1964. Describes inexpensive LDR compressor.

More precise details on performance of MAVCAT ought to be available when I get the opportunity to apply ruler, oscillator, and CRO. Qualitative performance reports have been very favourable, from use of the system in a hifi recording studio and even for ham rigs. 'Compression for the Experimenter' will be available for next month's EEB ((probably --Ed.)).

By the way, reference p. 10, MAVCAT is the only amplifier in the world which can claim low Disgortion. A comprehensive discussion on 'Disgortion, its causes and correcgion' will undoubtedly appear in a forthcoming volume of the EEB. ((yeah? well I'd like to see this 'limitless' compression, also ref. P. 10 -- Ed.))(((With two extra stages, and elimination of the meter, it could become 'TABCAT'))).

I might add that R. Maddever's criticism of the 'casual Australian Experimenter'

High Disgortion (continued).

is true, especially of me! But I'm learning. MAVCAT does use four similar stages because of (1) simplicity, (2) all transistors except TR4 are operating at approximately the same signal level anyway, and (3) it works.

+-+-+-+-+-+-+-+-+-+-+

A PRACTICAL TRANSISTORISED IGNITION SYSTEM. I. -- by G. van Leuven (VK5)

Practical transistorised ignition systems became popular in this country when an Australian technical magazine printed a 'How to do it' description of them. However, the transistorised ignition still does not have the popularity here that it deserves. One reason may be lack of knowledge about it by the automotive trade. And one reason is undoubtedly cost, though it is possible to build such a system for about A$30, being comparable in price and performance with American units. A third reason might be poor construction and improper fitting to cars by the home constructor. I have been driving on transistorised ignition since 1960, and am quite certain that some system using transistors or SCR's of some type will have to become standard in all automobiles in the near future. I am trying to help this popularity along.

Fundamentals.

Let us start from the beginning. The present day ignition system is shown in Fig. 1. It was designed by Kettering some 40 years ago. It is the only major part in our modern car that has never been altered. It works on the principle that when the breaker points close, current flows through the coil. The magnetic field builts up. Then the breaker points open, and the magnetic field collapses. By induction, the secondary winding produces approximately 10,000 to 20,000 volts.

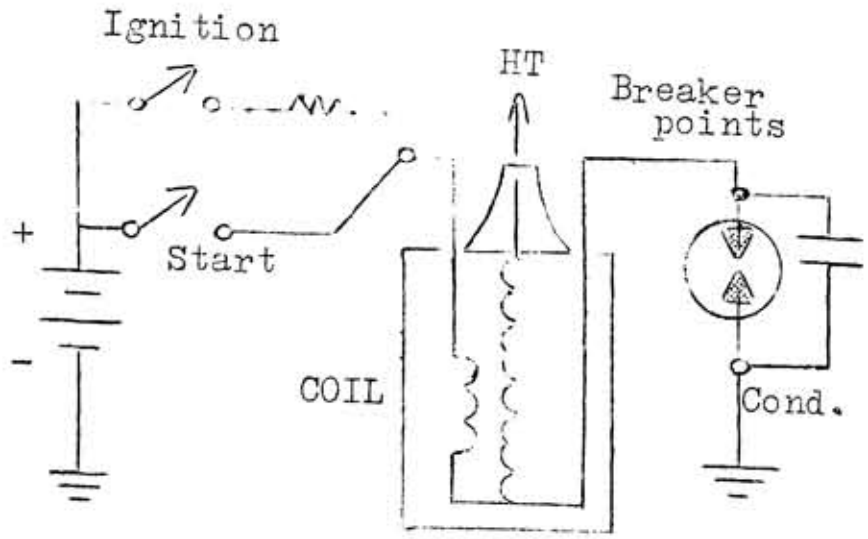

Fig. 1

Advantage. It works.

Disadvantage. Loss of top performance at high speed, and the breaker points wear. In present day cars, the points are pitted at 5,000 to 10,000 miles, when points carry about 4 Amps-- the absolute maximum. The voltage kick-back of several hundred volts which occurs when points open, cause them to pit, in spite of the bypass condenser. Because of the high primary inductance and the short time that the breaker points touch at high R.P.M., the primary current of the coil cannot build up to its full value, resulting in plug fouling and high speed misfire. Additional disadvantages are the possible failure of the bypass condenser, and the fact that the fibre breaker-points bearing wears rapidly because of metal splattered on the distributor cam by the violent arcing of the contacts. All of these things are avoided by the use of a transistorised ignition system.

A Transistor Ignition Circuit is shown in Fig. 2. It works on this principle: the breaker points trigger the transistor which in turn does the switching of the coil. Because the transistor is capable of switching some ten amperes, we can now modify the coil to take advantage of this. The transistor coil has a turns ratio higher than normal. In this case it is 300:1 (normal coil 100:1), and systems have been designed for ratios as high as 500:1. The higher ratio produces a higher secondary voltage, and

Transistorised Ignition (continued).

because it has fewer primary windings it can absorb current faster. But, protection is needed for the transistor, to prevent puncture of the PN junction by the strong 'inductive kick' that results when the coil's magnetic field collapses. The protection is afforded by the Zener Diode, Z, which turns the transistor 'on' for a brief moment at the peak of the inductive kick, thereby damping it out. This allows a small Zener to do the job of a much larger one placed in the collector circuit (as found in some older designs). An 80V Zener is used when the transistor voltage breakdown (BV_{ces}) rating is 100 volts; a 60 volt Zener is used for a transistor having an 80 volt rating. The safety margin of 20 volts in either case allows for effects due to heating, variation in semiconductor ratings, etc.

R_4 limits the maximum base current when the 'points' are closed. If base current were increased beyond the point at which the collector became 'saturated,' collector current would not increase, but base current would, to a possibly destructive level. This could depend upon difference between characteristics of transistors, and upon temperature of operation.

The 15 ampere diode, D_1 protects the unit against faulty installation. But, even as important, it guarantees transistor cut-off even at relatively high temperatures. A small current flows continuously through the diode D_1 and resistor R_3, ensuring a voltage drop of approximately 0.5 volt across the diode, causing its anode to become positive with respect to the cathode. The cathode is connected to the emitter and the anode through R_2 to the base of the transistor. The base is thus positive with respect to the emitter at the moment the points open. This is a reliable way of ensuring transistor cut-off. Without the diode this action might be faulty at high temperatures.

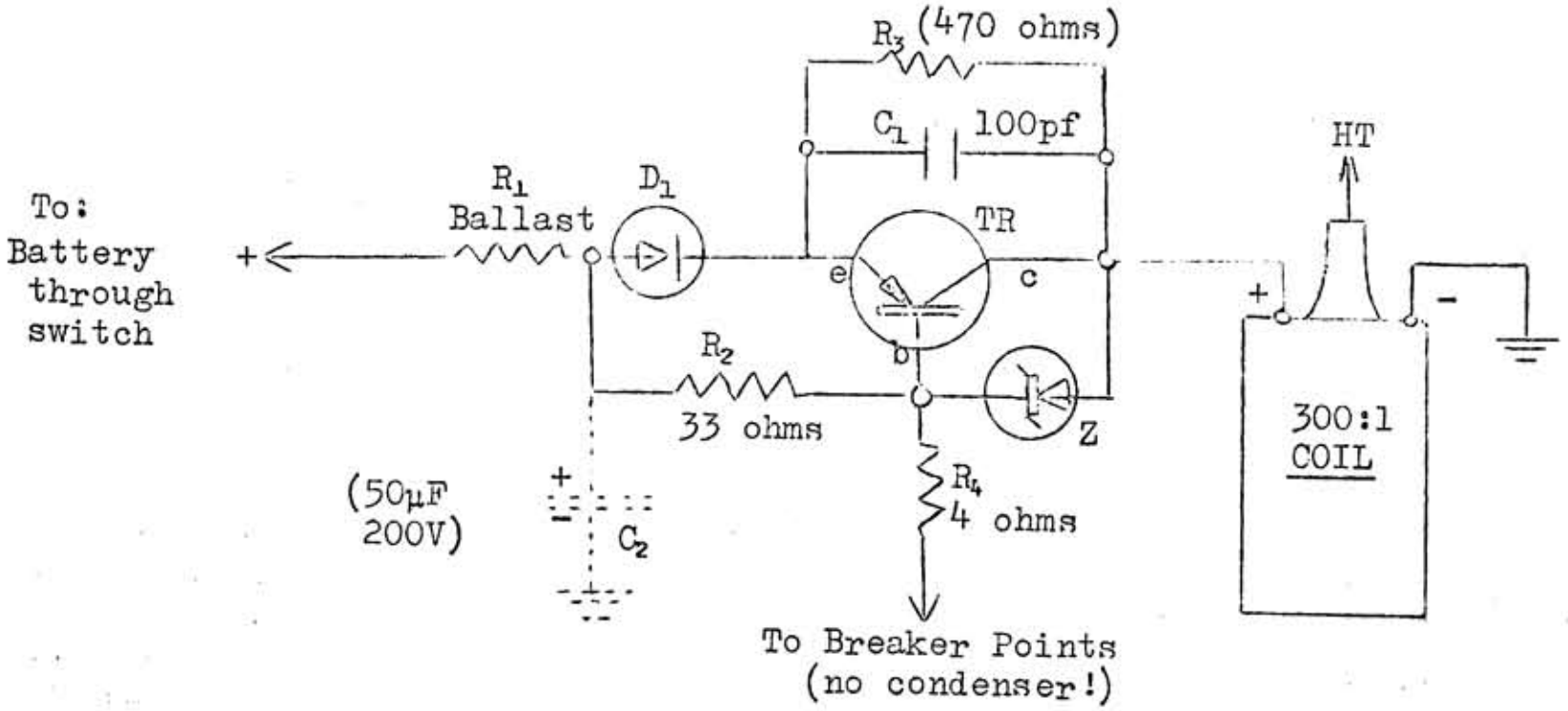

Fig. 2

A heat sink is necessary for the transistor, not only to prevent destructive 'thermal runaway', but also to prevent the transistor from conducting when hot, even without base excitation.

Condenser C_1 protects the transistor from high frequency spikes, and as extra protection you might add condenser C_2 which would damp any peaks generated in the car's electrical system by generator, starter, horn, etc. ((If radio noise is observed as a result of the more efficient switching action of the transistor system, it might also be desirable to add a 0.5µF condenser in parallel with C_2 --Ed.))

Transistorised Ignition (continued).

In the above circuit, the coil is wired in the earth side, the so-called cold coil configuration. The ballast resistor is on the ignition switch side for reasons which will be discussed later. This completes the preliminary description of a very useful and reliable transistor ignition system. This circuit is used in one form or another by several manufacturers all over the world. It is regarded as the best transistorised ignition system, if you consider cost and performance. We often put far more money than this into a car, with less to show for it in improved performance. Don't think, however, that when you have installed a transistorised ignition, your car will go so well that you'll have to find ways to make it stop.*

Well, then, what difference does it make? Smoother idling, better acceleration, and better pulling power at slow speeds ((and greatly improved petrol mileage on some makes of cars --Ed.)). The improvement will depend on the type of car, and will generally be greater for smaller ones.

In the next issue of the EEB I shall discuss installation and adjustments. Do not attempt to construct the system until the entire series of articles has been completed!

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ANSWER TO PUZZLE on p. 17 of last month's giant issue.

STOP PRESS! L. Osborne got the solution-- maybe. See discussion next month.

Although John Hill tells us he got a flood of replies to his advert, we got one lonely reply out of several hundred readers. He says 'I would say that the different base currents would be caused by a change in external base circuit resistance. I would estimate the voltage across R in position 1 to be about 20V, and R would be adjusted to give 6V (or slightly more) to the base of Q_1. In position 2, R has to be brought up for the same voltage, but the base circuit resistance is lower, therefore the current rises to the 4mA stated.'

Wrong. It is true that the base circuit resistance is increased in position 2 of the switch, for the reason stated above, but this would have no appreciable effect on the base current, because R is readjusted to maintain 6V output. Since the output voltage is the same, and since the output resistance is the same, the output current must be the same in the two different conditions. Since $I_c = \beta I_b$, the base currents must be the same in the two different conditions, if β remains constant, since the load resistance is reflected accurately to the Q_1 base circuit as an equivalent input resistance of $R_{in} = \beta_1\beta_2 R_L$, and therefore the I_{b_1} ought only to depend on the voltage developed at the tap of the pot, R.

No, the secret is the fact that β does not remain constant. The 500µF input filter condenser is the clue. It is insufficient to filter the output from the half wave rectifier. This means that the collector voltage applied to the two transistors fell too far in each cycle. In position 1 this did not matter, because the base voltage also fell in the same proportion. But in position 2, the base voltage was maintained constant, and at the point in the cycle where the collector voltage fell below the base voltage, current flowed between base and collector, rather than between base and emitter as it should. The extra base current was then flowing in the collector rather than emitter circuit, and I_L was unaffected. In this installation, however, 'R' represented a complicated d.c. preamplifier whose performance was ruined by the unexpectedly large I_{b_1}.

Increasing C to 3000µF cured the trouble. A similar behaviour had been observed as in switch position No. 2 (when C = 500µF), simply by bypassing R at the tap by a suitably large condenser from base to common line, but if we had said that, you might have guessed the answer right off So, the Editor gets a free one year subscription to the EEB. Ugh.

'PNP' reads the same, forward or backwards.

---

*Oh ? That's exactly what happened when I put one such gadget in our Volkswagen! Something to do with 'preignition'. But now it does it without the TI too. Oh well.--Ed.

ADVERTISING

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TRANSISTOR IGNITION KITS complete with coil and special ballast resistor with starting tap, and diode. Full instructions. 12 volt negative earth £15.0.0 post free. Literature free on request. Other models available. Unsurpassed for performance at this low price. MODERN ELECTRONIC EQUIPMENT CO. P.O. BOX 407, NARACOORTE, S.A.

METERS. 0-15 volt meter with coloured dial for Automotive use.
0-15 Amp meter with coloured dial for Transistor Ignition.
30-0-30 Amp meter (centre zero).
Others available. All meters 1-3/4 inch square clear plastic face. Priced at 48/-, post free, from MODERN ELECTRONIC EQUIPMENT CO. P.O. Box 407, NARACOORTE, S.A.

