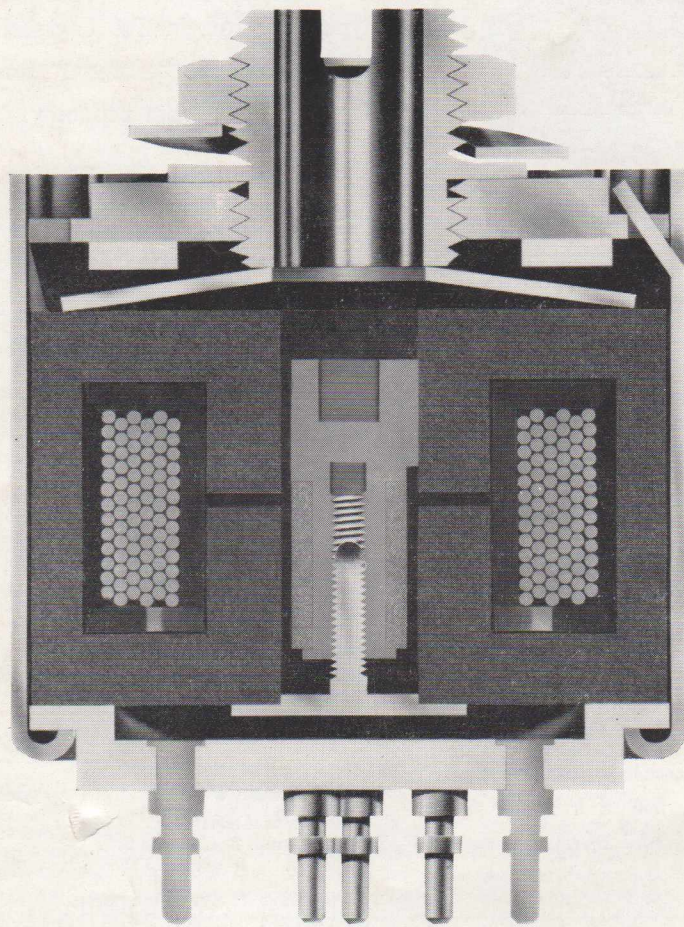


# Mullard Outlook

A U S T R A L I A N E D I T I O N



VOL. 5, No. 2,  
MARCH-APRIL, 1962



MULLARD-AUSTRALIA PTY. LTD.



VOL. 5 — No. 2

MARCH-APRIL, 1962

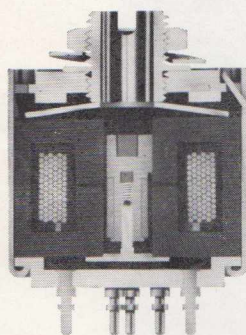
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**JOERN BORK**

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*Mullard Vinkors are the most efficient adjustable pot core assemblies commercially available. A cross-section of a Vinkor is illustrated and more detailed information may be found on page 20.*

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**On Tape Recorders and Single Side Band .....**

—not particularly compatible items except that both, in this decade, to some degree will come of age and it is on this score that we give them some attention in current Outlook issues.

Tape recorders might be classified within the consumer products grouping with a near virgin but delicate market potential, the wider use of SSB being mandatory.

By no means new arrivals, for they have both been with us for many years and, what is more, have been noble servants, although now with a maturity enhanced to some degree by semiconductors and special valve types, for imaginative engineering design and ultimate end-user appeal and SSB in the “essential” bracket for better voice communication and frequency spectrum economy.

It would be absorbing to contemplate the stage of development of steam-engines or steam-driven devices today, if the internal combustion engine had not been invented and, notwithstanding the present stage of development of tape recorders and SSB transmitting and receiving equipment, it will be absorbing to see the refinements in these two techniques by the end of this decade, and we look forward with interest to continuing our contribution in this regard.

M.A.B.

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# VIEWPOINT WITH MULLARD

## TAPE RECORDERS

The writer of this article is dictating into a tape recorder, a technique first developed in Europe and acclaimed immediately after the last war as one with tremendous commercial possibilities although, until recently, this has shown a relatively slow rate of development and appeal. We might at this time examine the status of the smaller tape recorders and, for ease of reference, take some figures of the consumer market in the United States.

### Status

It is interesting to note that last year in the United States, the sale of electric corn-poppers and electric knife-sharpener exceeded that of home tape recorders, the latter running at a rate of 450,000 to 500,000 per annum, compared with approximately 12,000,000 radio receivers and 6,500,000 TV receivers. These figures relative to AM receiver sales in Australia would indicate that the total sale of domestic tape recorders this year might be 20,000 to 25,000 but we believe it will be a little over 30,000 and we do not have a market for corn-poppers or knife sharpener! Indeed, the Americans in a recent market potential survey, listed thirty domestic articles which included TV, radio, electric can openers, de-humidifiers, blenders, etc., but strangely enough did not include tape recorders.

Further examination of these figures shows that in the United Kingdom alone the sales rate is about 350,000 in a market one-quarter that of the United States and, furthermore, of lower purchasing power.

Much the same situation exists in each major European country which prompts us to suggest that, for optimistic sales, we might analyse the reasons for the high sales rate in England and the Continent relative to the United States and two dominant factors emerge:—

- (1) the price relationship of tape recorders to radiograms being much the same in the United States and Australia; and
- (2) the care and, perhaps, elegance in selective merchandising in the U.K. and Europe, as distinct from the full-blooded efforts and perhaps less finesse in the United States.

It could be that a third factor rests with the purchaser in that, in the U.K. and Europe, the psychological approach as to the usefulness and benefits may be of a more serious nature.

The Australian pattern we feel must therefore be towards a wider price difference between radiograms and tape recorders if this is indeed possible, but, notwithstanding this, we must be mindful of the need for a good measure of sophisticated and individual selling effort.

We do not set out in this article to debunk the sales potential of recorders, but to objectively analyse it, for we are bold enough to say or believe that the market is greater than those who specialize in these devices consider it to be, and who are better equipped to comment than we are.

### The Specialists

We, as an Industry, must be grateful to the pioneering, perseverance and tenacity of those who have concentrated in the tape recorder field and have done so in this country in a careful and ordered manner, whilst others were selling TV or, to the more cynical, supplying the demand. We feel it is inevitable that more and more retailers will add tape recorders to their range of products—not that we believe it will water down to any degree the sales rate of the pioneers—but rather enhance their sales and, in so doing, enhance the sale of tape recorders generally to the ultimate advantage of all and, no less, provide the intelligent user with a most useful device.

### Dual Market

We will not dwell on the self-evident—two distinct market applications, domestic and business—for there are some strong arguments that suggest that commercial tape recorders are better handled by business equipment houses. Nevertheless, in some areas, particularly country towns, the local retailer, by his town knowledge and associations, on-the-spot service and trusted advice where he might be considered the local electronics adviser, may place himself at an advantage over the itinerant typewriter salesman. Then, of course, he may not know a great deal about the needs of the business house, what is required of a commercial tape recorder or how effectively it can be used, the time saved and so on. On the other hand, he may have studied these aspects and be a keen business tape recorderophile himself.

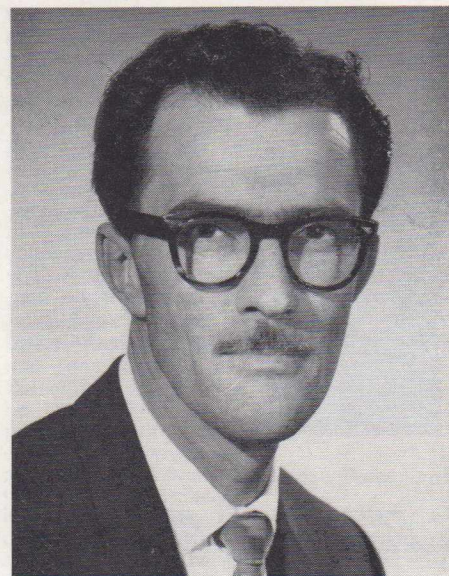
We might, therefore, have two groups of experts and give the benefit of the doubt to our business equipment colleagues with their special recorders for this purpose, devoting these notes to domestic recorders and the near-domestic and professional application of them, including continuous tape commercial recorders linked to a cash register, elevator, turnstile or toilet which respectively thanks one for one's custom, or, like Emily Post, suggests the gentlemen keep their hats on, directs one through the gates or to where small change can be obtained. The latter is a coming field and one that the alert retailer may benefit from, in both sales and service.

### Abstract Influence

As stated earlier, much groundwork has already been devoted to publicising tape recorders in that most folk know what a tape recorder is, apart from the communal applications such as schools, where a number are already equipped and a generation of young Australians are accustomed to them. For those who view television regularly and for those who still go to the pictures are bound, at some time or other, to regularly see a tape recorder applied in the script of a "whodunit". But perhaps the most useful support is obtained from that small band of home tape recorder adherents who subconsciously infect their friends with their own enthusiasm.

