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VOL. 8 . . . . NO. 4 SEPTEMBER 15 1943

★ **Survey of inverse feedback for audio amplifier circuits.**

★ **Another article about electronics and their medical applications.**

★ **A suggested design for the post-war de-luxe receiver.**

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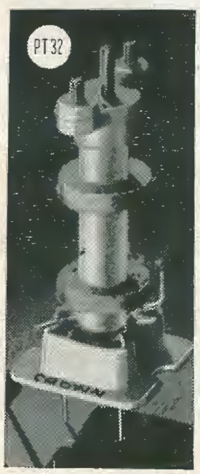

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THE AUSTRALASIAN RADIO WORLD

Devoted entirely to Technical Radio

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ALL-WAVE ALL-WORLD DX NEWS

Vol. 8. SEPTEMBER, 1943. No. 4.

CONTENTS

EDITORIAL

Anytime there happens to be a lull in the conversation you have only to mention post-war reconstruction and you will be sure to stir up plenty of enthusiasm.

Take, for example, radio trading of the future.

One thought is along the lines of extension of the socialism scheme, meaning possibly a standard design of "Peoples' Receiver," of utilitarian type, produced in big quantities under Government supervision and supplied at cost to each and every householder.

For contrast, there are those who plan to produce elaborate receivers of the most de luxe specification, claiming that when people start to spend their savings and their repaid war loan bonds they will want the best.

From an entirely different angle, there is the view that maybe the local radio manufacturers will have to face the prospect of free-trade, standing toe to toe and slogging for the market against the competition of mass-produced receivers from overseas, selling complete at a figure which the Australian public has become to regard as the price of a couple of valves.

All of the above thoughts are possibilities, even as there is a possibility that conditions will return to exactly the same stage where we left off as the war became intensified.

No matter what the answer may be we feel a happy confidence in the ability of the members of the Australian radio trade to face up to circumstances and overcome all obstacles, even as they did in the early days of their progress.

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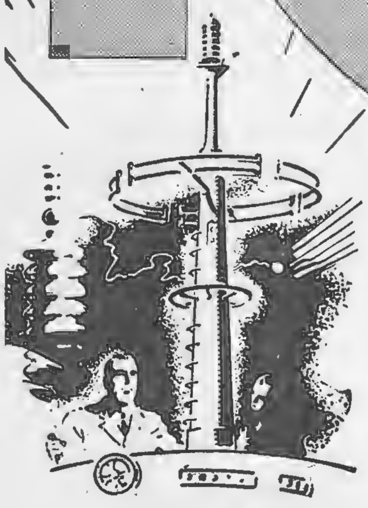

Radio developments, accelerated by increased war production and research have been "put in the ice" in the R.C.S, Laboratories until the end of the war. The directors of R.C.S. Radio feel confident that constructors and manufacturers who cannot obtain R.C.S. precision products fully appreciate the position and wish R.C.S. well in their all-out effort to supply the imperative needs of the Army, Navy and Air Force. The greatly increased R.C.S. production has been made possible by enlarged laboratory and factory space and new scientific equipment, all of which will be at the service of the manufacturers and constructors after the war.

Watch R.C.S.!—for the new improvements in materials and construction developed by R.C.S. technicians bid fair to revolutionise parts manufacture and will enhance the already high reputation of R.C.S. products.

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ELECTRONICS IN MEDICINE

(PART TWO)

IN a previous article (June, 1943) various applications of electronics to the science and art of medicine were discussed. In this concluding part, radio-surgery, the generation and use of X-rays and audiometry are explained.

Radio Surgery

High-frequency, high-tension voltages are comparatively harmless as regards shock — in fact, sparks an inch long may be received on a metal object held in the hand without danger. The current, however, must be

By

J. W. STRAEDE, B.Sc.

small as heat is produced by the flow of current through a resistance no matter whether the current is direct, low-frequency alternating, or high-frequency alternating. Heat from high-frequency eddy currents is used to stimulate body tissues as in Diathermy, which was discussed in Part 1. The actual flow of H.F. current (from a valve oscillator) may be used to produce intense local heating for cautery or radio-surgery. For the latter, a blunt "knife" is used, the current from the end severing the flesh and at the same time "cooking" the cut surface so that bleeding is prevented. The valve generator must be capable of accurate control so that intense heating at one spot rather than a general warmth over a large area is produced. When in use, small arteries that are to be cut are no longer clamped and tied. Instead, the radio knife is applied to the artery as it is being cut, or if the artery is a large one, the end is clamped and the radio knife is then applied. This "bloodless surgery" has the advantage of immediate sterilisation, a very useful feature when malignant growths or diseased areas are to be removed. Because high-power H.F. currents are required, the apparatus (and patient) must be enclosed in a screened room to prevent extensive radio interference.