SELL :- Three Pye Reporter taxi radiophones with valves, vibrators etc, two 12V and one 6V untested. Should be worth £12 each, first offer takes. Full data and conversion data supplied if all three sets taken by one buyer.

New 12V Transceiver, xtal locked type TR1196A with all valves and plugs and operating circuit. In transport case complete, only £10. Operates on frequencies approximately 3 to 8 mc/s.

Two U.S. Army BC-611B Walkie-talkies, excellent order, any offer takes.

One latest model Travel-aire Cooler-heater-air conditioner. NEW and perfect at under half price. £20 will secure. Size 15 in x 13 in x 14 in with adjustable louvres, multi heat and cool switch etc. 240V AC operation.

Surplus valves at 4/- each (minimum order 5 valves, assorted ok). Types :- 1A5G, 1A7GT, 1C5GT, 1C7G, 1D5GT, 1D8GT, 1F5G, 1H5GT, 1J6G, 1K7G, 1L5G, 1N5GT, 1M5GT, 1P5GT,

ADVERTISING (continued).

1Q5G, KL4, 6C6, 42, 43, EBC33, EF39, EF50, VR56 (EF36), VR503 (KT33C). Limited quantities only, all OK, S.A.E. for reply.

One only, high voltage flash tube (Mullard LSD3) absolutely new, also Ducon oil condenser 27μF 2700V to suit in perfect order. Cost £16 the pair but best offer takes.

Add freight all items. M. J. O'Brien, Edgar Road, San Remo, Vic. Phone 107.

FOR SALE. Halicrafters 12 volt power supply. Vib rator supply 200V at 50mA continuous, genemotor 400V at 200mA with PTT terminal and relay to switch 200V from receive to Tx. Original genemotor replaced by Command unit, reconnected for 12 volts. £5 or offer. Jon Kitchin, 52 Railway Pde, Midland, W.A.

AUSTRALIAN ELECTRONICS (formerly 'Electronics Associates'), 76 View Street, Hobart, Tasmania, where it is now gently snowing, while Sydney basks in heat.... We had a suggestion for an improved name: 'Apple Isle Electronic Services' (AIES). Hmmm, how about 'Society for the Promulgation of Incomparable Transistorised Electronics?' (SPITE).
Add: 50V/20A for 15/6 (a few), Zeners 26B for 8/6, 3N35 NPN silicon VHF tetrode transistor, very versatile for various things (an article on this next month in the EEB). 6/-
Here: 2N174, to our surprise. The first small lot arrived, and we look forward to the remainder in a month or so. It was really very easy. It required only several letters to the reluctant supplier (after he had our money), a telegram, and two phone calls from Representatives in different parts of the U.S.A. Nothing to it.

2N250 is definitely reported to be on its way from a more reputable supplier. In a few weeks or so. 34/6 for the 2N174, 12/- for the 2N250.
Also coming: 2N1100 PNP Ge VHP LF HT transistors (150W, 15A, 100V) from a reliable supplier, but to sell for the shocking price of 47/6 each. Sorry. But when used with the suitable Zener (80-90V) they will allow appreciably more output from transistorised ignition systems. We ordered these when we despaired of getting the 2N174's.
LAST MINUTE NEWS-- 2N1100 has arrived. BVces=100V, lovely. Also 2N1100B, BVces=110V, for 49/-, while they last... (We erased a minor announcement, to tell you about this)
Still available: Pseudo Tunnel Diodes, various types, as per the recent articles in EEB. 10/- each. We apologise for having sounded vague to enquirers about these, but you can see how much information was packed into those articles. We are not getting rich off of these; they represent a lot of work and time, but we are making them available to people who like to experiment with interesting things. Pls see the articles in question.

3N58 SCS's, ideal for high sensitivity triggering of SCR's and a host of other functions. Technical Characteristics plus applications notes supplied. 21/6.

100μA movement photographic exposure meters, easily convertible, for 30/6. No more 60μA movements, sorry... Many thanks to those of you who have converted them yourselves, and have not requested us for same. We lead three lives in one, and time is a terrible problem... Maybe we'll keep up the stock of these meters, maybe not. They are a lot of trouble, the yield is wretched (anyone interested in a few with wobbly movements, and who-knows-what-else? Name a price), and they are hard to pack. In addition we have our eye on those marvelous 350mA (2.5mA movement) thermocouple meters (no conversion, just ordinary lovely meters), as soon as we find an extra £100...

One of these months we shall be running out of the 50V/0.75A diodes (still 16 for £1) and 100V/0.75A (13/£1), and when they are gone, there will definitely be no more LT diodes. A great bother.
Modify: 100V/0.25A silicon signal diodes (similar OA200 series) to 2/-, and limit of twenty per customer. It's not fair for a few individuals to buy up the lot, and there will be no more of these either, when they are gone. Commercial equivalents cost much more... 200V/0.75A are 2/6ea, 10 for £1. 300V/0.75A 3/-, 8 for £1. (that 6 was misprint!
DELETE: T8G, T8S, T9G, T9S, T10, T11. We are not going to handle any more individual small transistors, and want to keep the remainder for our own use. But please note that small, good, transistors are now available on the Australian market for good prices.

AUSTRALIAN ELECTRONICS (continued).
Delete. 1200V/0.75A and 50V/5A diodes. No more 100V/5A reverse polarity, but some normal polarity left. This will probably also become a discontinued line soon. Delete Zen. 7.5C.
Note. Did anyone see our note about the 1kc/s (bandpass) mechanical filters? We got one lonely reply to that. Incredible. All right, if we don't get them, you go ahead and continue to pay £17 for similar items having 455kc/s centre frequency. Bah. What has happened to the Australian Experimenter, huh? A converter costs a whole lot less than £12.

==We receive so many letters on extracurricular subjects that we are strongly tempted to publish the best ones here. We shall, however, resist that temptation, because we must not turn this into a Club... Look, we can afford to be virtuous, concerned about our customers, and to offer the lowest possible prices, because we are not trying to get rich out of this. We can take time to be concerned, although even that commodity is becoming scarce (therefore we are cutting back on advertising), but if we had to run this enterprise on the reasonable and efficient basis that would be required of a proper business, we should have to become a lot more hardboiled, and to get the maximum possible value out of a £. This is not to disparage the practice of nominal business enterprise, but to say that a serious consideration of business activity carries with it some heavy respensibilities.... (to be continued !).

SENDER --

The Equipment Exchange Bulletin
P.O. Box 177
Sandy Bay, Tasmania
Australia

TO : Rodney Reynolds//42
St. Georges Rectory
Battery Point,
Hobart, TAS

Registered at the G.P.O. Hobart, for transmission by post as a periodical

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ISSUED MONTHLY

P.O. BOX 177
SANDY BAY · · TASMANIA

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ARTICLES are solicited for the EEB, each of which will provide the author with one year subscription to the EEB, and Glory. Articles can be on any hobby subject, not necessarily electronics. If you have any interesting ideas or results, send them in. If necessary, we can polish them for publication. Copyright is that of the individual authors. Although each article has been prepared carefully, we can accept no responsibility for errors. Opinions expressed in 'Letters' and elsewhere are those of the authors.

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BACK ISSUES are available at 5¢ each, except for Vol. 1, No. 11, which is 10¢. Subscriptions start with the issue published after receiving the remittance. The current issue and all others must be considered as back issues, because bulk mailing rates apply only when posting the entire month's printing.

BLANK PAGES do happen from time to time with our ancient duplicating machine, and sometimes we do not see them when assembling an issue. If you receive an issue with a page missing, please inform us, and we shall be pleased to supply it.

AN IDENTIFICATION NUMBER follows your name on the address label. Please refer to it in any correspondence to us, particularly for renewals or modifications of address. Please notify us promptly of any changes of address, for obvious reasons. And please send your renewal without our reminding you; the expiration date of your subscription is indicated on every address label. Thank you.

CONTENT:

Editorial.

We have had several reports from subscribers that they did not receive the July or Aug/Sept. issues of the EEB. One of us who worked in a Post Office at one time, says that printed matter is not always given the same consideration as First Class Mail. It seems, so to speak, that one gets what one pays for. Well, there is no help for it, because the bulk post rates are most reasonable. Therefore, we ask you to be certain to let us know if you don't receive a given issue, say, by the middle of the month, or so. Well-- the third week of the month, maybe! Shocking.

In the same vein, it seems that our readers are catching up to us. While we were cranking out the October issue, some mail arrived asking that the Advert. be placed with the October issue. Ummm, we may be late, but please don't depend on it. This month's tardiness was caused by complications arising from tetrode tr. research.

Toward the end of the year, (ie, next month) we shall make some nice folders, and gather complete sets of back issues into "Vol.I." of the EEB. Since nearly every one who requests back issues wants all of them, this should make the back issue situation more simple. After December, back issues for Vol.I. will be available only

Editorial (continued)
as a complete set, so if you are missing any, now is the time to request them. If you have requested any and have not received them, let us know that too, please.

We have had a request to indicate prices of items listed in our Bibliographies. We wont do this, because many of the items are available from sources abroad, and because prices in Australia can not only be higher, but can vary from one source to another. With all due respect for the domestic book trade, we suggest that you can save some money by sending directly overseas for literature published there. It is not difficult. Money for printed materail can be obtained simply by going to a bank and asking for a draft in Dollars, Sterling, or whatever. You then write to the distributor or publisher, enclosing the cheque, and requesting the publication. Add about 10% to the price, for postage. This is a reasonably accurate estimate, since large books which weigh more will ordinarily be more expensive. You will still often save over the domestic price, and there will be no customs duty charged. When ordering, it is not a bad idea to mention in your letter that there are no Customs formalities about which to worry, and the publication can be posted in the usual manner. But if you are handwriting, write legibly! Some of the addresses we receive are shocking, even though we have asked specifically for legibility.

One possible exception to overseas book procurement may apply to publications by the large valve and semi-conductor manufacturers. These can often be obtained from their Australian Representatives at a not-unreasonable price, not to mention the fact that an enquiry to the parent company may be met by a request for you to refer back to the local Representative. Warburton Franki handles International Rectifier Corp; Australian General Electric for General Electric; Cannon Electric for Motorola Corp; and of course Mullard, Philips, Amodeon, and AWV for their products. (Have we left anyone out?) Even so, reference to London book sellers may be profitable for some items.

The article on Speech Compression will be postponed until the January issue, so that we can present it with a minimum of interruption to the text. Sri.

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Does anyone know the whereabouts of K.C.Jewery, formerly of Woomera,S.A.? We'd hate to think of his missing any of our fascinating issues.

A PRACTICAL TRANSISTORISED IGNITION SYSTEM Part II - by G.van Leuven.

In part I. there was described a simple and practical Transistorised Ignition system, which would be worthwhile, effective and economical. It can be built by the home experimenter who has had a little experience, or similar systems can be obtained commercially. Commercial systems do not cost appreciably more than the cost of the parts, and they are provided with well engineered instructions which place less strain on the experience of the constructor.

Modifications (?)

Could we make it cheaper or better? With regard to the first query, an effort to economise on this already simple circuit could only result in sacrificing safety precautions (just think of your wife when she gets stuck on the road with an unconventional ignition system you have built, and which is a mystery to garage mechanics!). The bias diode could be omitted, but operation might be unreliable at higher summer temperatures.

Could we make it better? Oh yes, but then the "dollar-to-performance" ratio would be degraded.To make the transistorised ignition appreciably better would cost money, and not merely a few dollars. The amount of improvement that you would notice would not be comparable to the amount of money you would invest, even to the $50 or $60 level, at least as it applies to the family car. For car races, many things could be done, but that is another story, and ignition system is only part of it.

Transistor Ignition (continued)
Installation do's and don'ts.

Although it is generally understood that a transistor ignition makes car starting easy, the fact is, that supplied in its usual form, a transistor ignition is a poor starter and some cars won't even start with it, unless special precautions are taken.

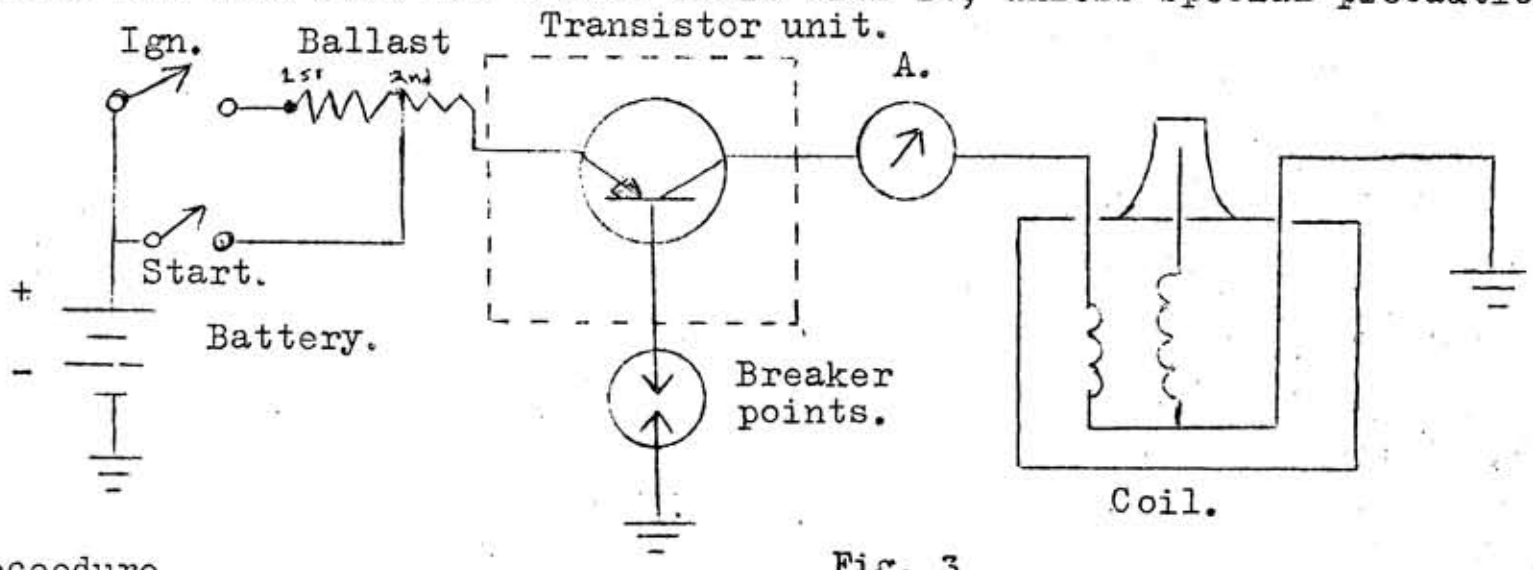

Fig. 3

Proceedure.

