THE WINDS OF CHANGE

It is perhaps appropriate at the commencement of this fifth year of publication that we dwell on Mullard Outlook and its contribution to this Industry, during a somewhat turbulent period and the ever-increasing influence of semiconductors. At a time in the sales promotion of TV receivers when there seems to be a splitting of hairs, for example, the difference between “new” and “brand new” and, for some, “cash” and “spot cash”, at least where the parameters of valves and semiconductors are concerned, the units are finite. It has been gratifying to us to find that the demand for Outlook has been, to a degree, infinite and, in order to best fulfil its particular purpose, we make no apology that, for personal copies we are now obliged to make a small charge.

In conclusion, I quote from the editorial—Volume 1, Number 1, January 1958:—

“The Mullard Outlook is dedicated to those of our fellow men whose livelihood and interest is in the electronic field and its scope directed to the salesman, the retailer, the service mechanic, the development engineer, the research worker and the hobbyist and it is my earnest trust that through the years this journal will be the happy medium linking our efforts to all whom we have the privilege and pleasure of offering our services.”

M.A.B.
VIEWPOINT WITH MULLARD

THE OTHER FELLOW'S BUSINESS

In Outlook, Vol. 4, No. 4, Page 39, we questioned just where the service area of Wollongong would finish and were hesitant to make any prediction. It is now evident that our hesitancy had some foundation, because WIN4 puts a usable signal into most of the Sydney metropolitan area. Alert retailers and service companies can capitalise on this by providing the additional channels in receivers that are not already equipped. A conservative estimate of the Sydney metropolitan set in this category with due allowance to the viewers not wishing to have the alteration is 350,000. If the alteration charge was £3 to £4 there is over £1,000,000 of business offering.

Alternatively, the fact that for Sydney WIN Channel 4 is available, but unable to be used is a selling factor to support obsolescence.
**MODERN RADIO COMMUNICATIONS**

**THE INFLUENCE OF SINGLE SIDEBAND**

"It is essential to bear in mind that the two terms, automation and communications, are so closely interlinked that automation can only function perfectly when the communications both up and down are a reality." The author, Mr. Alfred M. Cooper, writing in "Management Digest" for August/September, 1959, was endeavouring to emphasise the importance of communications in an automated industry.

Communication is important in any business undertaking and a definition of "communications" would include all of the means necessary to transfer people or things from any one point to another. It would also encompass the means taken to transfer information and implies ultimate understanding or a "meeting of minds" with respect to the information transferred.

The essential requirements of a communications system call for accuracy and speed commensurate with the importance of the information to be communicated, and today the need for both accuracy and speed has never been greater. Communication in transport is already into the jet age and only recently an astronaut crossed Australia in 9 minutes—the shape of things to come. An orbiting satellite or manned capsule may travel at a speed of the order of 5 miles per second; however, radio waves travel at a velocity of approximately 186,000 miles per second, vastly superior, and likely to remain so until man conquers the realm of the fourth dimension. Here then is real speed, which when coupled with a high degree of accuracy, provides an almost ideal system of transferring information from one point to another. This is radio communication, used in many modes, each one having particular advantages over the others, according to the type of information to be transferred and the speed required. Several of these modes are covered in greater detail in the following paragraphs.

**Modes of Communication**

Long distance communication circuits may be established in several ways, the method chosen depending upon the type of country and the distance to be spanned, whether intermediate junctions are required, and of course, capital outlay and cost of maintenance. The chief methods used are:

1. Multi-channel line system (carrier telephone);
2. Multi-channel VHF/UHF systems;
3. High frequency radio links.

High frequency radio links have the following advantages:

1. The capital cost is relatively low;
2. The system can be made quite flexible, transmitters and receivers being switched to different circuits according to traffic loading;
3. Installation is relatively speedy;
4. A large number of radio links can be terminated in central transmitting and receiving sites so that the provision of effective maintenance facilities is simplified.

The main disadvantages are lack of secrecy, susceptibility to jamming, and the influence of abnormal propagation effects.

High frequency communication systems may be divided broadly into two groups—telegraphy and telephony, each system requiring its own specialised equipment.

Several types of emission are listed below:

**Amplitude Modulation**

Type B. (Damped wave train) now obsolete, previously used by spark transmitters and the earliest form of radio communication.

Type A1. Keyed continuous wave (telegraphy).

Type A2. MCW modulated continuous wave (keyed).

Type A3. Telephony (double sideband full carrier).

Type A3a. Telephony (single sideband, reduced carrier).

Type A3b. Telephony (two independent sidebands, reduced carrier).

Type A4. Facsimile.

Type A5. Television.

Type A9. Composite transmission and cases not covered by the above.

Type A9c. Composite transmissions (reduced carrier).

In the past, most radio telegraphic communication systems have used on-off keying, "carrier on" indicating "mark" and "carrier off" indicating "space". The effect of this is to present the receiver with an intermittent signal, which, if integrated over a period of time, indicates the presence of a signal at a level longer than the "mark" condition; and this result in a low value of average power. If the keying is reversed so that a "mark" signal is represented by "carrier off" and the "space" by "carrier on", an increase in average power results; it has been found in practice that reversed on-off keying shows an advantage over the more conventional method. This method of machine telegraphy has now been replaced by the FSK system in most installations.