From a slow beginning there is now a wide range of equipment, some complicated, some less so, but most cleverly conceived and re-

## MULLARD-AUSTRALIA PERSONALITIES



Mr. L. J. Wenham

Mr. L. J. Wenham, "Laurie" to his many telephone friends within the Industry, administers the central Sales Office of Mullard-Australia at our Head Office here in Sydney and spent his first few years with us in the Entertainment Valve Section, where he made a name for himself in invariably finding those few "off-beat" valve types, exclusive and elusive when Service is the keynote. Now, with wider responsibility, he is also assisting the telecommunicators and sales engineers in the Industrial and Transmitting Valve Department with their sales records and invoicing, deliveries and so on.

lately simple to operate even for the ham-fisted, all fingers and thumbs. In addition, there is the flexibility of battery-operated units and a wide price range for the selective retailer to concentrate his efforts with a few brand names and our view is that almost all Australian families—and we say families rather than homes—are potential tape recorder owners.

### Synchronous Repeating Recorders

We can dial on our telephones, time and weather information, and a prayer repeated over continuous tape devices and the obvious extension to this is a device that might remind one to close a door, have change ready—in fact wherever business is progressed and people gather. To the purist a taped voice thanking one for one's custom prompts some measure of insincerity but the more direct and useful application can only win appreciation and thanks, for assistance without fuss or ambiguity. Such application will certainly not approach the wider home use but a useful turnover adjunct apart from promoting the

(Continued on page 17)

# MODERN RADIO COMMUNICATIONS

## THE INFLUENCE OF SINGLE SIDEBAND

(Continued from Outlook, Vol. 5, No. 1, Page 4.)

### Filter System

In the filter method of SSB the RF signal is generated at low frequency and a steep sided filter used to eliminate the carrier and one of the sidebands. (See Fig. 4.) If ordinary LC circuits are employed, this may be carried out at fairly low frequencies where the required circuit Q may be easily attained by the use of Mullard Vinkor Ferroxcube assemblies. Mechanical filters are employed quite satisfactorily in the frequency range from 250 to 500 kc/s and crystal filters in the frequency range from 100 kc/s to several Mc/s. The single sideband signal may then be converted to the desired frequency. A filter system may or may not use a balanced

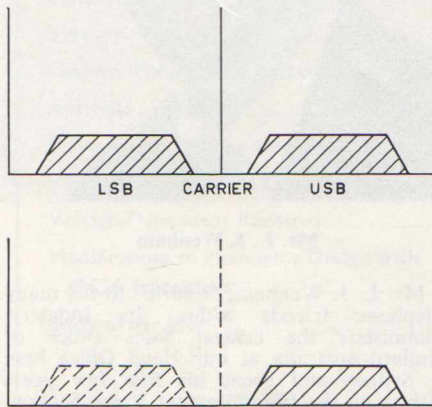


Fig. 4 SSB signal after removal of carrier and LSB.

modulator for reducing the carrier before application to the filter. This will mainly depend on the steepness of the slope on the carrier side of the filter bandpass characteristic. Reference to Fig. 5 will show the principles of the filter method of sideband generation, where the residual carrier and one sideband is removed by an appropriate filter, the output of which is a single sideband signal. This also may be carried out at the desired output frequency or at some convenient frequency which may then be converted to the final output frequency in a suitable mixer stage.

### Linear Amplification

When a single audio frequency tone is used to modulate a single sideband transmitter the output consists of a single frequency only (one of the sidebands). This has all the characteristics of an unmodulated RF carrier. Under these conditions, which can be made to correspond to the peak operating conditions, it is possible to properly adjust the output stages and make sure that these peak operating conditions fall within the published ratings of the output valves. Lower values of modulation voltage result in lower RF outputs and, as a consequence, the output stage requirements in SSB are those of a linear amplifier.

Linearity requirements are extremely severe in SSB, since intermodulation products lead to frequency components outside the desired passband. The linearity of a stage may be checked by using two audio tones of equal amplitude to modulate the transmitter and examining the result on a cathode ray oscilloscope. (Linearity can also be checked by using both sidebands, or the carrier and one sideband.) As a result single sideband power amplifiers are frequently rated for both the maximum "single tone" power output conditions and for "two tone" conditions. Power stages in SSB transmitters are linear amplifiers and the design, efficiency and adjustment considerations of such amplifiers for low distortion suggest Class AB1 operation. Pentodes (or tetrodes) are generally preferred since high anode currents are required without grid current. Whilst more power output can be obtained with driving voltages into the grid current region, the varying drive power requirements with changing modulation lead to additional linearity complications. The Mullard QVO8-100 is a recently announced beam tetrode designed specifically for use as a linear Class AB1 amplifier in SSB power amplifier stages. It features improved linearity over similar valves in its power range and is capable of providing 220W PEP (Peak Envelope Power) under continuous commercial service conditions at radio frequencies up to 30 Mc/s. Quite a number of Mullard valves are being used in SSB service and the following Table gives some indication of the performance obtainable.

Type No.	V <sub>a</sub> (V)	V <sub>g2</sub> (V)	I <sub>a</sub> (mA)	PEP (W)
QVO6-20	600	200	72	46
QVO8-100	750	310	270	220
QV1-150A	1,250	350	180	172
QV2-250B	2,000	350	190	320
QY3-65	3,000	360	45	130
QY3-125	3,000	600	77	228
QY4-250	4,000	500	115	454
QY4-400	4,000	700	180	586
QY5-500	5,000	700	178	810
QY5-800	4,000	600	330	1,300
QY5-3000A	5,000	1,000	576	1,380

### Conclusion

This article is intended to introduce to readers the subject of single sideband and, since the space available within these pages does not allow of a more comprehensive treatment, readers wishing to learn more of this subject and to become familiar with the

types of circuits used in single sideband transmitting and receiving equipment, are recommended to study publications listed below. Although the first and second books listed have been published for the radio amateur, they show some examples of commercial equipment—equipment designed by professional engineers who in many cases are also prominent in the field of amateur radio.

### LIST OF REFERENCES

- "The New Sideband Handbook", by Don Stoner—CQ Technical Series No. 103.
  - "Single Sideband for the Radio Amateur"—QST.
  - "Fundamentals of Single Sideband"—Collins Radio Company.
- In addition, much valuable information on this subject is contained in the Single Sideband Issue of the "Proceedings" of the I.R.E., U.S.A., December, 1956.

### DEFINITIONS

#### Absolute Frequency Control:

A communications system whereby carriers generated at the transmitter and receiver are accurate to within a certain specified figure due to the stability of the oscillator circuits employed.

#### AFC:

Automatic Frequency Control.

#### Anti-Trip:

System of voice controlled break-in operation which prevents a signal from the loudspeaker actuating the transmitter.

#### Automatic Load Control:

A means of maintaining a signal level adjusted so that the power amplifier works near its maximum power capability without being overdriven on signal peaks.

#### Balanced Modulator:

One of the most important components in the generation of single sideband signals. The balanced modulator enables signals to be heterodyned from one frequency to another providing carrier reduction at the same time.

#### Break-In:

The ability to break-in on a transmission during pauses in the sending station's transmission.

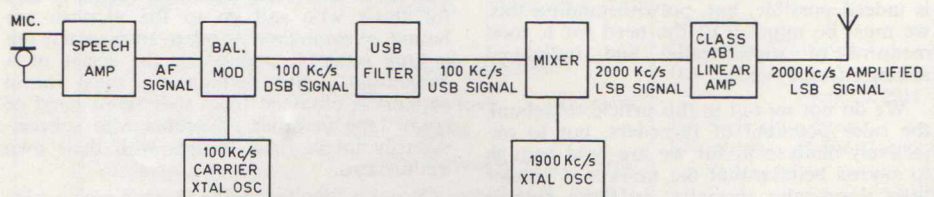


Fig. 5 Block diagram basic filter exciter.

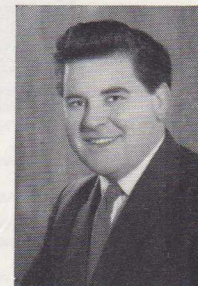
## AUSTRALIA

One Continent, One Nation,

One Language, One Authority  
for Internal Communications

We were recently reminded of this unique set of circumstances by Mr. J. Balcombe, a sales engineer of the Transmitting and Microwave Valve Department of the Government and Industrial Valve Division of Mullard Limited, London, who was visiting Australia in connection with a joint U.K. and Australian Government project.

With his particular interest in microwave devices and special valves for SSB and mobile equipment, the opportunity was taken for Mr. Balcombe to meet a representative group of Australian equipment manufacturers. Before departing for home, Mr. Balcombe said that he was most impressed with the engineering standards and the development that was taking place in communications in Australia, in particular with regard to microwave techniques and the imaginative planning behind the wide-band microwave link facilities being provided by the P.M.G. Department.



Mr. Jack Balcombe that was taking place in communications in Australia, in particular with regard to microwave techniques and the imaginative planning behind the wide-band microwave link facilities being provided by the P.M.G. Department. An expert in these techniques, he spoke with loving enthusiasm of the Mullard klystrons, magnetrons and travelling wave tubes and how these were being applied in many countries for communications and airborne, seagoing and ground radar equipment. For instance, the Mullard T.W.T. type LB6-12 providing 35dB gain over the range 5.9 to 7.2 Gc/s and 10,000 hours life, is now widely used in North America and, in particular, the new coast-to-coast service of Western Union.