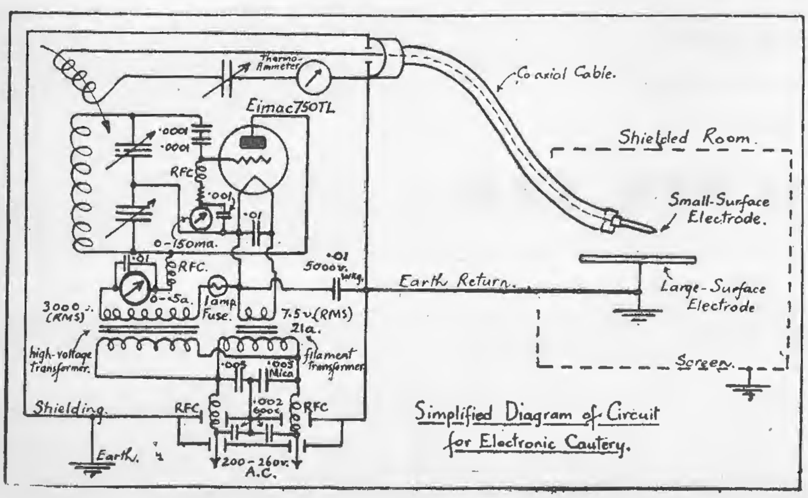
Circuits Used

Several types of oscillator circuits have been used, some valve manufacturers making special tubes for diathermy and radio-surgery oscillators. Meters are often used to indicate the current flowing in the "patient", or output circuit as well as the grid and anode currents of the valve. The load on the valve is adjusted by tuning the "patient" circuit by means of a series condenser. The tuning or "tank" condenser(s) across the grid/-plate oscillator coil may be fixed. In any case they must have a terrific voltage rating.

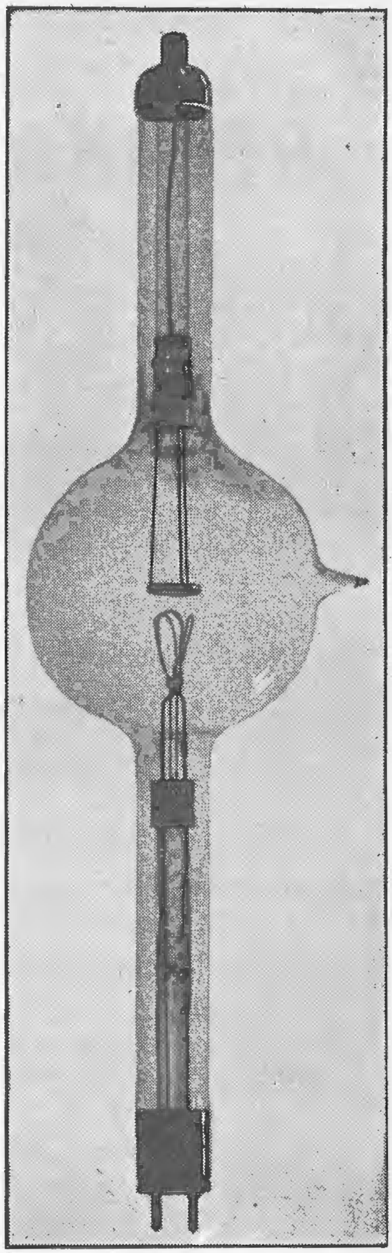
Radio Cautery

Radio Cautery has been used for dental work in place of the usual hot-wire loop heated by D.C. or low frequency A.C. The H.F. current is applied by a single straight platinum wire.

All radio surgery and cautery systems require two electrodes, a small "active" one and a very large "passive" or "cold" electrode. The latter must make exceptionally good contact with the patient, as otherwise heat would be produced at two places.



Simplified Diagram of Circuit for Electronic Cautery.



The high voltage Kenotrin

X-rays.

X-rays (electromagnetic waves of extremely short wave-length) are used in medicine for both diagnosis, e.g., clinical radiography or photography by X-rays, and for treatment. Malignant growths, e.g., cancer, are destroyed by the application of X-rays of suitable intensity and wave-length.