For point-to-point telephony circuits, single sideband (SSB) operation is replacing double sideband (DSB) for many reasons. In the case of a double sideband transmission with 100% modulation, half the power is concentrated in the carrier and a quarter of the power in each sideband. As the carrier can be replaced by a local oscillator in the receiver, and only one sideband needs to be transmitted to convey intelligence, it is obvious that the system is wasteful, both in power and in frequency spectrum. A single sideband system is one in which only one sideband is transmitted, the carrier being reduced to a level well below the peak sideband power. An independent sideband transmission is one in which separate intelligence is radiated on each sideband, the carrier being reduced as above.

The gain of a single sideband over a double sideband system may be summed up as follows:

1. The carrier is reduced to small proportions, and practically the whole of the radiated power is concentrated in the sideband, thus for a given signal-to-noise ratio at the receiver the transmitter power may be reduced. The more usual way of expressing the improvement is to consider the signal-to-noise ratio at the receiver for a given transmitter power. Under ideal propagation conditions the signal-to-noise ratio at a distant receiver will be the same for an AM transmitter having a carrier power of 100W with two sidebands of 25W each (a total transmitter output power of 150W) when compared with a SSB transmitter having an output of 50W in the one sideband. This assumes, of course, that the SSB signal is received on a SSB receiver with a passband half that of the AM receiver;

2. By the provision of a steady local or reconditioned carrier, over-modulation is eliminated when the carrier period is reduced by selective fading. This results in a reduction in distortion which cannot be expressed in dB but provides a very important contribution towards the intelligibility of a telephone conversation.

It may sometimes be found advantageous to use a single sideband receiver for excited carrier reception of a double sideband transmission, for although a decrease in signal-to-noise ratio will result due to the loss of one sideband, this may be offset by the reduction of distortion due to selective fading and also by the possibility of choosing the sideband which is less affected by interference. This is a form of communication that has some of the advantages of single sideband plus low cost and simplicity. It does, however, consume twice as much spectrum space as a single sideband signal.

**Frequency Modulation**

Type F1. Telegraphy, without the use of modulating audio frequency (frequency shift keying).

Type F2. Frequency modulation (telegraphy).

Type F3. Frequency modulation (telephony).

Type F4. Facsimile.

Type F5. Television.

Type F9. Composite transmissions and cases not covered by the above.
FM is a process of modulation whereby the carrier varies in frequency (rather than amplitude) at a rate determined by the modulation frequency. In effect, the carrier frequency reverses over its normal resting frequency during one-half cycle of modulation and below its normal resting frequency during the other half cycle. The distance (frequency difference) of the sidebands, determined by the amplitude of the modulation voltage. The total deviation of a commercial FM station (88-108 Mc/s) is limited to ±75 kc/s.

Most new teleprinter installations use frequency-shift keying (FSK): that is, the "mark" and "space" conditions are indicated by different carrier frequencies. With this method the transmitter is radiating continuously so that the receiver is presented with an unbroken signal. The advantages of frequency-shift keying over on-off operation may be summarised as follows:

1. Transmitter keying is relatively simple especially at higher power levels.
2. For a given keying speed the transmitted spectrum is small.
3. An unbroken signal is presented to the receiver although the effect of this may be offset to a certain extent by selective fading. A low value of shift is useful in this respect.
4. Reduction in random keying due to atmospherics owing to a frequency-sensitive, rather than an amplitude-sensitive system.
5. The adjustment of the receiver gain controls is less critical.

Pulse Modulation

Type P1. Pulse (telegraphy, amplitude modulated).
Type P2d. Pulse (telegraphy, width modulated).
Type P2e. Pulse (telegraphy, phase or position modulated).
Type P3d. Pulse (teletypewriter, amplitude modulated).
Type P3e. Pulse (teletypewriter, width modulated).
Type P3f. Pulse (teletypewriter, phase or position modulated).
Type P9. Complete transmissions and cases not covered by the above.

The classic example of pulse modulation is of course a radar transmitter. The intelligence is the timing of a pulse chain. The amount of time it takes for the echo pulse to return from an object is directly related to the distance of the object from the transmitter/receiver.

SSB Transmitting and Receiving

Single sideband is not a recent innovation; it was used after the first world war in conjunction with carrier telephone systems and has continued in use to the present day. Admittedly, both sidebands may be used, each sideband being divided into several segments by means of filters, thus enabling many conversations on each side of the suppressed carrier frequency. A typical system might include ten simultaneous voice channels on each side of the carrier for a total of 20 circuits, all carrying different information. Some systems place teletype or teleprinter circuits on one side of the suppressed carrier and voice channels on the other side.

Significance of Sidebands

The carrier and sideband frequencies have a real existence, as is evidenced by the fact that the various frequency components of a modulated wave can be separated from each other by suitable filters. The sideband frequencies can be considered as being generated as a result of varying the amplitude of the wave with modulation. They are present only when the modulating signal is varied, and their magnitude and frequency are determined by the character of the modulation. When the modulating voltage is superimposed on the amplitude of the modulating valve, the anode then alternately becomes more and less positive. As it becomes more positive the minimum anode potential tends to increase, causing the peak amplitude of the pulse of anode current to become larger whilst, at the same time, the angle of flow increases because of the greater anode voltage. The output is accordingly increased. Similarly when the modulating voltage causes the anode potential to be less than the anode supply voltage, the minimum anode voltage tends to become less, thus reducing the peak amplitude of the anode current pulses, which together with the smaller angle of flow, reduces the power output. This changing phase results in the generation of upper and lower sidebands in accordance with the modulating frequency, being removed from the carrier in the upper or lower direction, according to the characteristics of the modulating signal.