The ballast resistor is adjusted to get a primary coil current of some 10Amps, (12Volt system). During cranking, the battery voltage will drop to 10 Volts, or less, thus reducing the coil current below 10 Amps. Just when you want a good spark, it is not available Therefore we have put the ballast resistor in the switch circuit. An additional tap is now fitted to the ballast resistor and adjusted to 10Amps coil current, with the battery at 12 volt. This tap is then connected to the starting switch. (fig. 3) The taps on the ballast resistor can easily be adjusted on the work-bench. Wire up transistor ignition and ccil as in fig. 3. Place an Amp-meter between the transistor unit and the coil. (point A in fig. 3.) Connect 1st. tap on ballast resistor to positive of 12volt battery Connect breaker point wire to negative and adjust 1st tap to make amp-meter read 9½ -10 Amp. Now disconnect 12volt from first tap and connect 10volt to 2nd tap and adjust it to 9 -10 Amp. (these measurements and adjustments should be made very quickly). Cars having automatic choke (eg. Valiants) must have this special starting tap, as they must start at once If they don't start immediately, the carburettor will be flooded. This starting tap can be connect-ed to the special starting switch supplied on most modern cars. But if you do not want to upset the normal wiring in the car, you could connect it to the starter solenoid, as this is only operating during cranking. To determine how much the battery voltage will drop, it would be a good idea to connect a voltmeter to your car's electrical system, and watch it for a few days.*

Starting Relay. I have always favoured short and positive connections. The car's ignition switch is made to carry 4 or 5 amps. T.I. draws 7-10 amps through the switch. Although this can be done successfully, a better method would be to use a relay to connect the T.I. straight to the battery. Fig. 4 shows a complete install-ation circuit for transistor ignition using the special starting tap on the ballast resistor and starting relay. It also shows where "quick connect" plugs can be used for quick change-over to normal ignition.

Please note that some cars having a generator "tell-tale" light, might cause

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* Since the time of writing, "Electronics Australia" has published an article on the use of Voltmeters in the Automotive field. A voltmeter can be a real asset in your car, for the battery voltage will vary over a wide range under different conditions, and the instrument will reveal these variations at a glance . The ampmeter is also a handy instrument, for reading your primary current, (fig. 3), checking the state of ignition system, and indicating when your points are closed, when stationary.

Transistor Ignition (continued)
trouble when a starting relay is used. The ignition switch is by-passed and the relay coil might stay energized by the "tell-tale" light even when the ignition is turned off. This will become evident as soon as you turn off your ignition, after installing the relay. In fact it will not switch off, and your "tell-tale" light will remain alight. The trouble is easily rectified. Disconnect, (or break) the lead from generator indicator light to voltage regulator. Insert a 0.5A/400V silicon diode between the globe and the voltage regulator, (cathode towards regulator). If a flangeless diode is used it can be fitted inside a plastic fuse holder for protection and neatness.

Positive connections. Many a T.I. system fails to operate successfully because of poor connections. Give it a chance and make sure that all connections carrying 10Amps are good! Nut and bolt is best, although there are some good "quick connect" plugs about. However they are subject to corrosion due to heat, dampness, dirt and vibration, causing poor electrical connections. All connections in T.I. carry 10Amps except the breaker point wiring and the energiser wire to the starting relay. If an amp meter with a removable shunt is fitted to the car the shunt can be removed from the meter unit and fitted separately near the T.I. unit, while two wires will go through the fire wall to the meter unit on your dash. It might cause a reading error of $\frac{1}{4}$ - $\frac{1}{2}$ amp. on the meter, but this could be corrected by the zero adjuster. A word of warning! Never use an automotive amp-meter for adjusting your ballast resistor, as the readings are not accurate enough.

General considerations. The diode in the "tell-tale" light circuit can be replaced with a 12Amp/100V diode, in the ballast resistor circuit, from the starter solenoid. (cf D in fig. 4.) One thing should be remembered. T.I. will not cure a sick car. Before installing it be sure that your car performs normally. Since T.I. produces higher voltages, high tension wires, distributor cap, etc., should be clean and in good order. It has been found that after installing T.I. sparks between plug top and motor block were caused by dirty and greasy plug bases. Finally, T.I. can be fitted under the bonnet, in the engine compartment, provided it is NOT fitted on or above the engine block, or on the firewall facing the exhaust manifold.

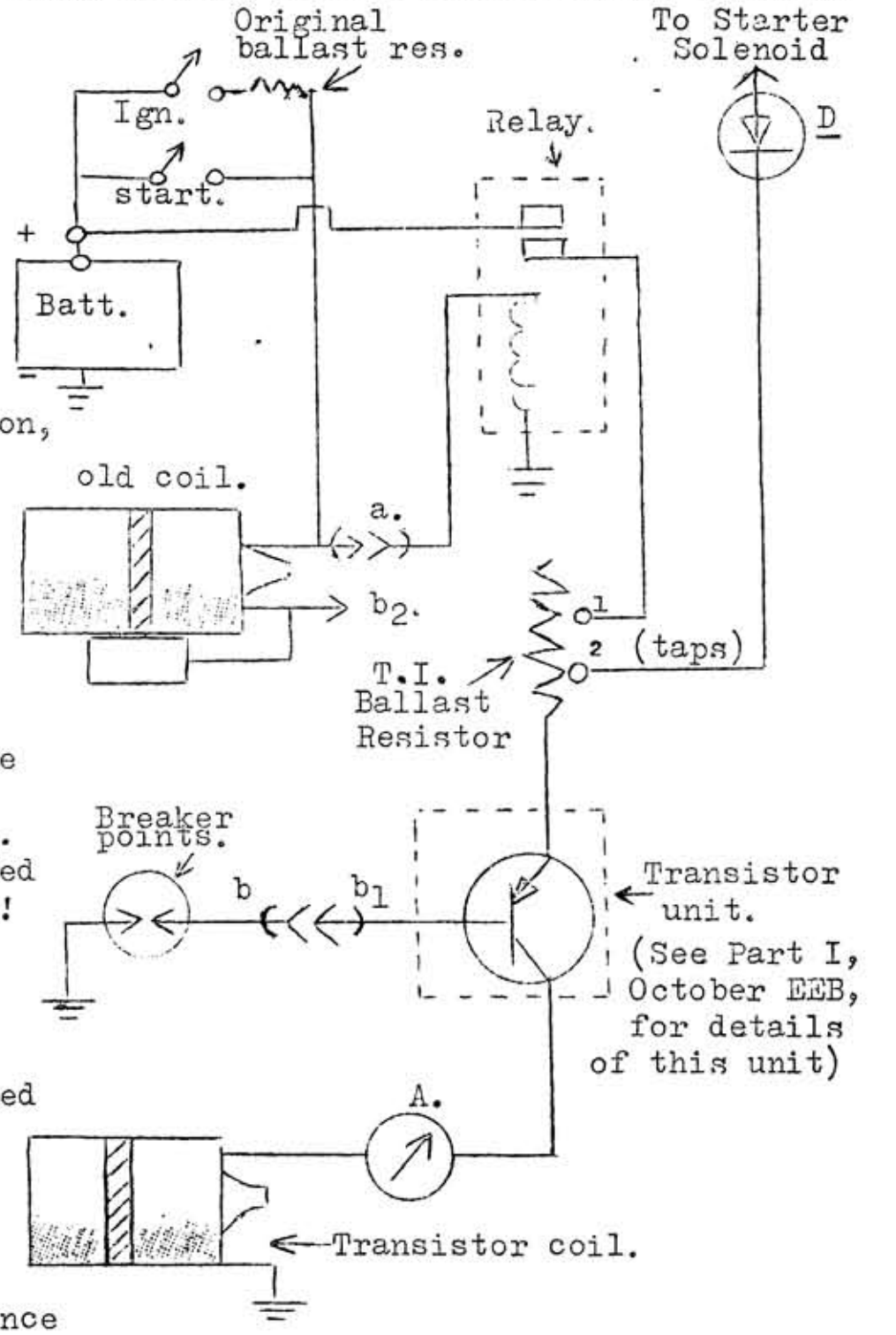


Fig. 4

When relay is used, original ballast wiring does not have to be disconnected. To go back to standard ignition, only three wires have to be changed; (1) disconnect "a" from old coil; (2) Disconnect distributor wire "b" from transistor unit "b_1"

Transistor Ignition (continued)
and plug wire "b" onto terminal "b_2" on old coil. (3) Take high tension wire out of transistor coil and plug it into old coil.

(To be concluded)

Puzzle.(Addendum)

In reference to the Puzzle presented two issues ago, last month just as we went to Press, we got a cryptic note from L.Osborn of Victoria who saith:

"Ripple from the rect?"

This was probably correct, as per our discussion in last month's issue (P.7), but it is so cryptic, that we are awarding him a 6-months subscription, to give him the ben fit of the doubt. We trust that he will enjoy the extra bonus; he is a new subscriber, and we look foward to receiving several dozen articles from him.

The puzzle presented in September is important and basic, because it illustrates that a PNP transistor is truly as symmetrical, as a first approximation, as those letters imply: an electrical donor sandwiched between two electron acceptor substances. The collector is simply arranged so that it can dissipate more heat than the emitter, and normally the collector-base junction is back biased, while the base-emitter junction is foward-biased. But it should not be overlooked that when the collector of a PNP transistor goes positive with respect to its base, the c-b junction becomes foward biased, and an appreciable current will then flow through that junction. You might take a more exact electrical symbol for a PNP transistor as the following:(figl) If, in fact, we had been making the decisions, that is what it would have been, with perhaps the collector line being somewhat heavier than the emitter one, or double, as shown.

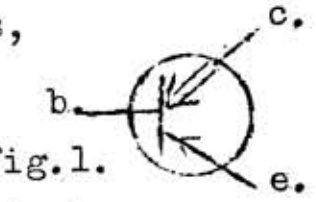
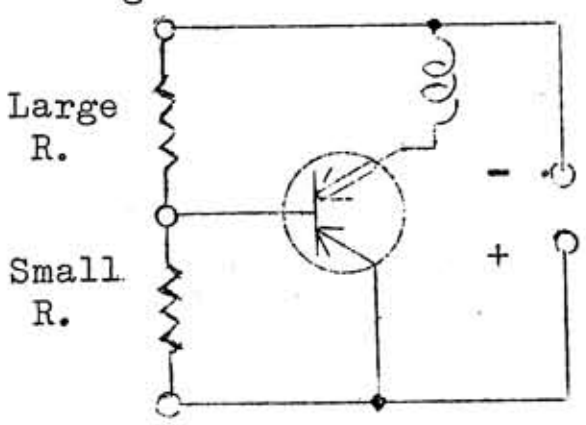


fig.1.

In the same vein, the only reason why reversed polarity can be death to transistor circuits, is the fact that when polarity is reversed, the base bias resistors get turned about, and the base simply becomes biased for excessive current through the now-collector (formerly emitter) junction. Quite paradoxically, this applies only to transistors stabilised for temperature effects by a base bleeder network. Transistor amplifiers will not be harmed by polarity reversal if initially they received their base bias through a series resistor -- only if the normally emitter-base junction can stand the back bias potential.Try it for yourself, if you don't believe us! Using the above suggested configuration for a PNP transistor, the situation becomes:=



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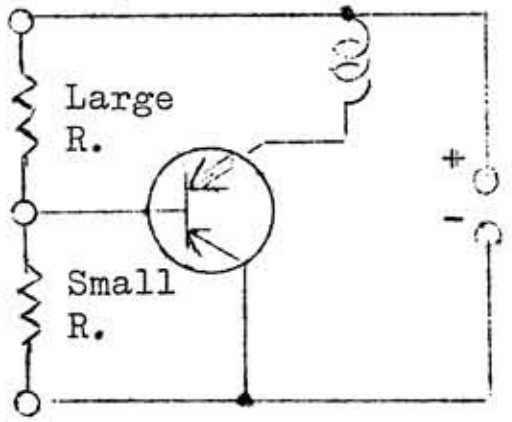
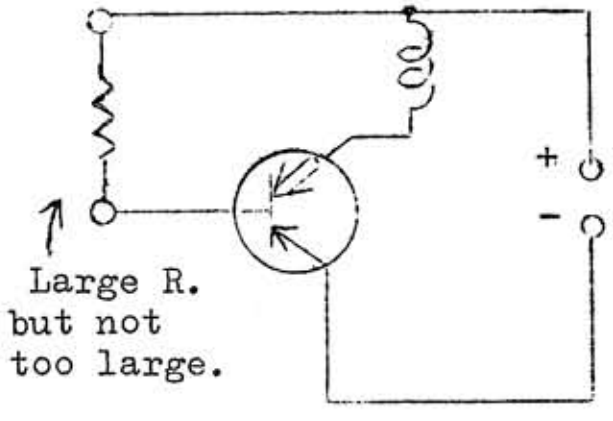


POOF !-



O.K.

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TETRODE TRANSISTORS, Etc. by R.L.Gunther.

Although John Hill made a wry joke in the September EEB about "pentabase" transistors, there are definitely duobase transistors (and more!), and they are interesting devices. Perhaps there may even be some use for them in Speech Compressor Circuits when it is inconvenient to provide the extra amplification needed for diode-control of gain, and where high fidelity is not most important.(Eg Radio amateur modulators.)

Tetrode Transistors, (continued)

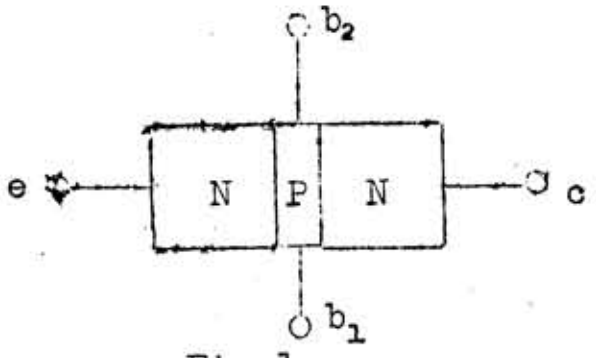


Fig.1.