### VIEWPOINT WITH MULLARD

(Continued from page 15)

technique and usefulness of tape recorders generally.

#### Part Of National Life

With the groundwork to some degree well covered and sales gaining impetus we are confident with intelligent merchandising and good after-sales service, that domestic tape recorders will become part of our national life. This is a strong claim, but nevertheless not without justification when one considers the practical implications of the return of family togetherness and the increasing rate of home ownership now reaching 80% in Australia.

A study of manufacturers' brochures and trade journals details the enormous field of serious and less serious applications—in education, entertainment, music, sport—in fact, wherever human activity abounds and the spoken word is king.

With conviction and on firm foundations, let us then promote the idea of a tape recorder as a superb medium for intelligence storage and reproduction, rather than as a party-prop for surprising the self-conscious.

#### Carrier Re-insertion:

Re-inserting the carrier at a late stage of the transmitter to provide simulated AM transmission.

#### Crystal Filter:

A filter using crystals, single and double lattice, half lattice or modified lattice configurations.

#### DSB:

Double sideband (reduced carrier).

#### Frequency Divider:

A device to obtain an output lower in frequency but harmonically related to a primary oscillator.

#### Frequency Inter-Comparison:

A method of determining short term stabilities of oscillators by inter-comparison of the frequencies of two or more oscillators.

#### Harmonic Frequency Synthesiser:

A circuit in which harmonics and sub-harmonics of a single standard oscillator are combined to provide a multiplicity of output signals.

#### High Level Converter:

Converting from a low frequency to a high frequency in a high level stage.

#### Linear Amplifier:

An amplifier whose output is always proportional to its input.

#### Loading Comparator:

A circuit technique used to indicate correct loading.

#### LSB:

Lower sideband.

#### Mechanical Filter:

Filter based on magneto-strictive properties of metals and their ability to be driven into mechanical oscillation.

#### Modulation Envelope:

Envelope of modulated signal. When recovered by rectification it is the modulation of an AM signal. In SSB the rectified envelope does not represent the modulating signal—the carrier must first be re-inserted. Envelope of SSB signal is of prime importance in determining the limits of linearity and power of amplifier.

PEP: Peak envelope power.

#### Phase Comparison Tuning:

The use of a phase comparator circuit to compare the phase of the input signal to the phase of the output signal to afford a sensitive means of correctly tuning the linear amplifier.

#### Phase Inter-Comparison:

A system wherein the relative phase of two oscillators operating at the same frequency may be measured or compared.

#### Phasing Generator:

SSB generator using the phasing principle.

#### Product Detector:

A type of demodulator; in operation somewhat analogous to the mixer in a superheterodyne receiver. Usually preferred for single sideband reception detection since it minimises inter-modulation distortion products in the audio output signal and usually requires a low amplitude local carrier voltage.

#### PTO:

Permeability tuned oscillator.

#### Q Multiplier:

Electronic means for increasing the selectivity of a circuit. Often used at receiver intermediate frequencies in a feedback circuit to peak a narrow band of frequencies.

#### Reduced Carrier:

See Suppressed Carrier.

#### Ring Modulator:

A method of modulating a radio frequency signal with an audio signal by the use of circuit elements, for instance diodes, in a ring configuration.

#### Shape Factor:

The ratio of the bandwidth of a filter at 60dB to its bandwidth at 6dB.

#### Sideband Selection:

The ability to select upper or lower sidebands at will.

#### Slicer, Sideband or Signal:

A selected sideband adaptor for receiving, using a phasing system.

#### SMO:

Stabilised master oscillator.

#### Speech Processing:

Means taken to provide the most effective speech characteristics for efficient transmission.

SSB: Single side band (reduced carrier).

#### Suppressed Carrier:

Somewhat synonymous with reduced carrier but implies a greater degree of carrier reduction.

#### T Notch Filter:

Used in receiving. A narrow band filter capable of being tuned through the passband of an IF channel to enable the removal of heterodynes.

#### TR Switch:

A means of coupling the transmitting aerial to the receiver without the use of relays.

#### Two-Tone Wave-Form:

Generated by combining two audio tones and then injecting this two-tone signal into the modulator for test purposes.

#### USB:

Upper sideband.

#### VOX:

Voice controlled break-in (literally, voice operated).