Advantages of SSB

The advantages of single sideband over AM under conditions of selective fading referred to earlier, provides perhaps one of the most important reasons for the use of SSB. The deterioration of an AM signal under poor propagation conditions and selective fading causes severe distortion and results in a much weaker received signal. At times this can even make the received signal unintelligible. The most serious result of selective fading, and indeed the most common, occurs when the carrier level is attenuated more than the sidebands and in such cases the carrier voltage at the receiver is reduced to the sum of the two sideband voltages. The RF envelope therefore does not retain its original shape and distortion on demodulation is extremely severe. This results because a carrier voltage at least as strong as the sum of the two sideband voltages is required to properly demodulate the signal. Selective fading can also result in a shift between the relative phase of the carrier and sidebands, and when the carrier is shifted by 90° from its original position relative to the sidebands, the original AM signal is converted to a phase-modulated signal which becomes high as the frequency of the modulating frequency is increased and can result in severe amplitude distortion.

(Continued on page 8)
### Survey of Mullard Types

<table>
<thead>
<tr>
<th>TYPE No.</th>
<th>MAIN APPLICATIONS OR USE</th>
<th>TYPICAL PEAK RESPONSE</th>
<th>CONDITIONS</th>
<th>SENSITIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPY10</td>
<td>Silicon Photovoltaic area 2.82mm²</td>
<td>Multi-track punched card and punched tape readout systems</td>
<td>Measured at 200 lm/ft² (current through a 2kΩ load)</td>
<td>—</td>
</tr>
<tr>
<td>OAP12</td>
<td>Germanium Photodiode area 1.0mm²</td>
<td>Film sound track scanning, relay triggering, light measurement and photoelectric comparison</td>
<td>Measured with a lamp of colour temperature 2500 K with $V_A = 10V$</td>
<td>0.5</td>
</tr>
<tr>
<td>OCP71</td>
<td>Germanium Phototransistor area 7mm²</td>
<td>General industrial switching applications</td>
<td>Measured at $V_A = -2V$ with uniform illumination of 75 lm/ft² falling on sensitive surface</td>
<td>1.5</td>
</tr>
</tbody>
</table>

#### Photoconductive Cells

| ORP11   | Cadmium sulphide area 1.25cm² | Smoke and oil flame failure detection, direct relay operation | Light resistance at 93 lm/ft² | 3.5 | 10 | 17 | — | mA |
| ORP12   | Cadmium sulphide area 57mm² | Automatic contrast and brightness control of television equipments | Dark resistance | 12 | 30 | 48 | — | mA |
| ORP30   | Cadmium sulphide area 4.5cm² | Smoke and oil flame failure detection, direct relay operation | Measured at 10V d.c. with 5.0 lm/ft² | 200 | 500 | 800 | — | μA |
| ORP50   | Cadmium sulphide area 1.0cm² | Oil flame failure detection | Measured at 30V d.c. with 5.0 lm/ft² | — | — | — | — | μA |
| ORP60   | Cadmium sulphide area of top of bulb dia. 5.2mm max | Oil flame failure detection, 0.67μm | — | — | — | — | μA |
| ORP61   | Cadmium sulphide area 0.25cm² | Oil flame failure detection | Measured at 30V d.c. with 5.0 lm/ft² | 200 | 500 | 800 | — | μA |
| ORP90   | Cadmium sulphide area 2.9cm² | Smoke and oil flame failure detection, direct relay operation | Measured at 10V d.c. with 5.0 lm/ft² | 3 | 10 | 16 | — | mA |
| ORP93   | Cadmium sulphide area 2.4cm² | Oil flame failure detection, 0.67μm | Measured at 10V d.c. with 5.0 lm/ft² | 3 | 6 | 14 | — | mA |
| 61SV    | Lead sulphide area 0.36cm² | Pyrometry, gas flame failure detection | Measured at 200V d.c. with chopped light 0.05 lm falling on cell area | — | 3 | — | — | mA(pk)/lm |
| 62SV    | Lead sulphide area 0.36cm² | Near infra-red spectrometry | Measured at 200V d.c. with chopped light 0.05 lm falling on cell area | — | 3 | — | — | mA(pk)/lm |
| ORP10   | Indium antimonide area 3.0mm² | Intermediate infra-red spectrometry, particularly gas analysis | Measured with 50mA d.c. passing through cell and with 200W of radiation falling on sensitive cell area at 20°C | — | 75 | — | — | Ω |
| ORP13   | Indium antimonide area 3.0mm² cooled by liquid nitrogen | Intermediate infra-red applications, spectrometry | Measured with 7.6μW/cm² of radiation of wavelength 4.6μm falling on the sensitive area | 10 | — | 60 | — | kΩ |

#### Photoemissive Cells

| 20CG    | Caesium on oxidised silver projected area 5.3cm² gas filled | Film sound track scanning, 0.8μm | Measured at $V_A = 90V$ with whole cathode area illuminated and $R_L = 1MΩ$ | 150 | — | — | — | μA/μW |
| 20CV    | Caesium on oxidised silver projected area 6.7cm² vacuum type | Oil flame failure detection, 0.8μm | Measured at $V_A = 100V$ with whole cathode area illuminated and $R_L = 1MΩ$ | 25 | — | — | — | μA/μW |
| 53CG    | Caesium on oxidised silver projected area 1.1cm² gas filled | Film sound track scanning, 0.8μm | Measured at $V_A = 85V$ with whole cathode area illuminated and $R_L = 1MΩ$ | 100 | — | — | — | μA/μW |
| 53CV    | Caesium on oxidised silver projected area 1.1cm² vacuum type | Oil flame failure detection, 0.8μm | Measured at $V_A = 50V$ with whole cathode area illuminated and $R_L = 1MΩ$ | 20 | — | — | — | μA/μW |
### ARD PHOTODEVICES