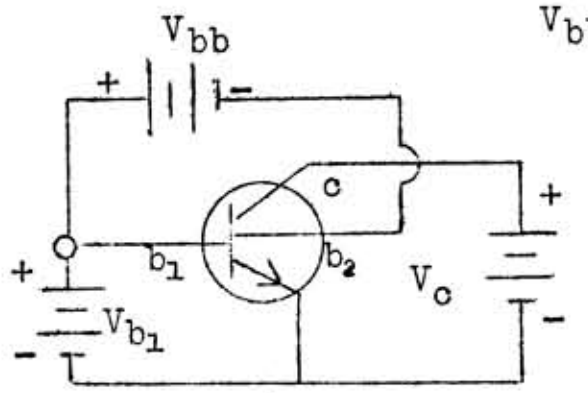
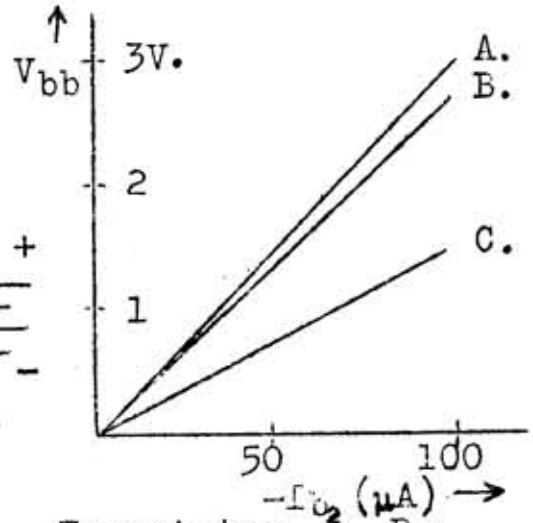


Fig.2.



Characteristics.

Transistor.	R_{bb}.
A.	29K
B.	27K
C.	14K

Fig.3.

The tetrode transistor is distinguished by an extra base connection on the side opposite the usual base connection. The normal signal base is "b_1" and the extra base is "b_2". (See Fig.1) The normal junctions are biased in the usual manner for NPN (fig.2), but an extra d.c. bias voltage(V_{bb}) is applied between the two bases. The part of the emitter junction near "b_2" is biased in the reverse direction, and does not emit electrons into the P layer. The only part of the emitter junction which is forward biased is the part near the "b_1" connection. Therefore "normal" base control action occ urs only in a small area of the b-e junction. Application of the transverse base current (I_{b_2}) sweeps carriers from the emitter toward "b_1", giving smaller "sideways" base resistance and smaller collector junction capacity. This results in a smaller output time constant, giving better high frequency performance. The "swept" emitter carriers, however, appear as increased"I_{b_1}", and therefore current gain is reduced. As we shall see, this can be put to good use.

The tetrode transistor is made from grown-diffused and melt-back processes, and can handle a relatively large amount of power compared to the VHF transistors which preceeded it, since selective etching is not necessary for the tetrode. A more recent development is the mesa or epitaxial planar transistor (eg. by Fairchild etc.) which is the logical successor to the tetrode, and which handles appreciable power. more simply, with higher gain, and much more inexpensively. (New tetrode transistors still cost £15). The tetrode has, however, some unique advantages, owing to the flexibility of circuit control offered by the extra base, and is by no means obsolete for these conditions.

In general, the decrease in current gain at high emitter current levels is less for NPN than PNP transistors(because electrons are more mobile than holes). The tetrode is NPN, and can also handle still higher currents, if "b_2" is made positive with respect to "b_1", because it reduces the "b_1" transverse voltage drop. The type 3N35 (currently most readily available in Australia) is only rated for a maximum current of 20mA., because it was designed principally for low power VHF uses, but the constant gain characteristic is valuable within its ratings.

I have measured* the electrical characteristics of a few Type 3N35 transistors, and the results are depicted in Figs.3-6. From fig.3 you can see that the resistance between the bases is of the order of 10-30K, and this alone could be useful. Fig.4 shows that application of transverse base bias has the effect of shifting the entire I_c/I_{b_1} characteristic, and reducing its slope (therefore current gain). Fig.5 illustrates the control characteristic of the second base, and its good linearity over a wide range suggests that b_2 could be used to inject a signal independently

*Thanks to Tony Ohsberg for measuring characteristics of Transistor 'D'.

Tetrode Transistor (continued)

of "b_1" as a mixer. The gain of 'b_2' is only a little less(eg.70%) than that of 'b_1'; the input impedence of 'b_1' is the 1K typical of common emitter, while that of 'b_2' is an order of magnitude higher. This can also have useful applications.

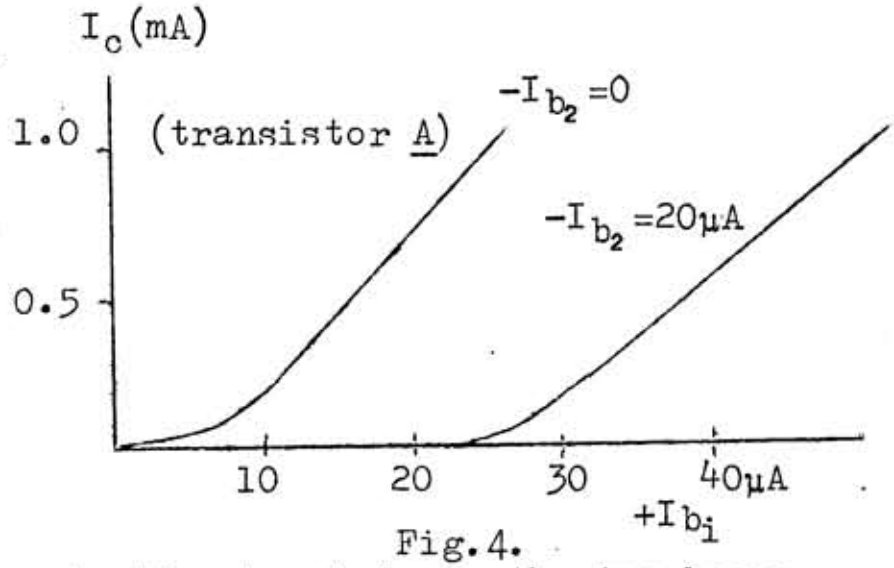


Fig.4.

The reduction of gain with transverse current (fig.6) varies considerably from one transistor to the next, and it is advisable to make this calibration for yourself, before designing circuits, using the transistor. This is accomplished most easily by connecting a battery, and microammeter and potentiometer between the two bases, and then measuring 'b_1' gain in the conventional manner, while keeping I_{b_2} constant. According to the electronic literature other types of tetrodes show even greater control of gain by 'b_2', but these were not immediately available. Other types are 3N29, 2N24, and type 700. Applications to Volume Compression or AGC suggest themselves. Although these functions can be accomplished by diodes or triodes, the use of tetrodes could have the advanta ge of compactness and high efficiency. In the case of AGC for receivers or modulators, distortion of strong signals will be less for a tetrode control stage than for a conventional triode transistor, because the gain can be controlled at levels of I_c where the I_c/I_{b_1} characteristic is still linear. (ref. Fig. 4)

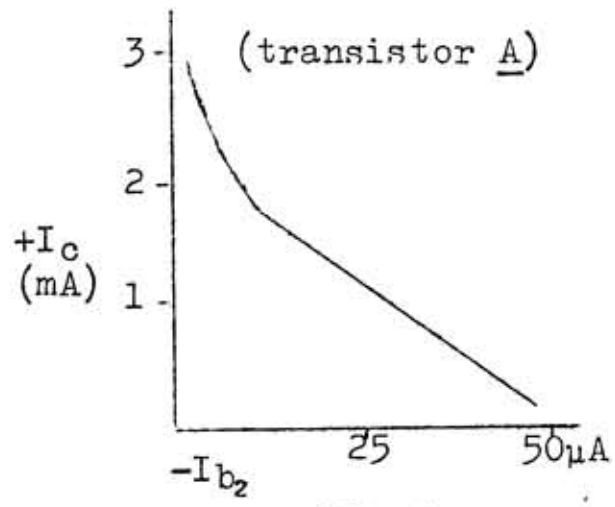


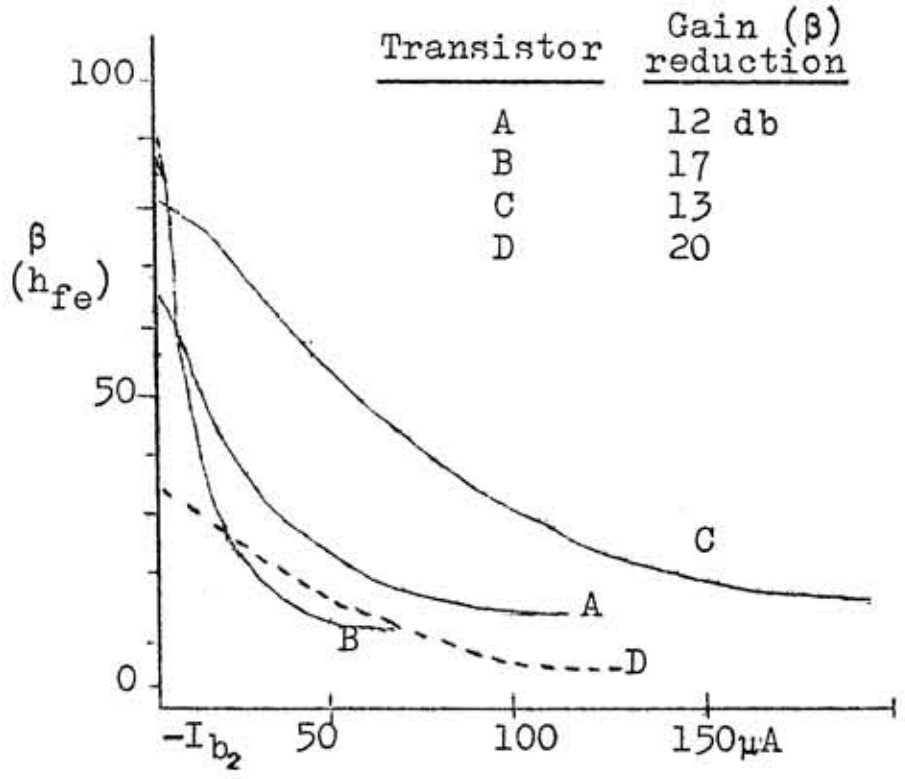
Fig.5

Amplifiers.

It would be impractical to present the many types of circuits for which tetrodes can be used, therefore I shall merely present a few design principles, from which you can select the application most favourable for your needs. Fig.7 shows in one figure the various ways in which the tetrode circuit can be employed as amplifier or oscillator. With the exception of the 'b_2' circuit, it also happens to be the general scheme describing operation of ordinary triode transistors, and is a good review of basic transistor circuit configuration. The two principal variables are circuit impedences and bias conditions. The circuit impedences depend on the nature of source and load, and on whether voltage or power gain is more important. Bias conditions allow the junctions to conduct in the appropriate directions, with minimum effect of temperature variation, or of variation of characteristics between different transistors.

Bias conditions.

Charts I and II illustrate typical values of components for various configurations and supply voltage. Design is for I_c about 1.5mA, V_{ce} about $0.5V_{cc}$,



Transistor	Gain (β) reduction
A	12 db
B	17
C	13
D	20

Fig. 6

Tetrode Transistors (continued)

and $-I_{b2}$ about 100µA. R_3 and R_4 form a voltage divider, with a bleed current about 1mA, putting half the supply voltage on b_1. Since the base$_1$-emitter voltage for the foward biased silicon junction is only about 0.4V, nearly half of the supply voltage appears across R1. According to Ohms law this defines the current through R_1, and therefore collector current is made quite independant of transistor gain or temperature effect (on I_{co}), as long as the current through R_3 is appreciably greater than the base currents, $I_{b1}+I_{b2}$. R_2 is chosen to pass 100 µA driven by the potential $V_{b1}-V_{bb}$ where Vbb will be about 2V. This general method for designing biases for an amplifier is simple and convenient, and ensures stable operation. Additional complications could arise from other dc conditions, eg., separate source of I_{b_2}, but the above type of reasoning and common sense will yield the correct result. The only other fact to know is the definition of current gain (forCE), where it is relevant, $\beta_1 \doteq I_c/I_{b_1}$, and analagous for β_2. The current gain is actually the slope of the I_c/I_b curve, but this approximation is adequate for ordinary purposes.

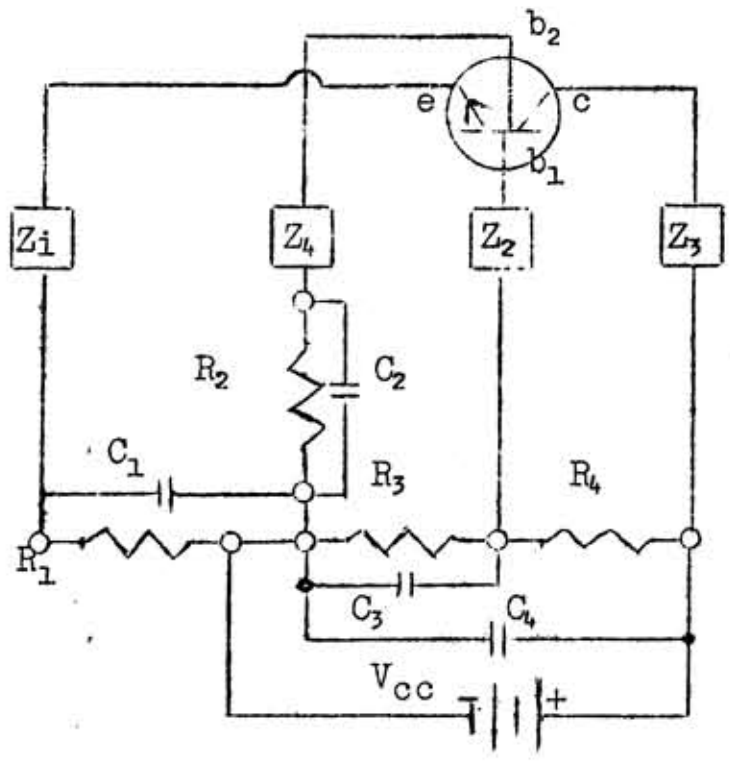


Fig.7.