# MULLARD TRANSMITTING VALVES

Valve Output Power in (W) or (kW)	Type Number	Construction	Characteristics							Capacitance				Limiting Values (ABSOLUTE)					Typical Operating Conditions				Cooling	Base	Equivalents	C.V. No.
			V <sub>r</sub> or V <sub>h</sub> (V)	I <sub>r</sub> or I <sub>h</sub> (A)	μ <sub>g1-g2</sub> or g <sub>m</sub> (mA/V)	C <sub>in</sub> (pF)	C <sub>out</sub> (pF)	C <sub>a-g1</sub> (pF)	C <sub>a-k</sub> (pF)	P <sub>a</sub> (W)	V <sub>a</sub> (V)	V <sub>g2</sub> (V)	I <sub>k</sub> (mA)	f (Mc/s)	Full Ratings		Reduced Ratings									
															f (Mc/s)	P <sub>out</sub> (W)	f (Mc/s)	P <sub>out</sub> (W)								
			FOR CLASS C TELEGRAPHY																							
108 kW	TY12-50A	P.T.	17.5	196	27	92	116	—	86	3.4	45000	15000	—	15000	30	15	108000	30	50000	W	—	6077	—			
41 kW	TY12-50W		8.0	130	33	40	45	—	27	0.6	15000	13000	—	5800	30	30	41000	—	—			—	—	6078	—	
39 kW	TY12-15A		8.0	130	21	30	42.5	—	23.5	0.9	15000	13000	—	6300	30	30	39000	—	—			—	—	7806	—	
17 kW	TY12-20V		6.3	154	60	60	65	—	29	0.6	15000	5500	—	7500	220	110	17000	—	—			—	—	7807	—	
14.3 kW	TY8-12W	P.T.	6.3	154	60	60	65	—	29	0.6	15000	5500	—	7500	220	110	17000	—	—	W	—	7804	—			
10 kW	TY8-15W		6.3	130	17.5	28	40	—	40	1.0	10000	8000	—	5000	30	30	14300	—	—			—	—	7805	—	
6.9 kW	TY7-6000A	P.T.	12.6	33	32	15	16	—	11	0.3	6000	7200	—	2800	55	30	10000	—	—	W	—	6961	5239			
6.9 kW	TY6-5000A		12.6	33	32	17	16	0.3	11	—	5000	6000	—	1850	220	75	6900	220	2500			—	—	6960	—	
4.1 kW	TY6-5000W		6.3	32.5	8.5	19	23.5	8.4	< 0.35	—	3000	5000	800	1300	220	75	4100	220	2650			—	—	59	3926	
2.0 kW	QY5-3000A		6.3	32.5	8.5	19	23.5	8.4	< 0.35	—	3000	5000	800	1300	220	75	4100	220	2650			—	—	59	—	
1.76 kW	QY5-500	Tet(D.H.)	4.0	60	9.0	20	50	—	0.15	6.5	1200	3300	600	1125	1000	600	2070	900	1500	—	—	607	5219			
1.69 kW	TY4-500		10	9.9	9.5	7.0	24	8.3	0.25	—	500	5000	700	600	110	75	1700	110	1100	A	B5F	6079	3522			
1.44 kW	TY4-350	P.T.	10	10	35	4.0	12.3	—	6.3	8.5	400	4000	—	600	75	20	1440	—	—	A	—	833A	635			
1.1 kW	QY4-400	Tet(D.H.)	5.0	14.5	5.1	4.0	12.7	4.9	0.12	—	400	4000	600	420	110	75	1100	100	800			—	—	7527	—	
1.0 kW	QY4-400B		5.0	14.1	5.1	4.0	12.7	4.5	0.12	—	250	4000	600	420	120	75	1000	120	500	—	—	7527	—			
930 W	QY4-500A		5.0	13.5	6.0	5.0	12.8	5.6	0.05	—	500	4000	500	440	220	110	930	186	630	A	—	4X500A	—			
845 W	TY3-250		P.T.	5.0	14	25	5.0	7.0	—	5.3	0.15	250	3000	—	480	150	100	845	150	300	—	B5F	5867	1350		
670 W	TD2-500A	D.S.T.	3.4	19	70	14	11	—	3.8	0.05	500	2700	—	575	940	400	670	625	580	A	—	—	—			
595 W	TD2-400A		3.4	19	33	10	11.5	—	6.5	0.12	400	2200	—	520	900	470	595	810	408	A	—	—	—			
390 W	TY2-125	P.T.	6.3	5.4	25	2.8	5.5	—	5.5	0.1	135	2500	—	250	200	150	390	200	245	—	B5F	5866	1924			
390 W	QV2-250B	Tet(I.H.)	6.0	2.6	5.2	12	15.7	—	< 0.06†	4.5	250	2000	300	350	500	175	390	500	225	A	—	5867	2487			
375 W	QY3-125		5.0	6.5	6.2	2.2	10.8	3.1	0.05	—	125	3000	400	300	200	120	375	200	225	—	B5F	6155	2130			
280 W	QY3-125B	Tet(D.H.)	6.0	3.5	5.0	4.0	8.0	2.1	0.08	—	65	3000	400	230	250	50	280	220	110	—	B5F	6155	2963			
200 W	QV08-100		6.3	3.9	5.7	9.0	30	—	< 0.9	12.7	100	825	300	450	30	30	200	—	—	—	B7A	4-65A	1905			
195 W	QV1-150A	Tet(I.H.)	6.0	2.6	5.0	12	15.5	4.5	< 0.06	—	150	1250	300	250	500	165	195	500	140	A	BBF	4X150A	2519			
195 W	QV1-150D		2.5	6.25	5.0	12	17†	4.5†	0.005†	—	150	1250	300	250	1200	165	195	500	140	A	Coax	4X150D	3991			
103 W	QQV07-50	D.Tet	6.3	1.8	8.0	4.5	6.7*	2.1*	IN	—	2x25	750	300	2x150	500	100	103	500	69	—	B7A	—	—			
90 W	QQV06-40A		12.6	0.9	8.0	4.5	6.7*	2.1*	IN	—	2x20	600	300	2x120	500	200	90	400	70	—	B7A	5894	2797			
87 W	QQV07-40†	D.Tet	6.3	2.5	9.0	8.5	14.5	7.0	< 0.12	—	2x20	750	225	2x145	250	100	87	250	60	—	B7A	829B	2666			
85 W	QQZ06-40		12.6	1.25	8.0	4.5	6.0*	2.0*	IN	—	2x20	750	300	2x120	500	200	85	470	58	—	B7A	—	—			
67 W	QQV03-25	D.Tet	6.3	1.3	8.0	2.5	4.4*	1.6*	IN	—	2x12.5	750	300	2x66	600	200	67	600	22	—	B7A	—	—			
66 W	QQZ06-20		12.6	0.65	4.5	7.0	13.5	8.5	< 0.24	—	25	650	200	170	175	60	66	175	35	—	Octal	—	—			
52 W	QV06-20	Tet(I.H.)	6.3	1.25	4.5	7.0	13.5	8.5	< 0.22	—	20	600	250	160	175	60	52	175	25	—	Octal	6146	3523			
48 W	QV06-20B		12.6	0.625	4.5	7.0	13.5	8.5	< 0.22	—	20	600	250	160	175	60	52	175	25	—	Octal	6883	—			
27 W	QV06-20C		26.5	0.3	8.0	2.5	4.4*	1.6*	IN	—	2x10	600	300	2x55	600	200	48	600	20	—	B7A	6159	—			
45 W	QQZ03-20	D.Tet	6.3	1.3	8.0	2.5	4.4*	1.6*	IN	—	2x10	600	300	2x55	600	200	48	600	20	—	B7A	6252	2799			
27 W	TD1-100A		1.6	4.5	8.0	2.5	4.5*	1.8*	IN	—	—	600	300	2x60	500	200	45	470	28	—	B7A	—	—			
26 W	QV04-15†	D.S.T.	6.3	1.0	100	25	6.6	—	2.0	< 0.035	100	1000	—	125	2500	500	27	2500	12	A	—	2C39A	2516			
23 W	TD04-20	D.Tet	6.3	1.6	6.5	3.0	8.0	3.8	< 0.07	—	2x7.5	750	250	2x55	250	200	26	250	18	—	B7A	832A	788			
16 W	TD04-20C		12.6	0.8	8.0	3.0	8.0	3.8	< 0.07	—	2x7.5	750	250	2x55	250	200	26	250	18	—	B7A	832A	788			
16 W	QQV03-10	D.Tet	6.3	0.83	7.5	3.3	5.0*	1.5*	IN	—	2x5	300	200	2x50	225	100	16	225	12.5	—	B9A	6360	2798			
14 W	QQZ03-10		12.6	0.42	7.5	3.0	6.8*	3.2*	IN	—	2x7	300	200	2x65	200	200	14	—	—	—	B9A	—	—			
10 W	QV03-12	Tet(I.H.)	6.0	0.75	16	7.0	9.5	4.5	< 0.3	—	12	300	250	70	175	30	10	50	8.0	—	B9A	5763	2129			
8.0 W	MQ096		12.6	0.3	26	10.5	4.5*	1.35*	0.145	—	2x8	400	225	2x49	960	960	8.0	—	—	—	BBG Spec.	6062	4039			
7.9 W	QV04-7R	Tet(I.H.)	6.3	0.6	5.6	3.0	8.2	6.0	0.07	—	7.5	400	250	55	150	20	7.9	150	6.3	—	BBG Spec.	7377	—			
6.0 W	QQV02-6		12.6	0.3	31	10.5	3.8*	0.95*	IN	—	2x3	250	200	2x48	500	500	5.8	—	—	—	B9A	6939	2466			
5.0 W	ECI58	D.S.T.	6.3	0.85	30	25	4.0	—	1.75	0.055	30	300	—	150	4000	—	—	4000	> 5.0	—	Octal	—	—			
2.8 W	TD03-10		12.6	0.3	30	6.0	2.2	—	1.1	0.02	10	350	—	50	3000	1000	2.8	3000	0.5	—	—	5861	273			
1.8 W	TD03-10C	D.S.T.	6.3	0.4	30	6.0	1.7	—	1.4	0.045	10	350	—	50	3000	1000	2.8	3000	—	—	—	—	2204			
—	TD03-10F		6.3	0.4	30	6.0	1.7	—	1.4	0.045	10	350	—	50	3000	1000	2.8	3000	—	—	—	—	5397			
—	ECI57	D.S.T.	6.3	0.735	43	21	3.0	—	1.4	0.035	12.5	300	—	70	4000	—	—	4000	1.8	—	Octal	—	—			
—	TD03-5		6.3	0.4	70	6.5	2.0	—	1.0	0.01	5.0	350	—	25	2000	—	—	—	—	—	—	—	354			

\* Two sections in push-pull  
 † Maintenance type only  
 ‡ Measured in grounded-grid configuration

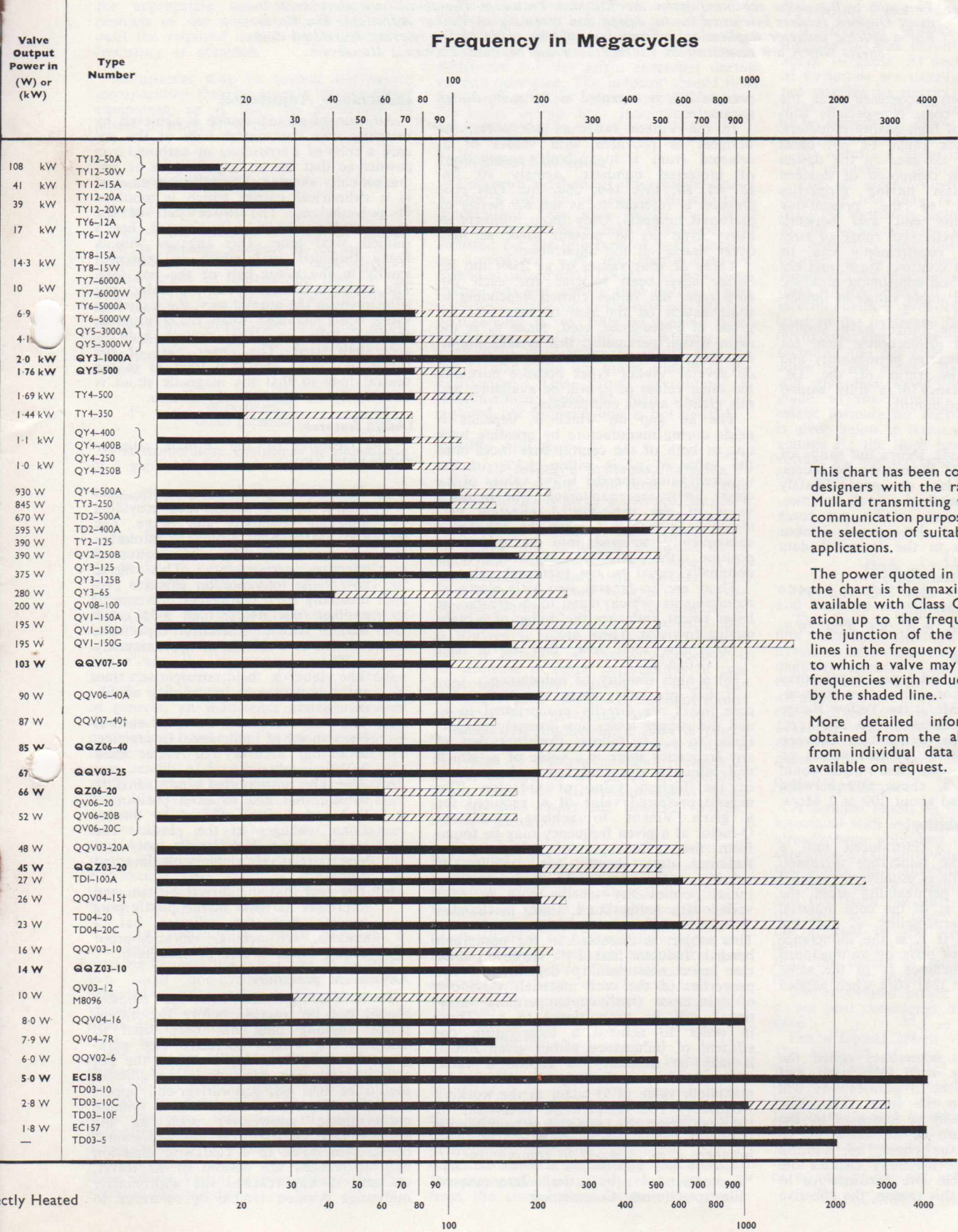
IN Internally neutralised  
 A Forced-air cooling  
 W Water cooling

**Construction Key**  
 D.S.T. Disc Seal Triode  
 D.Tet Double Tetrode  
 Tet(D.H.) Tetrode Directly Heated

Tet(I.H.) Tetrode Indirectly Heated  
 P.T. Power Triode  
 \*\* Quick Heating



# VALVE SELECTION CHART 1962



This chart has been compiled to acquaint designers with the range and scope of Mullard transmitting valves available for communication purposes, and to facilitate the selection of suitable types for given applications.