#### MAIN APPLICATIONS OR USE

<table>
<thead>
<tr>
<th>TYPE No.</th>
<th>Type</th>
<th>Projected Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>58CG</td>
<td>Caesium on oxidised silver</td>
<td>1·1cm²</td>
</tr>
<tr>
<td>58CV</td>
<td>Caesium on oxidised silver</td>
<td>1·1cm²</td>
</tr>
<tr>
<td>90CG</td>
<td>Caesium on oxidised silver</td>
<td>3·1cm²</td>
</tr>
<tr>
<td>90CV</td>
<td>Caesium on oxidised silver</td>
<td>3·0cm²</td>
</tr>
<tr>
<td>90AG</td>
<td>Caesium antimony</td>
<td>4·0cm²</td>
</tr>
<tr>
<td>90AV</td>
<td>Caesium antimony</td>
<td>4·0cm²</td>
</tr>
<tr>
<td>92AG</td>
<td>Caesium antimony</td>
<td>2·1cm²</td>
</tr>
<tr>
<td>92AV</td>
<td>Caesium antimony</td>
<td>2·1cm²</td>
</tr>
<tr>
<td>51UVP</td>
<td>Caesium antimony</td>
<td>8cm²</td>
</tr>
<tr>
<td>52AVP</td>
<td>Caesium antimony</td>
<td>3cm²</td>
</tr>
<tr>
<td>53AVP</td>
<td>Caesium antimony</td>
<td>15·2cm²</td>
</tr>
<tr>
<td>53UVP</td>
<td>Caesium antimony</td>
<td>15·2cm²</td>
</tr>
<tr>
<td>54AVP</td>
<td>Caesium antimony</td>
<td>97cm²</td>
</tr>
<tr>
<td>56AVP</td>
<td>Caesium antimony</td>
<td>97cm²</td>
</tr>
<tr>
<td>56UVP</td>
<td>Caesium antimony</td>
<td>97cm²</td>
</tr>
<tr>
<td>57AVP</td>
<td>Caesium antimony</td>
<td>315cm²</td>
</tr>
<tr>
<td>58AVP</td>
<td>Caesium antimony</td>
<td>95cm²</td>
</tr>
<tr>
<td>150AVP</td>
<td>Caesium antimony</td>
<td>8cm²</td>
</tr>
<tr>
<td>150CVP</td>
<td>Caesium on oxidised silver</td>
<td>8cm²</td>
</tr>
<tr>
<td>153AVP</td>
<td>Caesium antimony</td>
<td>15·2cm²</td>
</tr>
</tbody>
</table>

#### TYPICAL PEAK RESPONSE

<table>
<thead>
<tr>
<th>MAIN APPLICATIONS OR USE</th>
<th>Conditions</th>
<th>SENSITIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Film sound track scanning, 0·8μm</td>
<td>*Measured at ( V_a = 85) ( V )</td>
<td>100</td>
</tr>
<tr>
<td>oil flame failure detection</td>
<td>( \text{with whole cathode area illuminated and} \ R_1 = 1, \Omega )</td>
<td>-</td>
</tr>
<tr>
<td>Oil flame failure detection, 0·8μm</td>
<td>*Measured at ( V_a = 100) ( V )</td>
<td>20</td>
</tr>
<tr>
<td>register, positioning, tension control for printing</td>
<td>( \text{with whole cathode area illuminated and} \ R_1 = 1, \Omega )</td>
<td>-</td>
</tr>
<tr>
<td>Oil flame failure detection, 0·8μm</td>
<td>*Measured at ( V_a = 90) ( V )</td>
<td>125</td>
</tr>
<tr>
<td>register, positioning control for printing</td>
<td>( \text{with whole cathode area illuminated and} \ R_1 = 1, \Omega )</td>
<td>-</td>
</tr>
<tr>
<td>Sound reproducing system 0·4μm</td>
<td>*Measured at ( V_a = 85) ( V )</td>
<td>130</td>
</tr>
<tr>
<td>where a dye image sound track is used in conjunction with an incandescent light source</td>
<td>( \text{with whole cathode area illuminated and} \ R_1 = 1, \Omega )</td>
<td>-</td>
</tr>
<tr>
<td>Colorimetry, density measuring meters</td>
<td>*Measured at ( V_a = 100) ( V )</td>
<td>45</td>
</tr>
<tr>
<td>Film sound track scanning 0·4μm</td>
<td>( \text{with whole cathode area illuminated and} \ R_1 = 1, \Omega )</td>
<td>-</td>
</tr>
<tr>
<td>Colorimetry, densitometry</td>
<td>*Measured at ( V_a = 85) ( V )</td>
<td>45</td>
</tr>
</tbody>
</table>

**Illuminated by a lamp of colour temperature 2700 K.**

**Illuminated by a lamp of colour temperature 2870 K.**

Note \( R_1 \) is a series resistance.