It is important to realise in Fig.7, that the Z values given refer to a.c. impedences. If they contain appreciable resistance, the lumped resistances associated with them must be reduced appropriately. For strictly resistive circuits, (eg. for R-C coupled a.f. stages), the input and output electrodes are unbypassed, of course, and 'Z' in Fig. 7 is zero.

The values of bypass condensers will depend on the resistors they are bypassing, and in general the minimum value for a given condenser, C, will be:

$$C = 1.6/(fR)$$

where C is in µF, R is the resistance in ohms to be bypassed, and f the lowest operating frequency in Megacycles. If f is in cycles, C will be in Farads. For HF and VHF use, disc ceramic or tubular condensers are best. For pulsed HF signals, when common-emitter configuration is used, bypass C_1 and C_2 with 0.1µF.

V_{cc}	R_1	R_2	R_3	R_4
45V	15K	220K	22K	22K
22	8.2	120	12	12
12	4.7	39	5.6	5.6
9	3.3	27	4.7	4.7
6	1.8	10	2.7	2.7

CHART I

Since transistor collector current is relatively independent of collector voltage, a wide range of supply voltages can be used, as shown in Chart I, though higher supply voltage will result in better d.c. stability, due to higher bias resistances. In comparing Fig. 7 with Fig. 2, it can be seen that V_{bb} is derived from V_{R_1}, and consequently R_1 is an integral part of the design as shown, and is necessary in order to obtain V_{bb}. Alternatively, however, V_{bb} can be supplied from an external source such as d.c. rectified from r.f. for AGC, or rectified from a.f. for Speech Compression or fast-attack AVC, or d.c. from a potentiometer for remote control of gain. Note that at low supply voltages, V_{bb} becomes an appreciable part of V_{R_3}, and must be included in the computation for R_2. $V_{R_3} = V_{R_1}+V_{b_1e}$. $V_{b_1e} \doteq 0.4V$

Tetrode Transistors, etc. (continued). ((And also continued next month))

Impedances and Interactions

This discussion applies to triode or tetrode circuits, and reviews a few basic and useful principles. The data of Chart II define the circuit of Fig. 7 for operation

Type of circuit	Input	Output	Z_1	Z_2	Z_3	Z_4	Feedback
Common Base$_i$	Z_1	Z_3	80	0	100K	0	
			(350	0	1Meg	0)	
Common Emitter	Z_2	Z_3	0	1K	30K	0*	
Common Base$_i$-Emitter	Z_4	Z_3	0	0*	30K	20K	
Common Collector	Z_2	Z_1	1K	30K	0	high	
			(10K	220K	0	0)	
C-E Oscillator	Z_2+180°	+ Z_3	0			0*	$Z_2 \doteq 0.1Z_3$
C-B$_i$ Oscillator	Z_1	+ Z_3		0		0*	$Z_1 \doteq 0.03Z_3$

CHART II

*Nominal C-E impedance presented if signal (also) fed into this element

as amplifier or oscillator. The impedance figures given are those for maximum power gain, are nominal and approximate, and vary from one transistor to another. Equations deriving the exact relationships are complicated. It is, however, possible to obtain approximate experimental data for impedance relationships by relatively crude methods, for example by varying the voltage on the collector (with input electrodes fed with constant voltage) and observing the collector current change; this gives the minimum dynamic output resistance. I say 'minimum' output resistance, because there is (unlike valve behaviour) a considerable interaction between input and output, and output resistance will be higher when the input is open than when it is shorted. (Note that these comments refer to signal conditions; in each case appropriate d.c. bias conditions must be maintained). These variations are represented by the figures given in brackets in Chart II. To make the situation even more complicated, output impedance depends on collector current; for Common-Emitter, Z_o can be 200K at Ic = 0.2mA, 30K at 1mA, and 10K at 3mA. On the other hand, the input resistance of the Common Emitter circuit is not strongly affected by load, but can be increased by introducing negative voltage feedback (eg., by reducing or eliminating C_1). These interactions are the glory and the bane of transistor circuit design, but surprisingly it is possible to build useful circuits in spite of this. Circuits can be made relatively insensitive to interactions, through mismatching and by applying negative feedback of various types. Mismatching reduces power gain somewhat, but reduces the effect of input-output interactions, and increases bandwidth in r.f. tuned amplifiers. Capacitative negative feedback is called 'neutralisation,' and has the dual advantage of increasing stability (eg. reducing tendency to oscillate) and of reducing output-input interaction; for purposes of easier stage alignment, it can therefore be desirable to provide neutralisation of an i.f. or r.f. stage, even when it shows no tendency toward oscillation instability. On the other hand, simple voltage or current derived negative feedback (simple 180° phase shift) improves amplifier stability by reducing gain (though it does not exactly substitute for capacitative neutralisation), and has the additional advantages of reducing output-input interaction, and of improving the linearity of a transistorised amplifier. It must be remembered that in general transistors are not as linear as are valves in their optimum operating range, and where this matters it is desirable to reduce operating range and/or to apply negative feedback liberally.

Moral: problems of power transfer, interaction, and linearity can be attacked by negative feedback and purposeful mismatching. This requires more transistors for a given amplification, but transistors are small and cheap, and who worries?

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EQUIPMENT EXCHANGE BULLETIN Nov. 1965

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NOVEMBER 1965

COMPUTER CIRCUIT BOARDS. 2/- per transistor. Post free.

These boards are integral disassemblies of proper digital computers. We haven't the faintest idea why they have appeared on the surplus market (unless it be simple obsolescence), but they are lovely anyhow.

Two shillings per transistor includes any resistors, condensers, diodes, or coils and transformers on the boards. Most of the transistors are NPN Germanium, 150mW, 100mA, 25-130V, β from 20 to 100. A small percentage is PNP Germanium, and a few are NPN Silicon. Coils and condensers, or resistors are 1pc or 5pc, as marked; most component values are clearly marked, and components are of the miniature, LT type. Diodes are glass-encapsulated, transparent.

Please order the boards according to the total number of transistors involved. There is no choice of the type of board supplied, but we shall endeavour to make a representative selection in each instance. Minimum order: ten transistors-worth of boards. Owing to their weight, these items will have to be sent by Parcel Post, rather than by our usual First Class rate, therefore you should expect some delay. Quantities available are relatively limited.

One detail: This item is the one exception to our Guarantee. It is obviously impractical for us to test the transistors or other components on these circuit boards. The yield will certainly be high, if not 100 pc, but we cannot ascertain this in advance, and you take your own chances. We believe that you will be satisfied.

The circuits are of the logic type, and most of them are the commonly blocked two-input NOR Gate pair, having the general circuitry shown in Fig. 1 :

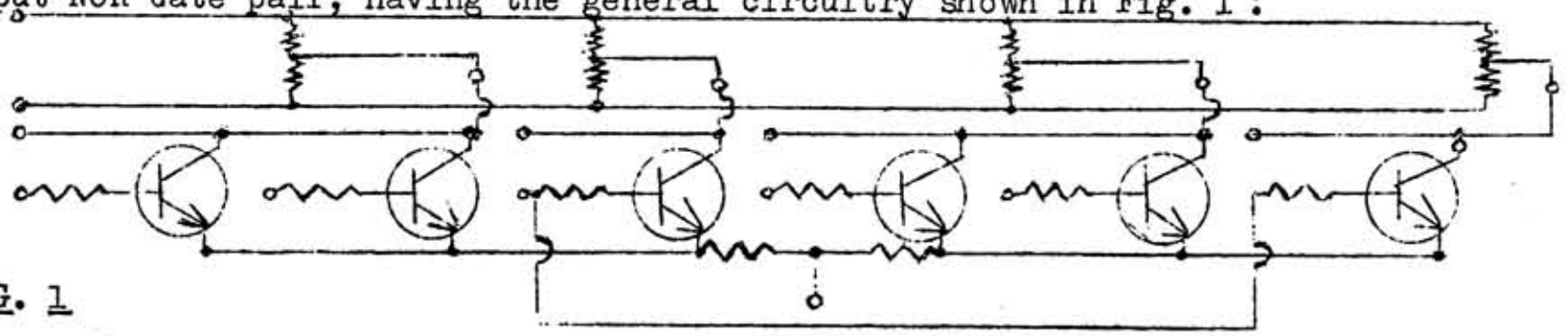

FIG. 1

Circuit boards having a lesser number of transistors lack one or another of these stages, for different types of control. Once you know the general configuration, it is not difficult to ascertain the exact circuit by inspection.

Some of the circuits accomplish common gating by the use of several diodes instead of transistors; diodes are also used for clamping. The diodes are of the miniature 200mA, 25mc/s silicon signal type, 30-300PIV, or VHF germanium point contact. The former have a broad strip of metal or large wire as internal anode contact; the latter have a very fine wire for same. Some of the circuits are AND Gates, such as the common base type shown in Fig. 2 (which could also be used as a stabilised three channel distributing amplifier).

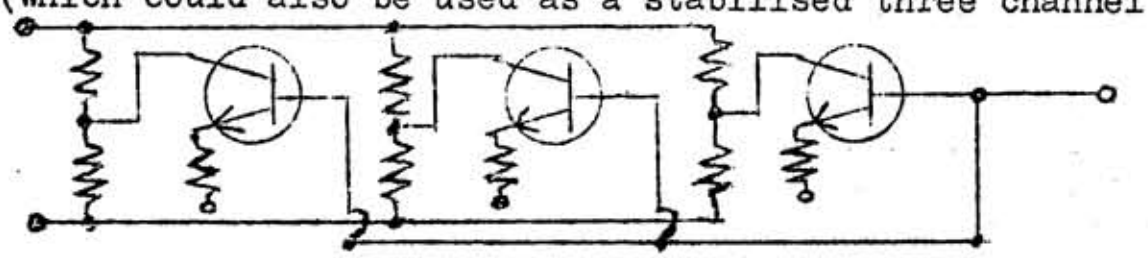

FIG. 2

These boards can be used as-is, for computer or scaling functions by educational institutions, or by ambitious experimenters. Inspection of the circuits, however, also shows that the boards could form an excellent basis for amplifier or oscillator circuits of all kinds. There is room for small components to be mounted in holes on the board, or components can be added on tag strips, etc. The result would be a neat and reliable installation. If, on the other hand, it is desired to strip the boards for components, it can be done by using conventional unsoldering techniques for circuit boards. It would be wise to make a couple of suitably shaped unsoldering tools which can be attached to soldering iron or torch. Apply heat intensively and briefly while pulling on the component from the other side. Note that if the other components are removed first, the board may be carefully sawed in pieces (using a blade with very fine teeth), with each transistor surrounded by a piece of board. This solves the messy (and hasardous) problem of unsoldering the transistors, and provides a piece of board forming convenient connections to the (otherwise short) transistor leads, as well as a convenient mounting element.

Diodes can be tested for PIV by applying voltage to them in the reverse direction, through a microammeter and large resistor, until the reverse current jumps up to about 10μA. The PIV can be measured directly across the diode, using a Valve Voltmeter, or it can be calculated from the voltage source and ohms law.

If you wish to test the transistors, and if you do not have a tester, simple measurements can be made with ordinary instruments, but do NOT use an ordinary ohmmeter! Breakdown voltage (BV_{cbo}) can be determined simply by measuring the voltage across the collector-base junction when 10-30μA is passed through it (Fig. 3). From elementary transistor theory this will tell you the polarity of the transistor: the voltage will be developed across collector-base for an NPN type when the collector is positive with respect to the base, and conversely for PNP. You can determine whether it is Germanium or Silicon type, by reversing the voltage applied to collector-base; apply 1mA of current (not more), and again measure the voltage. Germanium types will measure about 0.2V, Silicon about 0.4V.

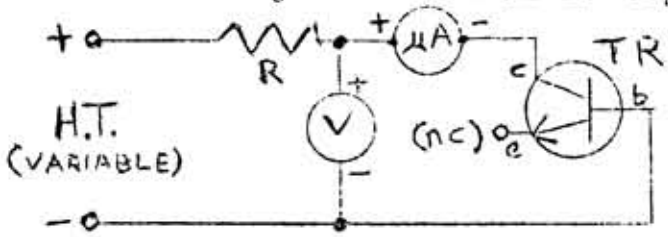

Fig. 3

Determination of frequency response is not simple, and it is best to assume that the maximum frequency of operation of these transistors is about 10mc/s when used in conventional common emitter circuits, or Hartley or Colpitts oscillators.[@] Forward current gain of the transistor is approximately the ratio of collector current to base current. Thus, if you apply base current (through a large resistor) until collector current is 1mA, the current gain is approximately:

$$\beta \doteq \frac{1000}{I_b}$$

(Note: This is actually h_{FE}. The exact value for h_{fe} is the slope.)

where I_b is the base current, in microamperes. (1000μA = 1mA). If you don't have a microammeter of required sensitivity, I_b can be calculated, using ohms law, from the base supply voltage and series base resistor, taking into account the 0.2V (for Germanium) or 0.4V (for Silicon) across the base-emitter junction.... One important caution: do not apply more than about 100μA to the base-emitter junction, or the transistor may be damaged. The protective resistor in series with the base can be calculated with this in mind. And remember that although transistor leads can stand some heat (after all, they were soldered into the circuit board), it should be limited, particularly with short transistor leads. Apply heat as briefly as possible, consistent with good connection, using a hot soldering instrument.

Good luck!

[@]The common-base configuration will give the best HF response, 30-100mc/s with these transistors as amplifiers or oscillators. ($f_{\alpha e}$)

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This activity has been a real education for us, in regard to learning about business responsibilities. It has shown us much about life which they don't tell in the books For example, like everyone else we used to think that it was shocking to realise that an item which cost $1 elsewhere cost £1 here. Well, we don't think so any more. The costs of Customs, overhead, advertising, hired help, and merchandise losses can be discouragingly heavy. Bear this in mind when you think that someone is making excess profit ...Or consider the matter of delivery.It is shocking when you order something, and hear nothing from the firm for several weeks. After all, it should only take them a day to process it, and only another few days in transit. Not so, not unless you are prepared to hire limitless help, and there are no pile-ups. Unfortunately the situation can be complicated by the fact that some firms add not caring to the nominal difficulties. But, with the best intentions in the world, delays can still occ ur. (To be continued....)