The power quoted in the first column of the chart is the maximum valve output available with Class C telegraphy operation up to the frequency indicated by the junction of the solid and shaded lines in the frequency chart. The extent to which a valve may be used at higher frequencies with reduced output is given by the shaded line.

More detailed information may be obtained from the abridged data, and from individual data sheets which are available on request.

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# VINKOR ADJUST

*This article has been reprinted from the Mullard Technical Handbook and its aim is to assist Outlook readers interested in the design and assembly of Vinkor Adjustable Pot Cores. For a specific inductor application, reference should be made to the relevant individual data sheets which are contained in Volume 5 of the Mullard Technical Handbook.*

It has long been recognised that the basic shape of pot cores is especially suitable for the cores of high-quality inductors. The Mullard Vinkor range of pot cores represents a major advance in the design of such cores. It is composed of modern Ferroxcube materials having properties carefully matched to the present-day requirements of the coil and network designer. The comprehensive range of sizes ensures that coil requirements can be realised in the most compact form, and the means of assembly and adjustment provided enable accurate and stable values of inductance to be attained.

The cores in the range have similar shapes, and are so proportioned that, for a given value of effective permeability and overall volume, the ratio of the DC resistance to inductance of a fully wound coil former is a minimum.

## Range of Sizes

The following table shows the range of nominal sizes of the ferroxcube pot cores. This range provides an approximately logarithmic progression of overall volumes. The outside dimensions of the pot cores when assembled in the special Vinkor housings are given in the technical data sheets.

Diameter (mm)	
14	18
16	21.5
18	25.4
25.5	29.5
35.5	45
Height (mm)	
9.0	10.2
11.2	13.6
16.0	18.8
22.8	29.2

## Frequency Range

The various sizes and types of pot cores comprising the Vinkor series cover frequencies up to about 2 Mc/s: the Yellow Range is suitable for frequencies up to 200 kc/s; the Red Range for frequencies between 200 kc/s and 2 Mc/s. Typical values of Q-factor obtainable within these ranges would be 100 at 500 c/s, about 600 between 10 and 500 kc/s, and about 200 at 2 Mc/s.

## Effective Permeability

If an air gap is introduced into a magnetic circuit, the reluctance increases. For convenience, this is usually represented as a decrease in permeability from the initial permeability  $\mu_1$  of the core material to an effective permeability  $\mu_e$  for the gapped core. Thus if  $L$  is the inductance of a given number of turns on an ungapped core, then the inductance  $L'$  of the same number of turns on that core when gapped will be

$$L' = L \frac{\mu_e}{\mu_1}$$

The ratio  $\mu_e/\mu_1$  is sometimes called the dilution ratio. The core loss angle and temperature coefficient of permeability will also be reduced in the same ratio. The copper loss angle will be increased by the inverse ratio because of the reduction of inductance. Thus the choice of dilution ratio or effective permeability enables the designer to vary the core performance to suit his needs. For this reason, the effective

permeability is regarded as the main design parameter.

In the Vinkor range of pot cores, the designer is provided with values of  $\mu_e$  selected from a logarithmic progression\* of preferred numbers, namely 10, 16, 25, 40, 63, 100, 160, 250, etc. This progression is referred to as the R5 Series of preferred numbers. Only those numbers in heavy type are at present used, as they cover nearly all the applications.

Three or four values of  $\mu_e$  from the R5 Series have been selected for each pot core type, the values chosen depending to some extent on the size of core and the grade of Ferroxcube used. Since  $\mu_e$  is the main design parameter, this system simplifies design procedure. A design may be tried on several Vinkor types because normally the same values of  $\mu_e$  will be available, and this greatly assists comparison.

The air gap on which  $\mu_e$  depends is made during manufacture by grinding back one or both of the central core faces until the value of  $\mu_e$  is within  $\pm 3\%$  of the required value; for the lower values of  $\mu_e$ , closer limits are maintained. The nominal value of the pre-adjusted effective permeability is such that, when the adjuster is subsequently screwed into its mid-range position, the effective permeability is nominally equal to the preferred value.

There are, in general, two main electrical requirements which may, to a greater or lesser extent, influence the design of a high-quality inductor. These are:

- a low total loss, that is, a high Q-factor;
- a high stability of inductance.

It has previously been stated that the core losses are directly proportional to  $\mu_e$  and the copper losses are inversely proportional to  $\mu_e$ . It follows therefore that at any frequency there is a value of  $\mu_e$  which will minimise the total loss and so result in the highest value of Q-factor. The nearest preferred value of  $\mu_e$  required for a given Vinkor to achieve maximum Q-factor at a given frequency may be found from the Q-factor curves given in the technical data sheets. The stability of inductance depends mainly on the way the initial permeability of the core material varies with temperature, time, mechanical disturbance and steady field polarisation. This subject is discussed in the paragraph headed "Inductor Stability". However, since the inductance stability depends on the properties of the core material, variations of inductance (such as temperature variations) will be proportional to  $\mu_e$ . Thus, in order to achieve a temperature coefficient of inductance within given limits, it may be necessary to choose a value of  $\mu_e$  which is incompatible with the maximum value of Q-factor at the working frequency. The temperature coefficient of the Ferroxcube has been chosen to minimise the difficulty in this respect, but in some instances it is necessary to compromise.

\*Recommended by the International Electrotechnical Commission.

## Inductance Adjustment

Adjustment of inductance is achieved by inserting into the central hole of the pot core a tube of Ferroxcube or carbonyl-iron powder so that the air gap is more or less magnetically shunted. The tube is contained in a cylindrical carrier which is moulded in polyethylene. The lower part of the carrier, where the tube is situated, has a splined axial hole. This engages with a finely threaded stud which is cemented axially to the lower half of the pot core. The screw action provides the inductance adjustment in the normal way, the minimum value being obtained when the adjuster is screwed fully in. The central hole is accurately sized. The upper part of the carrier is ribbed and is a tight fit in the central hole so that the magnetic shunt is held firmly on the axis of the core.

## Design features

The features of the Vinkor adjuster mechanism are:

- The clearance between tube and central hole is small, thus providing adequate sensitivity and range. The aim has been to provide a minimum adjustment of  $\pm 7\%$ , irrespective of effective permeability. This figure covers the tolerance on effective permeability from one ferroxcube core to another (not greater than  $\pm 3\%$ ), the use of  $\pm 2\%$  tolerance capacitors, and leaves a margin of approximately  $\pm 2\%$ .
- The tube is held concentric, thus ensuring a smooth unwavering adjustment curve.
- The fine thread on the stud ensures fine control of inductance. In practice, a setting accuracy of better than 0.02% is obtained.
- The tube is supported almost directly by the stud and its axial position is thus not directly affected by dimensional changes in the plastic. The plastic, being high-density polyethylene, is relatively stable with time and humidity.
- The fact that the thread on the stud impresses its form in the plastic plug ensures that the adjuster has a smooth, self-locking, vibration-proof action which is free of back lash.

## Adjustment procedure

It is recommended that the adjuster should not be inserted before the appropriate aligning plug has been used to assemble the Vinkor correctly (see paragraph headed "Assembly"). When the pot core is ready for adjustment, the adjuster should be inserted, screwdriver-end uppermost, into the central hole. With a suitable non-magnetic screwdriver such as the Mullard type DT2047, the adjuster should be screwed down in a clockwise direction until it reaches the bottom of its travel, or until it has reached the approximate mid-range position (found by reference to



# ABLE POT CORES

the appropriate adjustment curve). The position of the adjuster should be varied until the required inductance or resonance frequency is obtained.

Adjustment may be carried out before incorporating the pot core in its associated equipment, or it may be preferable to adjust it when it is in position.