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The majority of these photosensitive devices are already in use in Australia and are available from Mullard-Australia Pty. Ltd. and Distributors throughout the Commonwealth.
MODERN RADIO COMMUNICATIONS

(Continued from page 5)

modulated signal with the result that a conventional AM detector will not produce an intelligible signal, indeed any carrier phase shift from its original phase relationship to the sidebands, will produce a consequential loss of intelligibility in the audio signal.

A SSB signal is not subject to deterioration due to selective fading, since only one sideband is transmitted and the received signal level therefore does not depend upon the resultant amplitude of two sideband signals as in AM. SSB systems have no carrier, distortion cannot result from loss of carrier power or phase shift. Selective fading within the one sideband of the SSB system merely changes the amplitude and frequency response of the signal and very rarely produces enough distortion to cause the received signal to be unintelligible. (See Fig. 1 which compares the relative advantage of SSB over AM with limited propagation conditions.)

Further increases in transmitter efficiency may be obtained by considering the duty cycle, that is, the time over which the output valve is dissipating power versus the time over which it is virtually at rest. With an ABI linear output amplifier it is possible to have a power supply of say 1,000V with a resting anode current of 20mA which rises on speech peaks to somewhere in the vicinity of 200-250mA. In the unmodulated condition the power amplifier is dissipating only 20W and on speech peaks the operating conditions become somewhat tenuous to pulse operation ratings, with a resultant improvement in DC efficiency.

A single sideband signal consisting of a suppressed carrier of say 8 Mc/s and an audio tone of say 3,000 c/s is transmitted on a frequency of 8,003 kc/s, and is said to be an upper sideband signal. If, however, the upper sideband was suppressed and the signal was being transmitted on the lower sideband, the frequency would be 7,997 kc/s. Where sideband switching is incorporated in a system, it is therefore possible by pre-arrangement, to transfer from one sideband to another, enabling in many cases normal reception where interference is present on only one sideband. To receive a single sideband signal it is necessary to insert at the receiver a locally generated carrier whose frequency should be very close to the original carrier frequency, dependent of course, upon the actual signal level. This may be accomplished by transmitting sufficient carrier to operate an AFC circuit which maintains correct receiver tuning, or by using equipment with a high degree of stability, so that, once set, the receiver remains in tune for long periods without further need for adjustment. With present day techniques it is not unusual to achieve in high-class commercial equipment stability of 1 c/s at 10 Mc/s in fixed station equipment and 10 c/s at 10 Mc/s in mobile equipment and the need for AFC and pilot carriers is thus eliminated. In fact the modern approach suggests the use of high degrees of carrier suppression in order to reduce heterodyne interference from strong stations on adjacent channels. Where AFC is in use such a station on an adjacent channel may be capable of capturing the receiver and tuning it to that station. One other advantage to be achieved with high degrees of carrier and unwanted sideband suppression is the greater freedom from unwanted distortion products in linear amplifiers due to harmonics of sideband components beating with harmonics of the carrier and producing beat notes which appear on the transmitted signal.

Generators for SSB

There are several methods of generating single sideband signals, which however may be classified into two main groups, filter systems and phasing systems. In both methods one of the most important steps is the reduction of the carrier which may be effected by the use of a balanced modulator which is capable of providing considerable carrier suppression. A balanced modulator may be considered an electronic switch wherein the carrier frequency is switched on and off at the rate of the modulating signal. Either valves or semiconductor diodes may be used for this purpose and a simple balanced modulator circuit is shown in Fig. 2. This would at first appear to be a push-pull amplifier with some form of modulation applied to the centre tap of the grid inductor. It may be thought of as such except that the effects are slightly different from those normally encountered. The notations Fm and Fc denote two frequencies that are fed into the balanced modulator stage, Fc being the carrier frequency and Fm the modulating frequency. It may be readily seen that Fm is in phase at the two grids of the balanced modulator and will therefore cancel in the output circuit. Fm on the other hand is applied to the two grids in push-pull and, for all practical purposes, will not appear in the output circuit, as this is broadly tuned to the carrier frequency Fc. The output of the balanced modulator will therefore consist of the sum and difference frequencies Fm + Fc and Fc — Fm which are, in effect, the upper and lower sidebands.

Phasing System

In the phasing method, Fig. 3, aiding and opposing voltages are used to balance out the unwanted sideband rather than rejecting it as in the filter system. The voltages must also be of the proper phase, amplitude and frequency. As phase and amplitude requirements are met by employing phase-shift networks and associated amplitude balance controls, establishing the correct frequency in the system is therefore automatic. Referring to Fig. 3, it may be seen that the output of the speech amplifier is shifted 90° by an audio phase-shift network. The output of the carrier generator is also shifted 90°. The phase shifted audio and RF signals are combined in the balanced modulator, resulting in two double sideband suppressed carrier signals, 180° apart. When these are combined in a tuned circuit, the voltages in one sideband will add and the voltages in the other sideband will be in opposition, resulting in a single sideband suppressed carrier signal being presented to the following stage. These operations may be performed at the desired signal frequency or at some more convenient frequency and heterodyned to the desired final frequency. The phasing method presents difficulties in its ability to maintain the exact 90° phase shift over the entire desired audio frequency range and hence there may be some unwanted signals in sidebands unless a suitable low-pass filter is employed to restrict the audio frequency response prior to modulation. As a result the filter method appears to be more popular in commercial installations, whilst the phasing technique is used where cost is a factor, such as in amateur service.