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December 1965 Vol. 1 // No. 14

= EQUIPMENT EXCHANGE BULLETIN =

Issued Monthly

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CONTENT:

Editorial.

We have been doing this for one year now. Amazing, wot? How we'll stand it for another year is another matter, but perhaps we shall if we continue to receive help. Said help is beginning to be really useful, and authors are beginning to contribute articles nicely. We even have a pleasent backlog of several months worth of articles.

As you can see, we have been experimenting with various types of Heading. The Electronic Stencil one last month was very pretty, but requires more inking than is readily supplied by our ancient machine. Be patient, we'll find something nice,eventually.

We have prepared a lovely folder into which we have affixed all of the issues of Vol.I. of this publication. On the outside flat edge (like a book) of the folder is printed the relevant information, and the material will probably be "pearl board". We are proud of this item, though it cost us more than we expected. If you want the complete Vol.I. in folder, it will cost $1.25 (12/6) as from Jan. 1, 1966. The folder alone will be 45c (4/6), all post free. All orders received for either item in January will be filled in February. Until January, separate issues of the EEB may still be ordered on the same basis as before, so order any back issues or missing pages needed. 12/6 is an outrageous sum to pay for a thin volume of quasi-technical

Editorial (continued).
dissertations, but if readers balk at least we'll be rid of the tedious task of preparing Back Issues. Unfortunately, there is every indication that new subscribers will remain undeterred, and will continue rather frantically to request " please send every single Back Issue immediately." We are flattered, but overwhelmed.

The problem of authors is interesting. Presumably each author receives a one year subscription for each article. The only trouble is that when a contributor writes one thing he finds out how easy it is, and then follows that with more articles, and more. I can just see us providing a series of Lifetime Subscriptions to a number of people. This is contingent, however, on the lifetime of the Assistant Editors. If Editor No.1. perishes from overwork, all obligations are abrogated.

The problem of misaddressed communications is less amusing. Several people have been sending advertisment replies to the EEB, not to the advertisers. Owing to the above mentioned confusion*, this has resulted in the loss of at least one order, and we are confused and embarassed by it. PLEASE do not send advertisment replies to the EEB. Just advertisments. Thank you.

By some incredible stroke of fortune, the Ed.No.1 of this rag has acquired the call VK7RG. You people will all please now goway, while he gets on the air. If you want to contact him there, you'll probably have to do it on CW, and he has a ghastly fist.

Finally, as the festive season of Christmas draws near, the staff of EEB would like to wish all its readers and friends a very Happy Christmas, and a satisfying New Year.

-- RLG.

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A PRACTICAL TRANSISTORISED IGNITION SYSTEM. Part III -- by G.van Leuven.

IMPORTANT NOTE! Please add two corrections to last mont's text: Under"Proceedure" change text to, " an additional tap is now fitted to the ballast resistor and adjusted to 10Amp coil current, with the battery at 10Volts." And on P.4 under "general considerations" change text to read," the diode D (12Amp/100V) in fig.4 is fitted because the Starter Motor will be by-passed by the ballast resistor. It serves the same purpose as the diode in the "tell tale" light lead, but it does not replace this diode." We apologise for any confusion these errors may have caused.

What is the next best system after the type already described? I should say it would be a capacitative discharge ignition system. This converts the accumulator battery voltage to some 300V by means of a transistorised inverter. It is then rectified to d.c., to charge a condenser which is triggered by an SCR (from the breaker points), to discharge through the conventional ignition coil. From this the coil sees 300V instead of the normal 12V, and the energy available is appreciably increased.

The improvement by the condenser discharge system is derived principally from the higher output voltage. This is a mixed blessing. An excessive voltage might exceed the limits of the car's electrical system, particularly when the electrical wiring is not new, or is dirty. Can your distributor cap withstand the high voltage? Is your high voltage wiring of the highest insulation capacity? It amounts to the fact that the better your transistorised ignition is, the better the condition your car's electrical system must be. This is not a minor point, nor is it an attempt to justify an inferior system. The electrical wiring and components of an ordinary automobile are subjected to a harsh environment, and the wiring could only be

* But we didn't mention it. Only shows how confused we are.

Transistor Ignition (continued)
maintained in excellent condition by a thorough and periodic overhaul which few owners are anxious to undertake. And if the system is not kept in the best condition, excessive voltage could seek high conduction paths, burning a channel in or on the insulation. This would result in less of the HT energy getting to the plugs, than if a more modest voltage were used, which ensured reliable operation of the electrical distribution network.

It is important here to realise that the improvement to be gained from a transistorised ignition system is only partly the result of higher voltage. The most important aspect of it is the fact that a high voltage is available to the sparking plugs at all engine speeds, and it is exactly at high speeds that the conventional ignition becomes inadequate."High" engine speed does not necessarily mean high road velocity, every time you shift gears, the engine attains a considerable speed.

The transistorised system does provide a somewhat higher voltage, and it also provides a "hotter" spark, and it does so at all speeds. The Capacitive Discharge System has the principal advantage that a special coil is not needed, but it obtains this benefit at the expense of increased complexity (therefore cost!), and not always noticably improved performance. It can, indeed, be worse, as outlined above.

Breaker Points.

After spending some $30.00 on T.I. it would be poor economy if your breaker points were not in good condition. Chances are that nine times out of ten, your points will be pitted. If, on inspection, this proves to be the case, install new points. Keep them clean, free of finger marks and grease. If you are uncertain of their cleanliness, wash them in Carbon Tetrachloride (beware, it is poison!). Good points should be highly polished, so avoid damaging them with feeler guages, and make sure the feeler guages are also clean. The breaker point gap can be reduced below normal setting, to about .005" - .008". Spark plug gap can be made bigger, but if you are uncertain, the simplest thing to do is to follow the manufacturer's recommendations for correct gap. *

Gunk.

For those who prefer to buy complete kits or built systems, a word of warning. Don't be fooled by a fancy name. If a T.I. is marketed under the trade name " Gunk", you can be certain that it will be a failure, and not one would be sold. If on the

* Editor's Note Transistorised ignitions have been known to give one unique type of trouble that should be known. Even when perfectly clean points have been installed, the current through the breaker points is so low that the dirt or grease that collects on the points does not get burned out, as it does in the arc of the conventional system. Eventually the contamination can build up a high resistance barrier that can impair the proper functioning of the T.I. To prevent this happening, simply insert a piece of paper with a hard finish (eg. Bond) between the closed Breaker Points and pull it out. This can be done periodically, eg at 1000 miles, and might be useful as a precaution. It is a small price to pay for a system with such high performance. Incidentally, it is not unwise to clean out excess grease and oil from the distributor system, in the vicinity of the points. The distributor cam surface need be greased only very lightly; it should never be oiled .

Some systems work better with a larger than average Plug gap, some don't. You can investigate this for yourself, comparing performance in all respects. The reduction of Point Gap has been criticised on the basis of increased " bounce", but again this does not necessarily apply to all systems, and where it is applicable, a smaller gap at the Breaker Points is desirable,-- assuming, of course, that the "timing" of the distributor is adjusted to normal angle in every instance.

Transistor Ignition (continued)
other hand, it is called "Blue Flash", it would find a ready market, even by post. It is therefore desirable to consider the quality and design of a system before deciding on it. Perhaps this article may have assisted to provide the necessary background for experimenters or automobile owners who want to build or buy such a system.

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CHANGE PLUS-GROUND TO MINUS-GROUND.

In the August 1965 issue of Radio-Electronics is a note on this subject which may be of use to constructors of Transistor Ignitions. It relates that battery polarity is only important for items such as electronic tachometers, radios, transistorised voltage regulators, some types of fuel guages, and the dynamo.-- and unimportant for lights, starter motor, windscreed wipers, and turn flashers. It turns out that it is not too difficult to reverse polarity of critical items, and this can simplify installation of transistorised ignitions on automobiles with positive-earth configuration. Thus:

1. Turn battery around and reconnect the cables, exchanging the cable clamps if necessary.
2. Reverse the leads on the ammeter, and for best results also reverse primary leads on the spark coil. "Most Positive-ground accessory radios have a switch or shorting plug that converts them to negative-ground." Reverse leads on the fuel guage, for safety, and on electronic tach, etc; some mounting insulation may be necessary.
3. Reverse polarity of the dynamo, according to the following instructions:
   a. Locate the field terminal, (it is the smaller wire, no condenser connected).
   b. Briefly short the positive battery terminal to the field terminal on the dynamo.
   c. Start the motor. The ammeter should show a slight discharge at idle, and charge at high rpm. Full discharge means that the dynamo polarity has not been reversed successfully, and 'b' should be repeated again.
   d. If the ammeter behaves properly, as in 'c', all is well, and the electrical system oi the automobile has been converted to negative-earth, and conventional transistor ignition triggering can be employed.

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REFERENCE LIST. Part III

Here we are branching out to works not necessarily covering semiconductors exclusively; this is hasardous, but some of those are used at the University of Tasmania, and are good references.

Transistors, Theory and Application. , paperback by Philips.(1963) Full of useful and practical information, a good applied companion to Philip's book on Diodes and Transistors to which we referred in a previous list.

Transistor Fundamentals and Applications. AWV (no Date) Cat.No.T-8 (thin paperback). Being something in the nature of an abbreviated version of the abovementioned work by Philips. Another basic and useful element in one's library.

Foundations of Wireless, by M.G.Scroggie (Iliffe, London,1960). Mostly valves, but adequate and simple introduction to transistor theory and a bit of practical work. This is used as a text in some basic courses, and is reasonably well written. Second hand copies might be available.

RADIO AND ELECTRONICS,LABORATORY HANDBOOK, by M.G.Scroggie (Iliffe,1961). Again mostly valves, but a work highly to be recommended as a general practical reference to keep on your library shelves. It can be used in conjunction with the Radiotron Designers

Reference list continued.
Handbook to find nearly any basic general application of electronic circuits. This applies not only to engineers, but to ordinary experimenters who want to find something which can best be solved by esoteric relationships such as those as Kirchoff, Thevenin, or Ohm. Or elementary concepts such as the equation for a balanced (or unbalanced!) bridge, or how much inverse feedback to get from a given feedback ratio.

RADIOTRON DESIGNER'S HANDBOOK, edited by F.Langford-Smith (RCA,1952), which everyone knows about, but we mention it for the sake of completeness, and to get our own comment inserted: when is a fifth edition of this superb publication going to be created? 13 years is far too long to delay it.

Design and Operation of Regulated Power Supplies. Sams RPS-1 (Bobbs Merrill Co, Indianapolis). One of a series of well done but appallingly expensive paperback works by the H.Sams group. A similar line is published by Ryder.

ELECTRONIC CIRCUITS HANDBOOK, SHOP AND SHACK SHORTCUTS, and a large number of other competent and interesting works published by Cowan (who publishes CQ Magazine) They are advertised in the back pages of CQ.

AMATEUR RADIO CIRCUITS BOOK, G.R.Jessop, one of several booklets to be recommended, published by the Radio Society of Great Britain. If the presentation in this volume is somewhat terse, it is comprehensive; its 153 (or so) circuits cover a wide range of devices which are sufficiently enticing to sadden one at the thought that it would be impossible ever to build them all.

ELEMENTS OF ELECTRONIC CIRCUITS, by J.M.Peters (Iliffe,London,1962). Multivibrators, timebases, electronic markers, gates and coincidences, delay circuits, pulse modulator maths, etc.,etc. For the advanced experimenter, or serious research worker; relatively simple presentation, and very interesting.

And there we had better stop expanding our coverage of electronics references. In our next Reference list we shall start the listing of some leaflets, Applications notes, and periodical literature sometimes available from various manufacturers or publishers of semiconductor information. Some applications notes can be difficult to obtain here.

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TETRODE TRANSISTORS, etc. Part II. --by R.L.Gunther.

NOTE WELL On Fig.5 (P.7 of the Nov.EEB) please add the notation: $+I_{b_1} = 60\mu A$.

The first part of this article presented a general survey of tetrode (and triode) transistor operation, and finally a note on the problem of input-output interaction. The latter can be minimised by negative feedback or mismatching. In order to save us several diagrams (they are hard to draw!), I shall mention that voltage negative feedback differs from capacitively coupled neutralisation in that the condenser for the former is much larger, and the blocking impedence is provided primarily by a large resistor in series with the condenser. Current derived negative feedback could come from a collector or conventionally connected output transformer. As we have mentioned, voltage negative feedback could also be obtained within one stage simply by unbypassing the emitter resistor. This works for a.c., but for d.c. coupled stages the feedback must be taken from another stage which has inverted the phase appropriately. Sorry to be so terse about this, but you can find the standard circuits for these subjects in any of the convenient Australian, British or American semiconductor handbooks.

Coupling and Matching.

Where the utmost in high frequenoy operation is not required, the Common-emitter configuration is commonly used. As you can see from chart II, for an ordinary triode

Tetrode Transistors, etc. (continued)

transistor this means a low input impedance and a moderately high output one. The second base of the tetrode, however, has about the same resistance as does the collector, suggesting the very interesting possibility of easier matching.

For an r.f. amplifier or oscillator, coupling can be inductive, with the given windings having approximately the impedances indicated in Chart II. That situation allows one to tap down on windings, or provide windings of appropriate size, so that the unequal input and output impedances of the transistor are manageable. Even so, the low input impedance of a C-E stage can be a nuisance in requiring an input tap sufficiently small, and of course the situation is worse with C-B. For C-E i.f. stages this often is met by providing a small non-resonated winding to feed the base directly. An ordinary i.f. transformer can be used, however, by doing some minor surgery on it, to transform the parallel resonant circuit into a series one, as shown in Fig.8. Of course this requires parallel feed of the bias system, as shown.