## Inductance Stability

### Thermal disturbance

The cyclic thermal stability of inductance is usually defined in terms of a temperature coefficient. Its value depends on the grade of Ferroxcube used in the core and on the effective permeability of the core. In manufacture, the relation between the temperature and the initial permeability of the core is characterised by a temperature factor  $F_T$  which may be defined as:

$$F_T = \frac{\text{Temperature coefficient of permeability}}{\text{Initial permeability}} = \frac{\Delta\mu_i}{\mu_i \Delta T}$$

The temperature coefficient of inductance of a gapped inductor is then:

$$\text{Temperature coefficient of permeability} \times \frac{\mu_e}{\mu_i} = F_T \times \mu_e$$

The limits of  $F_T$  are chosen to enable the temperature coefficient of inductance of the Vinkor to be matched approximately to the negative temperature coefficients of polystyrene capacitors. The technical data sheets give the temperature coefficient of inductance for each particular Vinkor over a temperature range 20 to 50°C. Beyond this range, the temperature coefficient is somewhat greater; for example, between -70°C and room temperature, there is, in general, an inductance change between two and three times as great as that calculated from the given temperature coefficient. Above +70°C, the inductance rises steadily at first, but then more sharply until, as the Curie point is approached, there is a very rapid decrease in inductance towards unity. The Curie point of Vinkor Ferroxcubes is above 150°C. Vinkors should not generally be operated too close to the Curie point, although, as far as the Ferroxcube core itself is concerned, no permanent harm will result from uniform heating up to about 400°C.

If an inductor is taken through a succession of temperature cycles within its working temperature range, say 25 to 70°C, two small non-cyclic effects may be expected to be superimposed on the cyclic variation of inductance. The first is a small drift, usually a decrease, of inductance resulting from the first one or two cycles. This is attributed to the relief of stresses in the winding and the settling down of the housing parts. Typically, this amounts to about 0.2%. The second is a small decrease, with time, of inductance following each thermal disturbance. This would amount to about 0.1% and would virtually cease within 24 hours. Both of these effects would be proportional to the effective permeability.

Thus, in order to achieve a highly stable inductance, it is advisable to subject the completely finished assembly to several temperature cycles beyond the temperatures which the inductor might encounter during normal operation. The inductor should then be rested at room temperature for at least 24 hours before final inductance adjustment is carried out.

### Mechanical disturbance

The main mechanical disturbance that a Vinkor is likely to be required to withstand is vibration. Tests have shown that when Vinkors which have been assembled and adjusted but not impregnated were vibrated in accordance with the specification of British Standard 2011 (1954), the inductance change was not greater than 0.01%. These tests were made on cores with an effective permeability  $\mu_e$  of 100; no locking compound was used to fix the adjuster, but precautions were taken to ensure that the coil former could not move relative to the Ferroxcube. This latter precaution is recommended whenever high stability is required but impregnation is not desired.

### Stability with time

For all magnetic materials, variation in initial permeability with time will occur if the material is given a thermal, magnetic or mechanical shock. The initial permeability measured immediately after the shock will be higher than the stable value and will decrease with time in an approximately logarithmic manner. This phenomenon is often referred to as disaccommodation (Ref. 1). The amount of disaccommodation in the Ferroxcube used in Vinkors is strictly controlled in production. A measure of disaccommodation is the decrease in initial permeability at constant temperature between 1 minute and 24 hours after complete demagnetisation expressed as a percentage of the value at 1 minute. In production, a limit is placed on the disaccommodation factor, which is the value of disaccommodation defined as above, divided by the initial permeability. Limit values of disaccommodation factor are discussed under the heading "Supplementary Information".

For a Vinkor, the disaccommodation will be reduced by the dilution ratio  $\mu_e/\mu_i$ ; that is, the effective disaccommodation will be given by  $\mu_e \times$  disaccommodation factor. However, it should be emphasised that this measure of time decrease of permeability is related to a very severe disturbance and should be used only for comparison purposes. In practice, inductors are not subjected to such disturbances and will therefore be correspondingly more stable.

### DC polarisation

In general, the effect of DC polarisation on pot core inductors is to decrease the inductance. As with most other inductor characteristics, this decrease depends on the value of effective permeability, the decrease becoming less as the effective permeability decreases. For most applications, the effect is not serious. The decrease for any particular core may be obtained from the curves given in the data sheets.

## Operating Flux Densities

It is usual practice to operate filter inductors at flux densities not greater than about 10 gauss. At such levels, the effects of hysteresis are usually negligible. If it is not possible to restrict the flux density to these levels, then there are three effects to be considered. They are:

- increased loss due to hysteresis,
- waveform distortion,
- increase in inductance.

For a given Vinkor, the maximum hysteresis loss may be readily calculated from the hysteresis factor  $F_h$  which is given in the technical data sheets. The subject of waveform distortion (Ref. 2) is too lengthy to be considered in detail here. However, the manifestations of distortion (that is, production of third harmonics and intermodulation products) are directly related to the hysteresis loss angle  $\delta_h$  of the ferroxcube and therefore to the hysteresis factor of the pot core. Ferroxcubes or pot cores having smaller hysteresis parameters will give less waveform distortion. As a guide to the amount of distortion, the classic formula for third-harmonic products is given below in terms of the fundamental voltage  $E_1$ , the third harmonic open-circuit voltage  $E_3$ , and the tangent of the hysteresis loss angle:

$$\frac{E_3}{E_1} = 0.6 \tan \delta_h,$$

and for a gapped pot core:

$$\tan \delta_h = \frac{F_h I \sqrt{L}}{2\pi}$$

where  $I$  is the r.m.s. current in amperes and  $L$  is the inductance in henries.

The increase in permeability with AC flux density, although related to the hysteresis loss, cannot in practice be readily deduced from it, and so experimental results are usually more useful. For example, for a 25mm Vinkor having an effective permeability of 100 (that is, type LA2304), the increase in inductance on changing the flux density from 10 to 50 gauss would be about 0.3%.

## Self Capacitance

A detailed report on the self-capacitances associated with inductors using Vinkors has already been published (Ref. 3). The self-capacitance can be divided into three parts: that across the whole winding,  $c_a$ ; that from the finish of the winding to the core,  $c_b$ ; and that from the start of the winding to the core,  $c_c$ . All these three capacitances are affected by the size of Vinkor, the number of turns, the type of wire insulation, the nature of winding, and the impregnating or encapsulating material.

The associated power factors of  $c_b$  and  $c_c$  are also considered in the above reference.

For a typical 25mm Vinkor wound with 370 turns of 34 s.w.g. enamelled copper wire, the values of  $c_a$ ,  $c_b$  and  $c_c$  for an unimpregnated coil are 25, 8 and 12pF respectively, and the associated power factors of  $c_b$  and  $c_c$  are both 0.015. When the coil is impregnated in Okerin wax, type 4148, the values of  $c_a$ ,  $c_b$  and  $c_c$  are increased by about 20%; the power factors of  $c_b$  and  $c_c$  are not appreciably changed.

(Continued overleaf)

## Assembly

The following information should be read in conjunction with the exploded view in Fig. 1.

The correct assembly and alignment of Vinkors is essential to ensure a stable component and also to avoid breaking the Ferroxcube cup cores when tightening the fixing bush. For optimum results, the following procedure is recommended:

1. All mating surfaces of the cup cores (7 and 9) should be clean and free from any foreign material. Cleaning can be carried out with most of the normal cleaning fluids, for example, trichloroethylene, applied either with a lint free cloth or in a cleaning bath.

2. The wound coil former (8) (preferably unimpregnated) should be placed in the cup cores and the leads brought out radially through the appropriate slots. There are two ways of fitting the tag plate (11): the method used depends on the gauge of the lead-out wires, and is detailed below.

(a) **Heavy gauge wire.** Lay the tag plate on the studded end of the core assembly so that the two locating lugs are inserted into the slots of the pot core. Make sure that the datum pip between the soldering tags is correctly orientated, so that the lead-out wires may be taken directly to the tags specified on the wiring diagram. The leads are then soldered to the appropriate tags and the assembly is inserted into the container (10) so that the recesses of the tag plate are located in the rolled rim of the container.

(b) **Light gauge wire.** First, place the tag plate in the container and ensure that it is correctly located in the rolled rim. The leads are directed axially out of the slots in the studded end of the pot core assembly, and are then threaded through the appropriate slots in the tag plate as the pot core assembly is inserted into the container. Finally, the lead-out wires are soldered to the correct tags with reference to the datum pip and wiring diagram.

3. When the pot core assembly and its associated tag plate are made up and in the container, the correct alignment plug (Fig. 2) is inserted through the central hole of the cores until its shoulder rests on the Ferroxcube core. The spring washer (5) is placed over the alignment plug so that the periphery of the washer is in contact with the cup core.

4. The locking plate (4) is inserted on top of the spring and it is rotated through one-eighth of a turn. The locking tab on the edge of the container may now be pressed into the adjacent slot in the locking plate.

5. The short unslotted end of the fixing bush (3) should be screwed into the locking plate until it bottoms. The assembly is now properly aligned under the correct pressure and is ready for an inductance check. Before a measurement of inductance is made, it is important to remove the alignment plug. It may be preferred to have the fixing bush partly screwed into the locking plate before assembly.

There is no reason why this should not be so, provided that the inner end of the bush does not project beyond the surface of the locking plate.

6. For a permanent assembly which is not receiving varnish impregnation, it is recommended that a screw-locking compound is applied to the threads of the locking plate and fixing bush.
7. If the pot core assembly is to be impregnated, then the alignment plug should be replaced with one that has been covered with a suitable releasing agent such as silicone grease. It should be secured in position, for example, by passing binding wire across the slot in the fixing bush. The thread on the fixing bush should also be protected.
8. After impregnation, the alignment plug may easily be removed to make way for the adjuster.