To be continued in Outlook Vol. 5, No. 2
THE 6HG8/ECF86 — A NEW FREQUENCY CHANGER
FOR VHF UP TO 220 Mc/s

The latest addition to the range of frame grid valves is the 6HG8, a combined triode and frame grid RF pentode intended for use as a VHF frequency changer. The addition of the 6HG8 to the frame grid range of television valves enables engineers to design a receiver equipped with frame grid valves from the aerial input to the vision detector.

The complete range of RF and IF frame grid valves for entertainment applications is tabulated below:—

<table>
<thead>
<tr>
<th>Valve</th>
<th>Description</th>
<th>Gain (measured without an external shield)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6ES8</td>
<td>Variable μ, low noise VHF frame grid double triode for use as a cascode amplifier.</td>
<td>6mA/V</td>
</tr>
<tr>
<td>6HG8</td>
<td>Combined triode and frame grid RF pentode for use as a frequency changer for VHF up to 220 Mc/s.</td>
<td>12mA/V</td>
</tr>
<tr>
<td>6EH7</td>
<td>Frame grid variable μ, RF pentode for use as an automatic gain-controlled IF amplifier.</td>
<td>10mA</td>
</tr>
<tr>
<td>6EJ7</td>
<td>Frame grid sharp cut-off pentode for use as an IF amplifier.</td>
<td>3mA</td>
</tr>
</tbody>
</table>

The mutual conductance of the 6HG8 pentode section is 12mA/V compared with 6.3mA/V for the 6BL8. The conversion gain obtainable in this section, when used as a mixer, is therefore approximately doubled.

The short I, V, characteristic enables the oscillator injection voltage to be reduced to approximately 1.7 Vp when using the 6BL8. This results in a reduction of unwanted oscillator radiation for a given application. The lower injection voltage simplifies the task of main­

THE OTHER FELLOW'S BUSINESS

(Continued from page 3)

sity—sell both and get the repeat business of additional tapes. The tape recorder sales potential and merchandising is delicate and specialised and this subject will be covered in some detail in the next issue of Outlook.

Little New:

Whilst we are limited in this country to AM medium frequency sound broadcasting and 625 line black and white TV, it will take real selling and inspired "new set" presentation to encourage the expansion of obsolescence. This then is the challenge to both manufacturer and retailer as much as the sensible disposal of the resultant trade-ins.
ME1260 INFORMATION STORAGE TUBE

Improvements in data handling and processing techniques have resulted in a need for a simple information storage tube without visual presentation, which will store, process or convert information from one standard to another.

To meet this requirement, Mullard have introduced the ME1260 "TENICON", which is a low voltage, single gun information storage tube with a capacitive discharge readout process. It is capable of storing high resolution half-tone information, which may be read out immediately or retained for an interval of time. The stored information can be extracted in a different order or at a different rate from that in which it was originally stored.

APPLICATIONS

The full range of applications in which the Tenicon high resolution storage tube would offer improved performance has not yet been established but several uses for this tube are being investigated and developed. These are as follows:

1. As a delay unit in a tele-recording film equipment, whereby a television field occurring during the film pull-down time is stored in the Tenicon. During the next field, the stored field is read out and recorded on the film together with the occurring field.
2. As a change of rate device, in a system where it is required to transmit information at a slower rate than it is received. The incoming information is stored as it is received and is later read out at the required rate.
3. The Tenicon, in common with other half-tone storage tubes, may be used to integrate recurrent information as a means of enhancing the signal-to-noise ratio of the received information.
4. As a means of cancelling permanent echoes in a moving target system, where it is required to store information as a means of cancelling per­manent information as a means of enhancing the signal-to-noise ratio of the received information.
5. To produce true motion on a p-p-r radar display.

To simplify the operation of the Tenicon, the tube has been designed to operate with a standard Vidicon camera tube, and with similar focusing and scanning components to those used with a Vidicon camera tube.

The operation of the Tenicon is very similar to that of a Video camera tube, the electron gun and readout principle being identical. The storage layer or target, consists of a continuous layer of insulating material, on which information is stored as a positive charge pattern which is built up on the target surface by secondary emission. A metallic coating on the surface of the target, remote from the electron beam, is the output electrode. Positioned in front of, and close to, the target surface, is a fine metal mesh which collects secondary electrons in the writing operation and also ensures that the electron beam approaches the target normally.

The action of the tube requires the surface of the target to be stabilised initially at the potential of the cathode (defined as zero). This is achieved by uniformly scanning the target surface with a beam of low velocity electrons, such that the secondary emission coefficient of the target is less than unity.

Secondary current will be less than the primary current, electrons will be gained by the target and its potential will become less positive. This process continues until the potential of the target has fallen to that of the cathode.

No further electrons can land on the target, and it is said to be "cathode potential stabilised". The target is now at the "black level" and to establish writing conditions the cathode potential is reduced by approximately 100V. Simultaneously, the grid and second and third anode voltages are reduced to retain the beam in focus at the time of the writing process and to keep the beam cut off until the commencement of writing.

Information is written on to the target by applying to the grid a positive signal which modulates the electron beam as it scans the target surface. The primary electron energy is sufficient to make the secondary emission coefficient of the target greater than unity. As the electron beam scans the target, the areas on which the beam impinges are charged positively by an amount which is determined by the instantaneous beam current. The maximum change in potential of a small area of the target is inherently limited to a few volts.

The reading process is identical to that of a Vidicon camera tube. The cathode potential is restored to zero and the grid, second and third anode voltages are restored to the value required to produce a well-focused beam at the target. The modulated beam is scanned over the target surface, landing with an energy of only a few volts, so that secondary emission is negligibly small. Those parts of the target which have been charged in potential during the writing process are discharged, restoring them to zero volts and producing a capacitive signal current in the output lead.