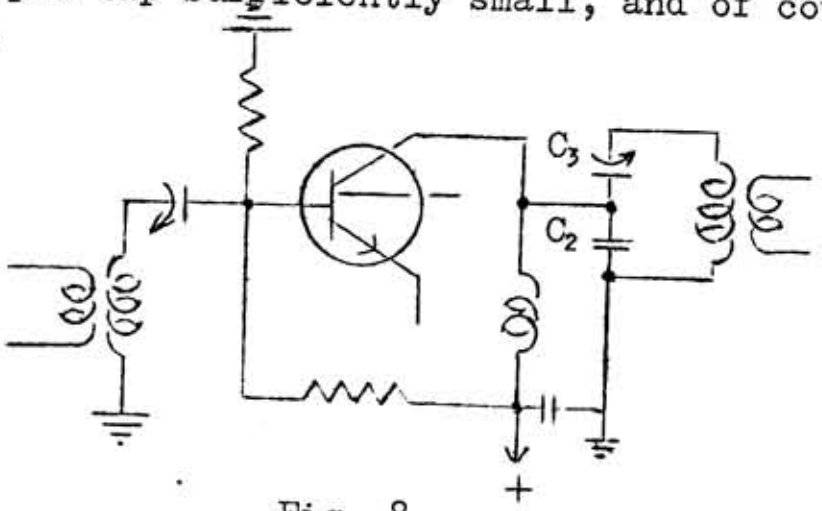

Fig. 8.

Similarly, an ordinary untapped i.f. transformer can be used in the output by providing capacitative tapping, as shown, with the ratio of C_2 to C_3 being about 10:1.

In a resistance coupled cascaded amplifier string, the input-output mismatching becomes important, because the collector of one stage is being loaded directly by the base of the next. This can be important even when power transfer is not the most important factor, as in a voltage amplifier, because the voltage gain is approximately:

$$A_V \doteq \beta \times \frac{R_L}{R_{in}}$$ (Note that $\doteq$ means approximately)

where β is the d.c. current gain, R_L is the load resistance in parallel with the transistor output resistance (therefore essentially just R_{Load} when it is small), and R_{in} is the transistor's input resistance. In an ordinary resistance coupled stage, R_L could be about 5K (V_{cc}= 12V, I_c=1mA), and R_{in} about 1K. β could be about 50. With no load, this stage would have a voltage gain of 50 x (5/1) =250. But if you couple it into the base of a common emitter stage, that base's resistance directly shunts the load resistor, for a.c., and the voltage gain will not be much greater than the current gain of the transistor, in this case, 50. Input impedance of the following stage can indeed be raised by using negative feedback, but that reduces the gain.

Now why not use the second base of the tetrode transistor as the load? With an input resistance of about 20K, a larger load resistor could be used on the preceeding stage, and voltage gain of same would be appreciably greater. On the other hand, in an a.f. or r.f. stage where power gain is important, the collector of one stage could be directly coupled to the $base_2$ of the next, and d.c. conditions could be maintained by chokes and/or resistors. Impedance matching would be automatically nearly perfect. If parallel resonant tuned circuits were used, the input tap could be much higher up, or, indeed the $base_2$ could be taken right from the top of the coil if not the highest Q were required. This latter situation is found in i.f. and bandpass r.f. stages.

Tetrode Transistors. etc. (continued)

High Frequency Amplification.

Although the new epitaxial planar transistors now provide a relatively inexpensive means of transistor operation at high frequencies, tetrodes can still be used to good advantage up to about 100mc/s. They can be obtained cheaply on the surplus market, and their extra electrode offers versitility not to be found in triodes. Since bandwidth increases as I_{b_2} increases, the control of I_{b_2} could provide a unique method for controlling amplifier gain at VHF. As I_{b_2} is decreased, VHF gain decreases and transistor β increases, but VHF gain decreases more rapidly, as indicated in Fig.9. Optimum VHF response is obtained for the 3N35 transistor at I_{b_2} about 100µA though Base$_2$ control varies somewhat from one transistor to another, as indicated in fig. 6.

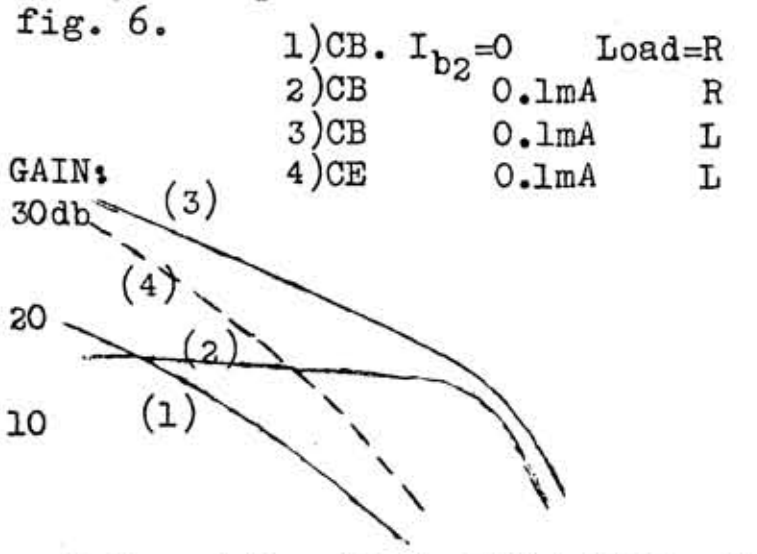

Fig. 9

Note that the gain of the Common-emitter stage is appreciably less than that of the Common-base one at high frequencies, as one would expect from conventional transistor circuit theory. And that the amplification at VHF is drastically affected by I_{b_2} though the tetrode will amplify quite normally at low frequencies when $I_{b_2} = 0$. As a matter of fact, one Australian firm at one time sold an NPN silicon transistor under the code name of "T9" or "T9S". If you bought one, look carefully at the seal, and if you see the end of an extra wire poking through, make a (careful!) connection to it, and you will have a perfectly (?) good tetrode transistor.

In the common-base configuration, both bases are bypassed to earth, but in the Common-emitter configuration, the signal may be fed into either base, or one of them may be bypassed. The gain curves given in Fig.9. for inductive load, represents the peak gain obtained by using various inductances in place of R, to resonate the collector capacitance at the frequency indicated. For a given inductance only a relatively narrow band of frequencies will be passed, though this may be broadened (at expense of gain) by shunting L with R. Additional capacity can be added to resonate a smaller L. This decreases bandwidth, but also decreases the effect of ambient temperature on resonant frequency (another interaction). Practical values of L and C are shown in the SSC Handbook (p.4-33) or Bevitt (p.144) mentioned in the Bibliography. Common sense should dictate the relationship between supply voltage and collector voltage in Fig.7; a resistor in place of Z_3 will reduce collector voltage compared to a coil in the same position.

Although the C-B configuration allows operation at a higher frequency than C-E, it is rarely used nowadays. Partly this is due to the fact that C-E affords a good compromise between voltage and power gain for a given number of stages. And it may also be related to the fact that the C-E looks more like the familiar valve configuration. The C-B circuit will, however, give useful power gain at frequencies far beyond the C-E operating frequency (therefore higher power gain at any one high frequency; see Fig 9.), and requires only that the input be fed from a very low impedance. If the C-B stage is used as an r.f. amplifier (for example), it can be fed directly from a 50 ohm line (or winding), and its output can be used directly across the output tank coil to give high Q operation without tapping.

In all justice, however, it must be admitted that C-B can sometimes result in impractical values for input coupling inductances, eg. a fraction of a turn, though a capacitative step-down impedance matching bleeder could be a practical alternative.

Tetrode Transistors, etc. (continued).

Class B Operation

The discussion has so far assumed Class A linear operation. For Class B, R_3 is not zero, because that would cause the base to be biased negatively by b_2, and collector current would flow during only part of the input a.c. cycle (ie, Class C). Ref. Fig. 4 (p. 7, November EEB). You can see that for a given value of I_{b_2}, a certain minimum value of I_{b_1} is required to bias the collector current just to zero. This value will vary with different transistors, and is best found experimentally. For Class B operation, increase R_3 (in Fig. 7) until collector current just begins to flow, and then reduce R_3 until it is just zero. For $R_1=R_2=0$, this threshold for I_{b_1} will be from 15μA to 40μA, depending on the transistor. For this condition, $I_{b_1} \doteq I_{b_2}$. If it is desirable to increase I_{b_2}, eg. to increase the frequency cutoff or decrease the d.c. current gain of the transistor, this can be accomplished merely by increasing R_1 slightly. But then, of course, the threshold of I_{b_1} for $I_C = 0$ will be increased.

Class C Operation

The tetrode transistor is ideally suited for Class C operation, because the angle of collector current flow will be determined uniquely by the transverse bias current (ie., $-I_{b_2}$). For Common-emitter configuration, when $R_1=R_2=0$, $-I_{b_2}$ is derived from the inherent voltage drop between base$_1$ and the emitter. If, then, $R_3=0$, collector current will not start to flow until the threshold is reached for I_{b_1}, described above for Class B. This threshold was 17μA for Transistor A, 15μA for Transistor B, and 35μA for Transistor C of Fig. 6. Thus, if $R_1=R_2=R_3=0$, and if the signal is fed into Z_2, Transistor B will allow a 90° angle of collector current flow, if peak collector current is 0.5mA. In general,

$$\phi = 180^\circ - 2 \text{ arc sin } (I_o/I_{pk})$$

where ϕ is the angle of collector current flow, I_o is the base$_1$ threshold current (ie, the base$_1$ current at which collector current begins to flow), and I_{pk} is the peak value of the signal current. I_o can be determined easily with a few meters, battery, and potentiometer. I_{pk} is known from the output of the driver, turns ratio of driving transformer (if any), and the input impedance of the Class C stage, or it can be measured. The smaller the angle, ϕ the higher will be the efficiency of the stage, but the more difficult it will be to drive, etc. For a stage having a more conventional $\phi = 140^\circ$, the peak driving current should be about three times the threshold current, I_o. For $\phi = 90^\circ$, I_{pk}/I_o is about 1.5. If you have a fixed amount of drive available, ϕ can be adjusted by increasing $-I_{b_2}$. This is effected simply by increasing R_1 (but of course do not omit C_1), while R_2 and R_3 remain zero. In this case R_1 is increased until collector current falls to the correct value (eg as determined by collector dissipation limits, for a given amount of ventilation). Needless to say, this operation should be performed under reduced drive initially. Note that it will not help to make the adjustment with reduced collector voltage, as you might with the anode voltage of a Class C operated valve, because collector current is relatively independent of collector voltage, as with a tetrode valve. A transistor can draw excessive collector current from a voltage of 1.5V nearly as easily as from 20V.

Design considerations for the tetrode transistor operated Class D (Pulse Width Modulated) or Class K (Bias Shift Modulated) are beyond the scope of this article.

Oscillators

To make an amplifier oscillate, as everyone knows, the output is simply coupled back to the input in the same phase. The easiest way to do this is to build the amplifier only to amplify, some say, and it will be sure to oscillate..... The more conventional configuration for oscillation is the Colpitts or Clapp, or Hartley circuit, depending on the method of coupling. These are all Common-emitter types. The Common-base oscillator is an interesting creature indeed, and will be the subject of another EEB article. This

Tetrode Transistors, etc. (continued).

oscillator allows a transistor to operate at a frequency several times higher than when operating in the Common-emitter mode, in analagous fashion to the C-B amplifier. The Common-base oscillator is in fact simply a Colpitts type in which the feedback capacity is provided by the inherent interjunction capacities of the transistor. Although its operating freuency is considerably higher, its capacities are also affected by changes of ambient temperature, though its frequency could be stabilised by a crystal operating in the current mode.

To keep an amplifier from oscillating, you simply keep the input and output circuits well separated electrically, and avoid common feedback impedances. That is why all of the bypass condensers in Fig. 7 are shown returning to a common point. The amplifier using a 3N35 ought to be stable to 60mc/s without neutralisation, but it may be necessary to mismatch input and output to ensure most stable operation. Which is only a weaselworded way of saying that the amplifier isn't stable at all if it is operating at maximum gain. On the other hand, a single 3N35 operating at 60mc/s as C-E can still provide 12db gain after a 5:1 coupling mismatch. If you are unable to adjust impedance match appropriately, you could try a resistor shunting input and/or output coils; it will increase bandwidth and decrease gain. Decrease the resistance until the amplifier shows no sign of oscillating spontaneously without load. Or you could (ugh) neutralise it.

Mixing

The relatively independent action of the two bases of a tetrode is ideal for mixing. One of the bases could be used for oscillation, as described above, and the other could be used to inject signal. Isolation would be better than in the more conventional configuration in which mixing is done simply in the base of a triode, the conversion gain would be higher, and frequency of operation would be higher than most triodes. Fig. 10 shows a conventional type of converter, similar to that which appeared in the September 1965 issue of 'Amateur Radio.' Fig. 11 shows the tetrode equivalent. If it were more conventint, the base$_1$ could be used for injecting a signal, and base$_2$ for oscillation.

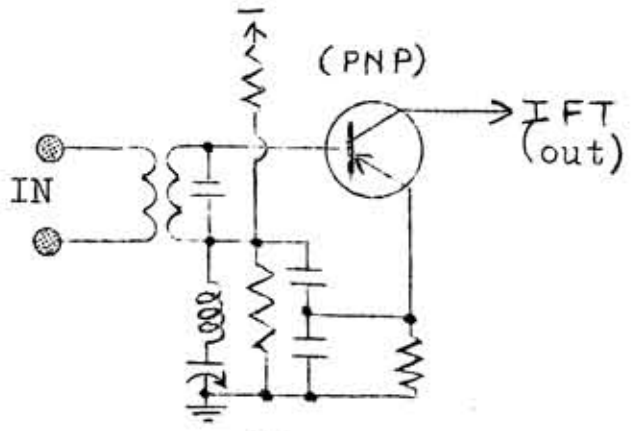

Fig. 10

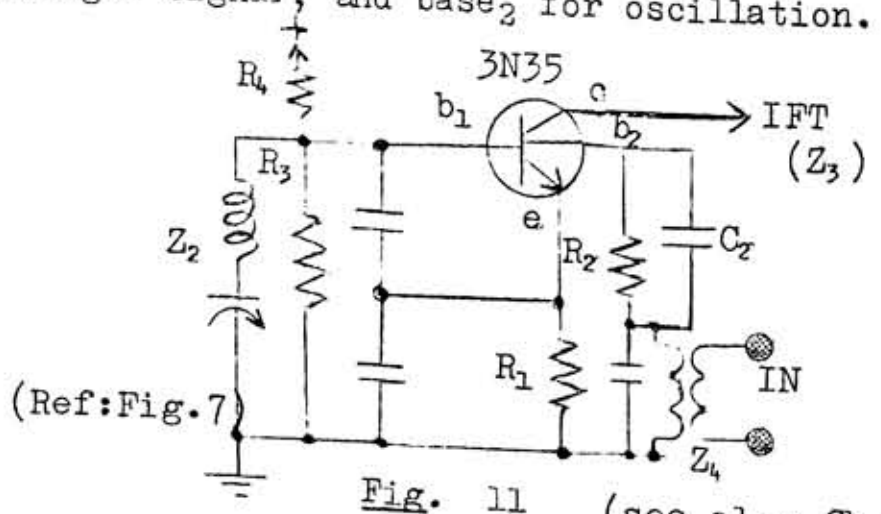

Fig. 11

David Brown (in a personal communication) suggests application as Voice Operated Relay ('VOX'), and although I think that VOX can be used abominably by some on the air, I pass it along for what it is worth, and it will appear in Fig. 12, of the third (and final) installment of this thrilling subject, in next month's EEB. David suggests the interesting possibility of VOX with automatic speech compression, also using tetrodes. I think that compression of speech on the amateur bands is an excellent idea, and the more of it, the better. I shall leave it to John Hill to work out the details, in collaboration with David Brown. We expect a nice article from you chaps. Heh.