## Supplementary Information

### Disaccommodation factor

The disaccommodation factor has been defined (see paragraph headed "Stability with time"). For the lower frequency Vinkors (*Yellow Range*) this factor is less than  $2.2 \times 10^{-3}$ . For the higher frequency Vinkors (*Red Range*) it is less than  $4.0 \times 10^{-3}$ .

### Eddy current copper loss

The eddy current copper loss may be expressed in the following form:

$$\tan \delta_{ecc} = \frac{k_e f d^2 N n}{\mu_e}$$

where  $k_e$  is the copper eddy-current constant for the particular core and bobbin,  $f$  is the frequency in c/s,  $d$  is the wire strand diameter in cm,  $N$  is the number of turns,  $n$  is the number of strands,  $\mu_e$  is the effective permeability.

The value of  $k_e$  for the 18, 21 and 25mm Vinkors using single-section coil formers is 0.12, 0.08 and 0.06 respectively.

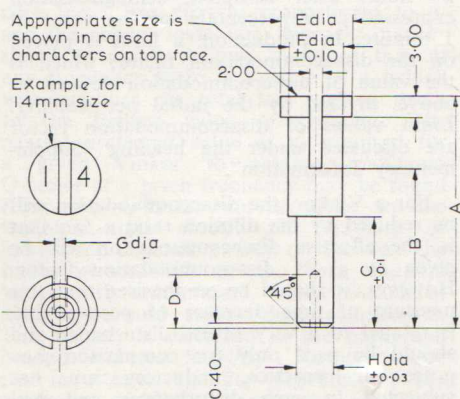


Fig. 2. Alignment plug types and sizes.

### Dimensions

Type number	A	B	C	D	E	F	G	H	Pot core size (mm)
DT2156	25.3	15.4	8.2	4.5	6.3	4.25	1.2	3.55	14
DT2157	26.7	16.6	9.4	5.1	6.3	4.25	1.2	3.55	16
DT2158	27.7	17.6	10.4	5.5	7.9	5.85	1.2	4.55	18
DT2159	30.1	20.5	12.8	6.5	7.9	5.85	1.2	4.55	21
DT2160	32.7	23.1	15.2	7.5	7.9	5.85	1.5	5.34	25
DT2161	36.3	26.2	18.0	8.5	10.7	8.65	1.5	5.34	30
DT2162	40.4	30.2	22.0	10.5	10.7	8.65	1.5	5.34	35
DT2163	48.8	38.3	28.4	15.0	10.7	8.65	1.5	5.34	45

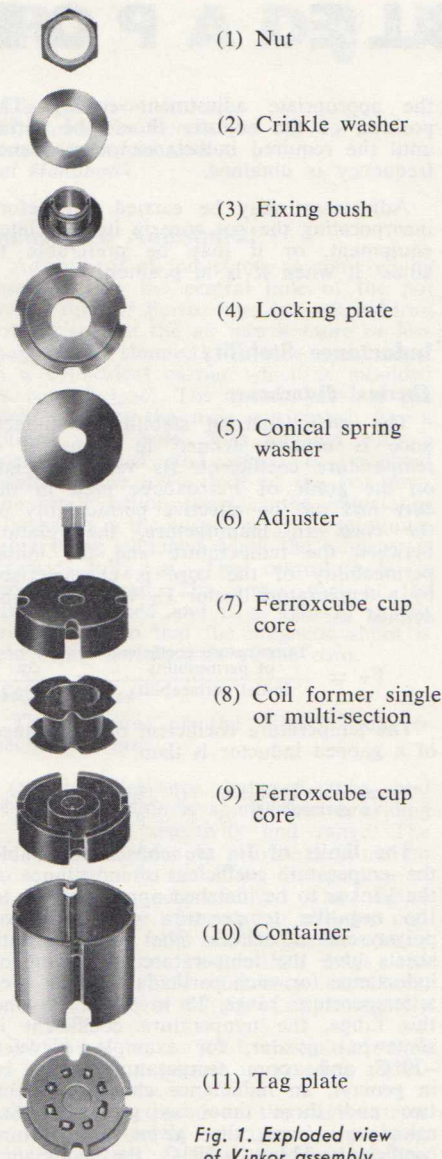


Fig. 1. Exploded view of Vinkor assembly.

## REFERENCES

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# VOLTAGE-DEPENDENT RESISTORS IN TELEVISION RECEIVERS

*This article describes some of the basic properties of voltage-dependent resistors and shows how they may be incorporated in television receiver circuit applications.*

The resistance of a normal (linear) resistor is constant despite any variations in the applied voltage. As shown in Fig. 1, the graph of current through the resistor plotted against the applied voltage is, therefore, a straight line. With a voltage-dependent resistor the resistance is not constant but falls as the applied voltage increases. The voltage/current relationship for a VDR plotted on a linear scale, is shown in Fig. 2. If this voltage/current relationship is plotted on a double logarithmic scale, as in Fig. 3, it will be seen that over most of the voltage range the relationship is represented by a straight line. Over this portion of the graph, the voltage and current relationship can be expressed by the equation:

$$V = CI^\beta$$

where C is a constant and  $\beta$  is the slope of the graph. The corresponding equation for a linear resistor is the familiar:

$$V = IR$$

The variation of the actual resistance of the VDR with increasing voltage is shown in Fig. 4. This clearly shows the drop in resistance with the increase of applied voltage.

In the same way that the electrical characteristics of a linear resistor can be specified by the resistance (R in the equation  $V = IR$ ), the electrical properties of a VDR can be specified by the values of C and  $\beta$ . It can be seen from the equation  $V = CI^\beta$  that C is the voltage developed across the VDR when a current of 1A flows through. However, since most VDR are not designed to pass a current of 1A, an alternative method is used to specify Mullard voltage-dependent resistors. This uses  $\beta$  as before, but replaces C by the voltage developed by currents flowing through the VDR of 1, 10 or 100mA. This has an advantage over the previous method, of specifying a VDR with a closer tolerance in the working range.

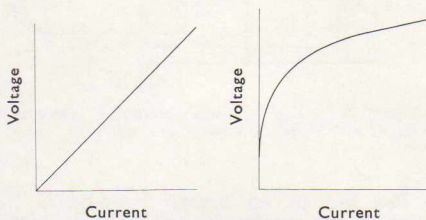


Fig. 1. (l.) Voltage/current characteristics for linear resistor.

Fig. 2. (r.) Voltage/current characteristics for VDR (linear scale).

### Surge Suppression

The decrease of resistance with an increase of voltage suggests the use of a VDR in a surge suppression circuit. If a suitable VDR is connected between the two supply lines, a voltage surge down the lines causes the resistance of the VDR to be decreased thus forming a low impedance path which effectively suppresses the surge voltage.

An application in a television receiver using this principle is limiting the peak anode voltage and the prevention of oscillation in the frame output stage. A typical circuit is shown in Fig. 5 where the VDR is connected across the primary winding of the frame output transformer. During the scanning period the resistance of the VDR is high and it has no effect on the circuit. During the flyback period, however, the fly-

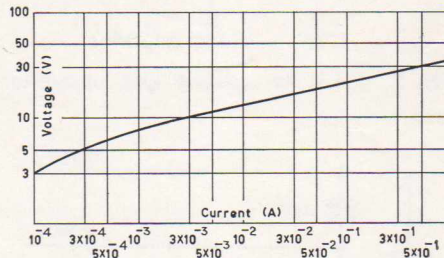


Fig. 3. Voltage/current characteristics for VDR (double log. scale).

back pulse causes the resistance of the VDR to fall thus damping the circuit.

### Stabilisation

The variation of resistance with voltage can be used to stabilise circuits against changes in supply voltage. A circuit for a stabilised horizontal output stage is shown in Fig. 6 and typical circuits for stabilised frame oscillators are shown in Figs. 7 and 8. In both cases it can be seen that the VDR is effectively connected across the circuit to be stabilised. Any fluctuation in the supply voltage causes changes in the resistance of the VDR and, hence, changes in the current drawn by the VDR. The current through the stabilised circuit and, therefore, the voltage across it, will remain sensibly constant. For the circuits shown, a 10% variation in supply voltage will be reduced to approximately 3% across the stabilised circuit.

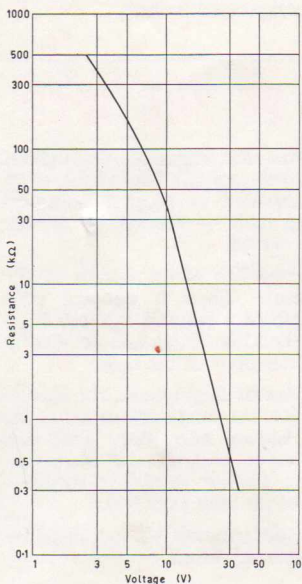


Fig. 4. Resistance plotted against voltage for VDR.