Providing sufficient beam current is used in the reading scan, the discharge will be almost complete, leaving the target ready for a further signal to be written. The residual signal after one readout is less than 20%.

The name TENICON has been derived from the Latin Tenere—to hold or retain—and the Greek Ikon—an image.

Cathode Anode 1 Anode 2 Anode 3 Target

17 INCH STUDIO MONITOR TUBE

The AW43-48 is a new Mullard 17 inch television picture tube intended for use in precision television studio picture monitors.

The tube uses electrostatic focusing and magnetic deflection, the scanning angle being 70°.

Under typical operating conditions a first anode voltage of 300V and a final anode voltage of 16kV are required. The cut-off voltage (V_C) is from -30 to -70V.

The AW43-48 will resolve a minimum of 650 lines based on a picture height of 275 mm and measured at a brightness of 50 cd/lm. The focus voltage is adjusted for optimum spot size.

Apart from requiring a final anode voltage of 16kV, the AW43-48 is electrically identical to its characteristics to the 14 inch type, AW36-48 and has been introduced to meet the demand for a 17 inch precision monitor tube.

1000 Mc/s TRANSISTOR

Exhibited at the Physical Society's Exhibition in London, January 15th-19th, 1961

Following investigations by Mullard Research Laboratories, the Company's well-established alloy-diffused technique of manufacturing junction transistors has been used successfully to produce experimental devices that work satisfactorily in the region of 1000 Mc/s.

Experimental types have been produced with an f_t above 1000 Mc/s and a base resistance around 20 ohms. These transistors have been used in experimental amplifiers which have gains of approximately 10dB and noise figures of 6 to 8dB at frequencies around 1000 Mc/s.

These new experimental types were demonstrated in such an amplifier fed with an input equivalent to a modulated UHF transmitted signal. The output was demodulated and suitably displayed.
THE PROTECTION OF RF TRANSISTORS
AGAINST ATMOSPHERIC DISCHARGE IN AERIALS

The aerial input stage of transistor receivers and amplifiers may fail due to a breakdown of the base-emitter junction resulting from high-voltage pulses being induced in the aerial during a thunderstorm and, in the case of car radio aerials, due to static charge.

The effect will take place when the amplifier earth is separated from the real earth by a physical or stray capacitance of perhaps several thousand picofarads. When this capacitor discharges via the aerial, the resultant pulse applied to the base of the RF transistor will be in opposite polarity to the charge potential. This condition is illustrated in Fig. 1.

In the case of a car radio, the aerial invariably charges negatively to a voltage of 1 to 2 kV, which on discharge would destroy the base-emitter junction of the transistor. The base-emitter potential can be maintained at a safe value by applying a low voltage VDR such as an E299DD/P2316 across the base input circuit. This VDR measured at 1 Mc/s appears as a capacitor in the range of 100 to 200 pF in parallel with a resistance of 5kΩ to 10kΩ. It is therefore possible to connect the VDR across the transistor input circuit without affecting the receiver performance. Alternatively, a resistor of approximately 2 kΩ would offer a considerable degree of protection. At VHF a diode would be more suitable than a VDR.

An aerial may be charged to a high potential due to atmospheric conditions and discharged through a leakage path in the amplifier circuit. Perhaps a more appropriate equivalent circuit is that of Fig. 2, where C represents the "antenna-to-ground capacitance" and R represents the "discharge path between the real and artificial ground". If the aerial capacitance C is charged to some positive potential, this potential will not affect the amplifier input unless R is of some finite value, such as an ionisation path between artificial and real earth. As C is discharged through R a pulse of opposite polarity will then be applied to the base of the transistor.

In addition, with VHF masthead amplifiers a charge may appear between the 75Ω coaxial line and the aerial circuit which may be bonded to ground. If this occurs the induced charge will appear across the supply and, depending upon the supply impedance, the collector voltage rating may be exceeded when a discharge path is provided through the aerial input transformer. In this case a VDR connected across the transistor supply will provide adequate protection.

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FREQUENCY COVERAGE OF BROADCAST RECEIVERS

The following information was recently circularised to the electronics industry by the Australian Broadcasting Control Board:

"The Radio Regulations of the International Telecommunications Union (Geneva, 1959) provided, inter alia, for the medium frequency band allocated to broadcasting in the region including Australia to be extended from 535-1605 kc/s to 525-1605 kc/s. The Australian Broadcasting Control Board has been notified by the Postmaster-General's Department that the extended band is now available for the broadcasting service and the additional channel (530 kc/s) will, at the appropriate time, be allocated to one or more Australian broadcasting stations.

It is desirable, therefore, that all medium frequency broadcast receivers manufactured in the future should be capable of reception over the band 525-1605 kc/s.

In the high frequency bands, the allocations for broadcasting purposes are as follows:

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2300-2495</td>
<td>9500-9775</td>
</tr>
<tr>
<td>3200-3400</td>
<td>11700-11975</td>
</tr>
<tr>
<td>3900-4000</td>
<td>15100-15450</td>
</tr>
<tr>
<td>4750-4995</td>
<td>17700-17900</td>
</tr>
<tr>
<td>5005-5060</td>
<td>21450-21750</td>
</tr>
<tr>
<td>5950-6200</td>
<td>25600-26100</td>
</tr>
<tr>
<td>7100-7300</td>
<td></td>
</tr>
</tbody>
</table>

It is unlikely, however, that local broadcast transmissions intended for reception in Australia or the Territories will be in the bands 2300-2495 kc/s or the bands above 15450 kc/s.