(see also Ch.I)

-- (To be concluded)///

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IF YOU find two sheets of p.10 following, it might not be a mistake. Why not give one of them to a friend, acquaintance, colleague, or girl friend? At least she'd be impressed....

ANNUAL INDEX — EEB.

SUBSCRIBE to the EQUIPMENT EXCHANGE BULLETIN. P.O. Box 177, Sandy Bay, Tasmania

-- The EEB is a technical periodical of a casual type, published as a hobby by the Sandy Bay Basement Laboratories, and featuring interesting articles and effective advertisements. Subscription still 3/- per year. Bound copy of Vol. I, 12/6 each, available maybe in January 1966. No more individual back-issues available, probably.

ANNUAL INDEX of the EEB. Volume 1: 1965

No.	Month	Page	Item
1	1	1	Silicon Controlled Rectifiers, Part I. Fundamental.
2	1+	1	Use of reversed diodes.
		4	SCR, II:Simple pwr supply.
3	2	1	SCR, III: Transients.
4	2+	1	SCR, IV: Transients.
		4	Did you know? (Lab perils)
5	3	2	SCR,V:Efficient control.
		4	Did you know?(More perils)
6	3+	1	Protecting SCRs by diodes.
		1	How to avoid Baked Ham.
		5	Tape Recording, Part I.
7	4	1	Articles planned, maybe.
		2	PIV safety factors.
		4	Pseudo-tunnel Diodes.
		5	Tape Recording, Part II.
		6	Protecting electric trains.
		7	Peak currents in diodes.
8	5	1	EEB Explored
		3	SCR, VI: A practical variable-phase voltage control system with inherent voltage regulation. Nice.
		5	SCR, VII: Uses of V_{BO}.
		6	Tape Recording, III.
9	6	1	Train protection, again.
		2	More Laboratory Perils!
		4	Tape Recording, IV.
		5	High current power supplies, and heat sinks.
		6	Semiannual Index.
10	7	1	More back-biased diodes.
		6	Semiconductors Reference,I.
		7	Tape Recording, Part V.
11	8+9	3	Back-biased diodes (concl.)
		6	Bibliography, Part II.
		7	Volume Compression, I and II
		14	Tape Recording, Part VI
		17	Puzzle.
12	10	2	Fluorescent power?
		3	Pseudo-tunnel transistors!
		4	Volume Compression (adden.)
		5	Practical transist. ignition.
		7	Answer to Puzzle.
13	11	2	How to buy technical books.
		2	A practical Transistorised Ignition System, Part. II.
		5	Puzzle Postscript.
		5	Tetrode Transistors, Part I.
14	12	2	Transistor Ign. Part III.
		4	Reversing battery polarity.
		4	Reference List. Part III.
		5	Tetrode Transistors, Pt.II.
		10	Annual Index, ie, this.
		10	Field Effect Transistors.

Please note that advertisements appear in each issue, though we have not listed them here. We have found them to be amazingly effective, and all this from a circulation which has only now reached 200! Tell your friends about us.

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FIELD EFFECT TRANSISTORS are now available in Australia. It is rather startling to consider the possibility of running a loudspeaker directly from a crystal pickup, with only one stage of amplification, or to design a transistor voltmeter as one would a valve voltmeter. But the enthusiastic experimenter is emphatically to be cautioned that a device with an input impedance of 10^{15} ohms has one serious liability -- If the input circuit is allowed to remain completely open, it can accumulate enough static electric potential to destroy the transistor! Therefore keep the transistor's leads shorted until ready to install, and ensure that the input is always shunted by some resistance.

Further details can be obtained from the manufacturer's specifications.....

ADVERTISING

WANTED Back issues of A.W.V. Radiotronics (before 1963 and some 1963), Mullard Outlook (before 1962 and some 1963), Miniwatt Digest (1961 and some 1962), R.T.V.+H. (some 1956-1961). Write R. Brown, 29 Pangee St., Kingsgrove, Sydney, giving details and prices.

GEMSTONE JEWELLERY.. Tumbled polished gemstones, necklaces (or pendants), key-chains, bracelets. These are attractively boxed and would make ideal Christmas presents. Necklaces 18 inch chain in rhodium or gold plate. Small size stone = 10/- ea., Medium = 11/-, Large = 13/- ea. 24 inch chain, add 1/-.

Available in the following stones: Carnelian, Amethyst, Quartz dyed pink, Golden tiger-eye, Red tiger-eye, Sodalite, Blue tiger-eye, Amazonite, Smoky quartz, Ruby cullet, Petrified wood, Goldstone, Quartz dyed blue, Quartz dyed green. Also Key-chains, 7/6 to 12/6 ea. Bracelets from 12/6.

All prices include postage. Most of the above available in sterling silver and rolled gold. A free sample stone, one of the above will be sent with each detailed price list from: R. M. Gems, P.O. Box 77, North Essendon, Victoria.

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GROUT MULTIPLE wave winding machine for power, audio transformers etc. Bed 3 ft 6 in., 18 fingers, winds from about 16 B&S to 40 B&S, head can swing coils up to 6 inches across. Width of coil approximately 4 inches maximum, but could be easily extended. With all electrics, 1 h.p. 3-ph motor, starter, etc., steel bench, clutch foot control, and 18 spindle reel carriers in steel frame with tensioners etc. $200 -- no offers. The current price of this equipment is $3700, and an energetic man with a flair for transformer design could earn himself a comfortable living with it. Reason for sale: lack of space, no wish to hoard. Reference 'GM', c/o MEC, P.O. Box 177, Sandy Bay, Tasmania.

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ASSOCIATION OF PUBLIC ADDRESS ENGINEERS. Full or Associate Membership available. Benefits = Free monthly 'Journal,' Library service, free 'Technical Bulletins,' Technical enquiry service, free advertising, and much else. Annual Subscription = £1-5-6. Enquirers will receive full details. Write to A.P.A.E., Box 122, Oakleigh, Victoria.

ELECTRONIC SPEED CONTROLS for portable (ac/dc) drills, saws, sanders, etc., up to 3 Amp nameplate rating. Controls speed from 0-50pc of full speed, and closely maintains preset speed under varying load conditions. Suitable for countersinking wood screws into timber without pilot holes. Ideal for sanding off paint, and will not clog discs. Allows reduced speed for portable drills, for longer life of large bits. Attractively housed in hard plastic case with carrying handle. Guaranteed for 12 months. £7.17.6. Post free in Australia. ELECTRONIC SWITCHES, P.O. Box 138, Balgowlah, N.S.W.

FOR SALE. Halicrafters 12V power supply. Vibrator supply 200V at 50mA continuous, genemotor 400V at 200mA with PTT terminal and relay to switch 200V from receive to Tx. Original genemotor replaced by Command Unit, reconnected for 12V. £5 or offer. Jon Kitchin, 52 Railway Pde, Midland, W.A.

TRANSISTOR IGNITION KITS complete with coil and special ballast resistor with starting tap, and diode. Full instructions. 12V negative earth £15.0.0. post free. Literature free on request. Other models available. Unsurpassed for performance at this low price. There is much more to the engineering of a Transistorised Ignition than merely hooking up a transistor to a coil; our kits provide maximum reliability at minimum cost.

Also available: 0-15V meter with coloured dial for Automotive use, 0-15Amp meter with coloured dial for Transistor Ignition, 30-0-30 Amp meter (centre zero). Each 1-3/4" square, clear plastic face. 48/- ea. post free. MEECO, P.O. Box 407, Naracoorte, S.A.

Advertising (continued).

STILL SELLING interesting and useful electronic items of all sorts, including valves. See Oct. EEB, or write M.J. O'Brien, Edgar Rd., San Remo, Vic. Phone 107.

WANTED: Handbook or circuit and component list for P104 or P38. Also for BC624C and BC 639A. Write= F. Hicowe, Box 15, Sorrento, Victoria.

FROM AUSTRALIAN ELECTRONICS, 76 View Street, Hobart, Tasmania. Formerly 'Electronics Associates.' After several months of not-advertising in the national magazines, and yet getting a full mailbag every week, we are forced to the reluctant conclusion that most of the current business is coming from our advertisements in the EEB. This is terrible. How can we get anything done if you keep ordering stuff? We'll have to look around now for a less effective advertising medium. Anyone have any good ideas?
== Although we receive frequent compliments on our service and quality of merchandise, occasionally we receive (through third parties) the report that "you don't want to trade with that gang in Tasmania, their diodes are no good. Mine blew up as soon as I put them in...." And this after all of our guarantees, our mountain of gratuitous technical information supplied each new customer, etc. It is entirely possible that an occasional semiconductor could slip by our rigorous testing procedure; who isn't human? But we have the feeling that a reluctance to submit a discussion of the conditions under which a component failed, is a tacit admission of a guilty conscience. What indeed, could be simpler than providing a condenser across the a.c. input to the rectifier, and including a 1.5-fold PIV safety factor? If the load is inductive, be sure also to supply an output transient suppressor too -- a suitably large condenser or/and zener..... Bah.
== We regret to announce that the Vβ8 lot of 3N35 transistors are gone, but we still do have the Vβ9 rating (50-75V) for 7/6 each. They sell for about £12 new.
==We are pleased to announce a SALE of zener diodes in certain ratings. The following one-watt zeners are available for 5/- each: 70V, 75V, 95V, and 100V. Tolerance ±3V, dynamic impedance about 150 ω at 10mA. Now you can have effective HT voltage regulation at a low price. Zeners are smaller, more effective, and have wider voltage ranges than neon or voltage regulator valves. They can be used for stabilising power supplies, VFO's, instruments of all kinds; where their ratings are not exceeded they are excellent for suppressing transient overvoltages. The 75V size, for example, would be suitable for Transistorised ignitions using 2N1100 transistors, which we also stock at a shocking price (but, ah, compare !). You know, we have actually been asked why we don't stock 30V zeners, since two of them are needed for a certain T.I. design. We reply: why use two 30V ones when one can be used with a 60V rating-- and more cheaply too. Zeners can be used in series, and our HT ones can thereby attain impressive voltage ratings. We also have our regular not-so-cheap zeners in various wattages, every 5V from 25 to 155V. For ordinary 6V, 9V, 12V, etc zeners please consult the '0AZ' series, which is cheap, reliable, and widely available.
== We are in process of discontinuing our stock of LT diodes. Already 50V and 100V/0.75A have been removed from public sale, as well as 50-200V/5A. But other diodes are available at our usual low prices, at higher voltages up to 2000, and currents up to 100 Amps.
== We regret to announce that we are holding a SALE of 300V/4.7Amp Silicon Controlled Rectifiers. We regret it, because they are the residue remaining after we tested the SCRs ordered for a firm which wanted ones having V_{BO} of 380V or more, for operation on mains with diode protection. Unfortunately a considerable number had V_{BO} less than 380V, many with a frustratingly close 360V, etc. As they are, they are good for nothing but 300PIV SCRs, so we are selling them at 2 for 30/-, 4 for 53/-, or 8 for 88/-. Hopefully you won't take us up on the latter figure, because it represents a loss. We do, however, need the cash, and that is the truth. In this activity we are perpetually short of investment. This offer is for EEB readers only, so please don't pay attention to the regular Catalogue price for this item, which will remain the same for Everyone Else for awhile. We also have other SCRs up to 600V for those who don't like diode protection, and who want to afford us a better profit. You can, however put two 300V SCRs in series, towork on the mains,

Australian Electronics (continued)

but would need ganged pots for control. Tony has done some research on this subject, and we'll have to get him to write it up. Though ganged pots don't grow on trees, a total of 22/- for a 600V SCR (no diode protection needed for the anode) should allow many things. Does anyone know of a better way to control two SCRs in series?
--- Technical data is supplied individually for each SCR sold. Very useful.

== Please note than when we sell you an SCR with a PIV much higher than V_{BO}, we rate it for the value of V_{BO}, for the simple reason that for most cases that is the limiting value for operation of the SCR. Various exceptions and amplifications of this will be discussed here next month.
== Next month we shall continue with our discussion of Business Philosophy, for which we had no room here this time. We have also had several minor crises with Credit, and are in process of engaging in a major one, and are feeling wrothful indeed. So, we are gradually becoming hardboiled, and insisting on CWO for small firms and individuals. The policy for large firms remains Discount Nett, with prompt payment requested in 30 days. Please do be prompt, or our Bank will also wax wrothful. Thank you.

FROM= The Equipment Exchange Bulletin
P.O. Box 177, Sandy Bay,
Tasmania, Australia

//Registered at the G.P.O. Hobart, for transmission by post as a periodical//

TO:

Rodney Reynolds//42
St. Georges Rectory
Battery Point,
Hobart, TAS

EQUIPMENT EXCHANGE BULLETIN
P.O. Box 177
Sandy Bay,
Tasmania

-- A technical periodical of a casual type, published as a hobby by the Sandy Bay Basement Laboratories, and featuring an occasional interesting article and some effective advertisements. Send to the address shown, for free copy. If you include a S.A.E. it will be appreciated!

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DO YOU HAVE AN INTERESTING IDEA, AN INTERESTING RESULT FROM THE WORKSHOP? TELL US !