### Prevention of Switch-Off Spot Burn

When a television receiver is switched off, the voltages on the grid and cathode of the picture tube fall together which results in the picture collapsing to form a spot which may burn the screen of the picture tube. A circuit for suppressing this spot is shown in Fig. 9. When the receiver is switched off, the VDR holds the grid more positive than the cathode, causing a large EHT current to flow within the tube so discharging the distributed EHT capacitance and preventing the formation of the spot. The VDR also tends to stabilise the brightness potential against changes in supply voltage.

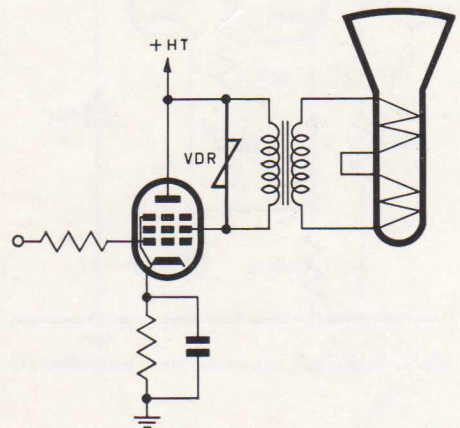


Fig. 5. VDR in frame output stage.

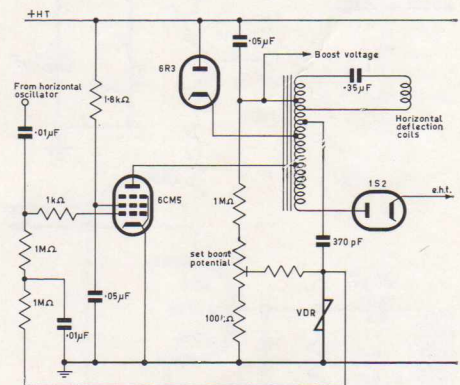


Fig. 6. Horizontal output stage.

### Higher Boost Voltage

A VDR can be used to obtain a higher boost voltage for certain applications. A circuit is shown in Fig. 10 in which the 4kV pulse from the cathode of the booster diode is applied to the VDR. In this case, a voltage of 900V is obtained for the first anode of the picture tube with an external load of approximately 12MΩ (presented by the anode). The series resistor of 680kΩ may be eliminated by a suitable choice of output transformer tap.

There are many applications outside the field of television. The use of a VDR for stabilisation previously mentioned can be applied to many circuits, especially when space is restricted and the relatively simple circuitry of the VDR stabiliser has advantages over more elaborate circuits using valves or transistors.

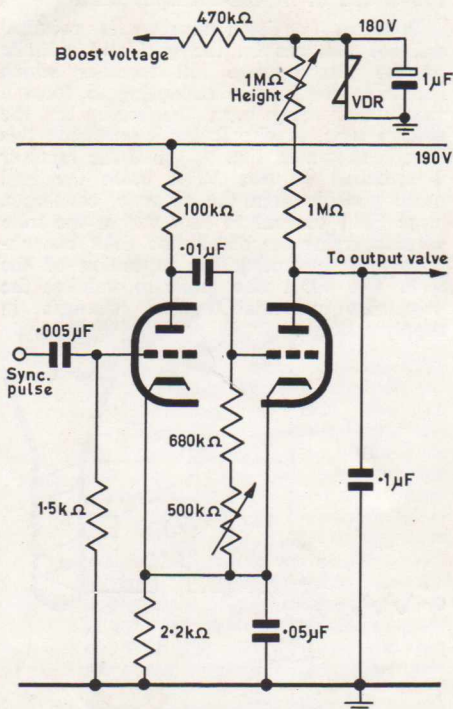


Fig. 7. Stabilised frame oscillator (multivibrator).

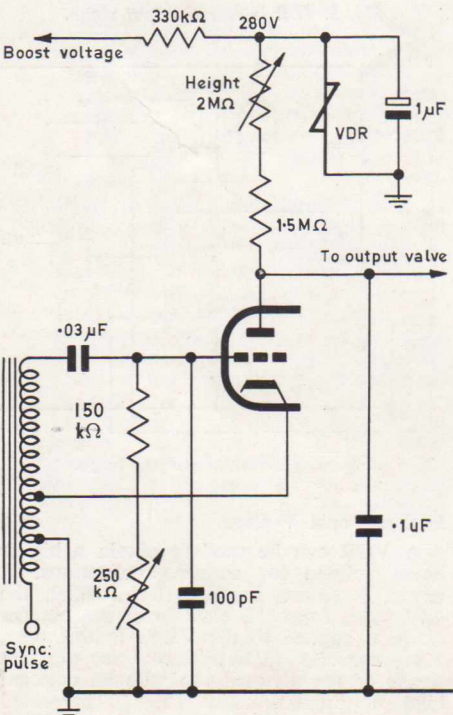


Fig. 8. Stabilised frame oscillator (blocking-oscillator).

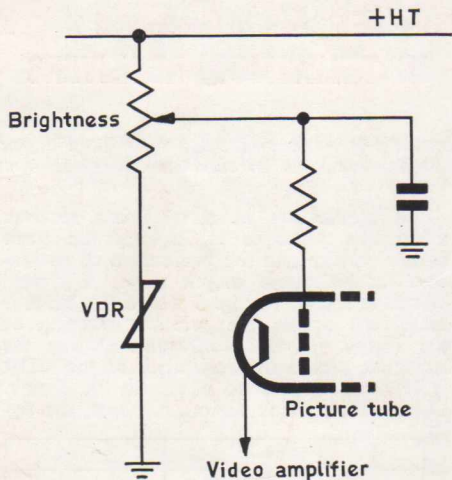


Fig. 9. Circuit for switch-off spot suppression.

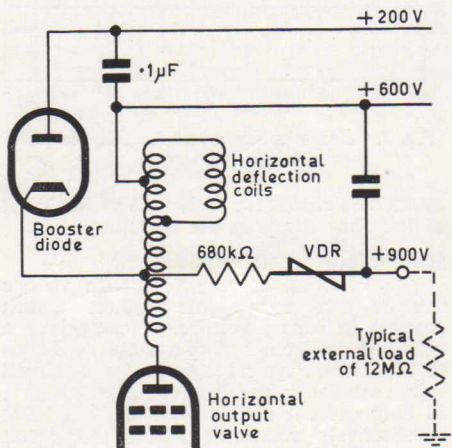


Fig. 10. Circuit to increase boost voltage.

The circuits described in this article are typical only and do not refer to a particular television receiver. Circuits encountered by the service engineer may be similar in principle to those described but there may be considerable differences in detail, especially in component values.

## STORY OF THE INCH

Mathematicians and engineers throughout the Commonwealth and the United States of America have decided to adopt a standard measure for the inch — the most variable measure in the world.

The inch started life as the length of the first thumb joint. Then it became one-twelfth the length of a Roman soldier's foot. Henry I took a hand in things and decided to make it a measurement of his nose.

In 1856, by Act of Parliament, the British Imperial Yard was measured out on two gold studs set in a bronze alloy bar. This was kept in the Office of Weights and Measures. The trouble was, the bar started to shrink — by a millionth of an inch each year.

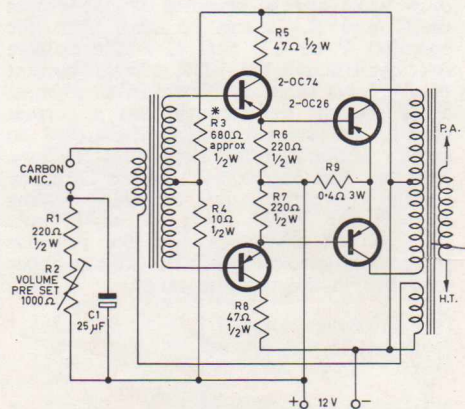
All future measurements will be based on the Canadian inch (25.4 mm).

## MODIFICATIONS TO MODULATOR DESIGN WITH OC26 TRANSISTORS

It has been found that under unfavourable circumstances — particularly under sustained drive — the previously described (Mullard Outlook, Australian Edition Vol. 3, No. 3, pages 28, 29 — Ed.) "Modulator Design with OC26 Transistors" may be thermally unstable. Leakage currents in the OC74 driver transistors and in the OC26 output transistors may be equally responsible. To guarantee thermal stability under sustained-drive conditions at ambient temperatures of up to 45°C, it is recommended that the following modifications be made:

- a resistor of 0.4Ω (R9 in the accompanying circuit diagram) should be included in the common emitter return of the output transistors.
- to minimize heating of the driver transistors under drive, 47Ω collector load resistors (R5, R8) should be used.
- the return resistors for OC74-emitter-OC26-base (R6, R7) should be decreased from 1.2kΩ to 220Ω.

It should, in addition, be ensured that the 2-OC74 as well as the 2-OC26 have adequate heat sinks — the cooling fins being screwed onto any available flat metal surface.



\*Adjust base bias for total quiescent current of 40mA, not including microphone current.

The use of an emitter resistor in the output stage results in some loss of power and sensitivity, although there is an improvement in the fidelity at moderate power levels. The revised performance figures are as follows:

Maximum output power, 1,000 c/s (10% total harmonic distortion)	14.5	W
Voltage across input terminals for maximum output power:	920	mV
Input Impedance	≈ 50	Ω
Negative Feedback	9	dB