Because of the scarcity of receivers suitable for reception in the high frequency bands below 6000 kc/s, very limited use has been made of those bands in Australia in the past. However, more of these receivers have recently become available and it is expected that use will be made of the bands above 3200 kc/s in the future, particularly as they are very suitable for serving remote areas of the mainland and the Territories of Papua and New Guinea. In recent years stations VLM Brisbane and VLX Perth have been transmitting on these frequencies to listeners outside the normal range of medium frequency stations, and additional stations will probably commence operation on these frequencies in other parts of the Commonwealth or Territories.

It is hoped that receiver manufacturers will give due consideration to including the appropriate high frequency bands in the tuning range of at least some of their future models."

BREAK-BEFORE-MAKE

The Mullard Technical Service Department is frequently asked why it is stipulated that the section SA8 of the record-playback switch in the Mullard amplifier and preamplifier tape circuits (**"Circuits for Audio Amplifiers," pp. 88 to 112) should be "break-before-make".

This switch section connects the HT supply to the oscillator valve. If the connection is not broken when switching from "record" to "playback", the stage will continue to oscillate. The momentary break introduced by a break-before-make contact is sufficient to stop oscillation.

Once oscillation has been interrupted, it is then important to ensure that the decay of the oscillatory current is not too rapid. Too sudden a decay can result in permanent magnetisation of the record-playback head. To prevent this, a delay is introduced by means of a 0.5uF capacitor connected between the oscillator tuned circuit and the chassis.

**"Circuits for Audio Amplifiers" is available from Mullard Offices and Distributors throughout the Commonwealth, price 12/6 plus 1/5 postage.
NEW VINKOR WOUND COMPONENTS
FOR MULLARD AUDIO CIRCUITS

WINNING DETAILS OF VINKOR INDUCTORS

<table>
<thead>
<tr>
<th>Vinkor assembly</th>
<th>WF1738 (LA2304)</th>
<th>WF1932 (LA2403)</th>
<th>WF1933 (LA2403)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference diagram</td>
<td>Primary</td>
<td>Secondary</td>
<td>Primary</td>
</tr>
<tr>
<td>No. of turns</td>
<td>(1-8) 107</td>
<td>(9-7) 134</td>
<td>(1-8) 863</td>
</tr>
<tr>
<td>Wire</td>
<td>9/46 s.w.g. (e.s.s.)</td>
<td>42 s.w.g.</td>
<td>45 s.w.g. (enamelled to BS1844F)</td>
</tr>
<tr>
<td>Impregnation**</td>
<td>wax</td>
<td>wax</td>
<td>wax</td>
</tr>
<tr>
<td>Inductance (low-level)</td>
<td>3.4 mH ± 30% (at 1 kc/s)</td>
<td>5.3 mH ± 20% (at 1 kc/s)</td>
<td>350 mH ± 10% (at 1 kc/s)</td>
</tr>
<tr>
<td>DC resistance</td>
<td>3.7Ω ± 10%</td>
<td>5.65Ω ± 10%</td>
<td>78Ω ± 10%</td>
</tr>
</tbody>
</table>

In the Mullard publication “Circuits for Audio Amplifiers” type numbers of wound components are given for the oscillator transformer in the tape pre-amplifier circuit, the treble-equalisation inductor in the tape amplifier and pre-amplifier circuits and the low-pass filter coil in the three-valve pre-amplifier circuit. These components are now superseded by the following wound Vinkor assemblies:

WF1738—which supersedes WF1388 as the oscillator transformer;
WF1932—which supersedes WF816 as the equalisation inductor; and
WF1933—which supersedes WF1428 as the filter coil.

Full winding details of the three Vinkor components are given in the Table.

Two features of the new components are:
1. The termination of all leads (except the earth lead of the WF1738) at solder tags;
2. Single-hole mounting (a fixing nut and shake-proof washer being supplied with the component).

The complete wound components are available from Special Transformers Pty. Ltd., 139 Sydenham Road, Marrickville, N.S.W.

Where enthusiasts wish to wind their own coils, care must be taken that the fine wires used do not become contaminated. It is essential that the completed unit be impregnated with a non-hygroscopic wax such as that manufactured by Vacuum Oil Co. Pty. Ltd. **type number Mobilwax 2305.

Vinkor data may be obtained by forwarding a stamped, addressed, foolscap envelope.

"Circuits for Audio Amplifiers" is available from Mullard Offices and Distributors throughout the Commonwealth, price 12/6 plus 1/5 postage.

IF YOU CHANGE YOUR ADDRESS:
1. Notify Mullard-Australia Pty. Ltd. immediately.
2. If possible let us know in advance. Thirty days’ notice will enable our mailing system to operate more efficiently.
3. Notify us in writing and include the address label from one of the recent issues showing your old address and code line.

THANK YOU.

Diagrams illustrating physical differences between the new Vinkor wound components and the old components which they have superseded.

Approximate dimensions:
- Vinkor wound transformer, type WF1738
- Ferroxcube wound transformer, type WF1388

Approximate dimensions:
- Vinkor wound inductors, types WF1932:WF1933
- Ferroxcube wound inductors, types WF816:WF1428

(The drawings are not to scale.)