X-rays are produced by exciting

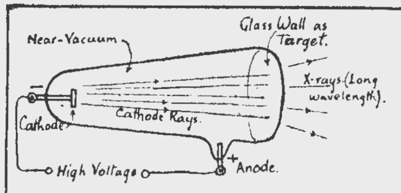
(Continued on next page)

ELECTRO-MEDICINE

(Continued)

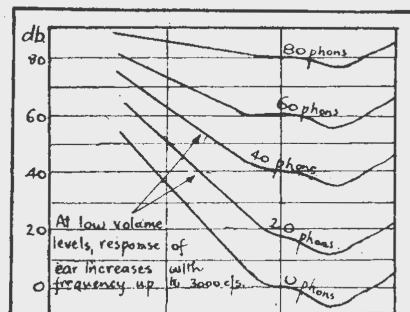
suitable oscillatory circuits with electrons. The frequency required is so high and the wave-length so small that the oscillatory circuits consist of atoms of various metallic substances. Different frequencies are obtained by varying the type of atom!

An X-ray tube is very much like an oscilloscope tube. The differences are these: Instead of producing light by striking a phosphorescent screen,



Production of X-rays by early cold-cathode tube.

the cathode rays produce X-rays by striking a metallic button. Instead of the cathode rays being deflected as in the oscilloscope tubes, they are focussed to a small spot on the metal button (the "target") so that all X-rays produced come from the same point. Another difference is the use of higher voltages — the oscillatory circuits (the electron orbits of the target atoms) will not produce oscillations unless the striking electrons are moving sufficiently fast and the electron velocity depends on the voltage between anode and cathode.



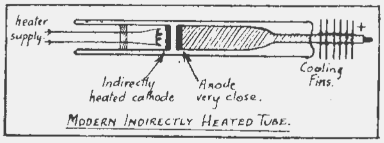
The history of the X-ray tube is interesting: Early tubes were merely cathode ray tubes, the glass wall of the tube acting as the target. The X-rays produced were diffuse, of low intensity and of comparatively long wave-length. A metal target consisting of a tungsten button set in a copper block was used in later tubes.

The tube current was controlled by varying the pressure of the residual gas in the evacuated tube! No easy task, but not impossible. How would you like to control the current of a radio valve that way?

The introduction of the heated cathode enabled a ready means of controlling the current as well as giving greater uniformity from tube to tube. Some modern tubes have indirectly heated cathodes with the cathode and anode plane parallel and quite close together. Other modern tubes are almost completely all-metal in construction. The advances in the construction of X-ray tubes, oscilloscope tubes and radio valves are more or less in step with one another.

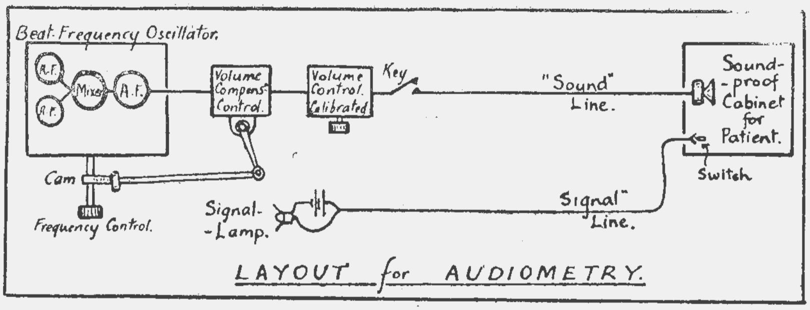
X-ray Voltages.

Some tubes are self-rectifying and may operate from alternating current which is stepped up to high potential by means of a transformer. Usually the centre-tap of the second-



MODERN INDIRECTLY HEATED TUBE.

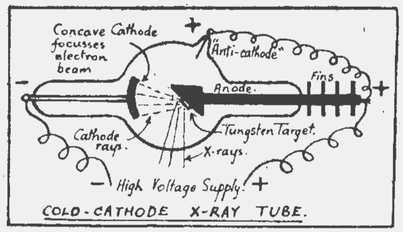
ary is earthed so that a person touching one of the leads receives only half of the secondary voltage (which may be tens of thousands of volts). Other tubes require D.C. which may be obtained from a valve rectifier consisting of one or two high-voltage kenotrons (high-vacuum diode rectifiers). To reduce the cost and insulation requirements of the transformer, a voltage doubling circuit (see diagram) may be used. The tubes must be capable of withstanding an extremely high inverse peak voltage. Only a small current is required for most tubes — sometimes just a few milliamperes. Besides tube rectifiers there are mechanical rectifiers consisting of a large commutator disc driven by a synchronous motor. In some designs the contacts consist of a series of spokes mounted on a rotating shaft. Mechanical rectifiers are now completely out of date.



LAYOUT for AUDIOMETRY.

Audiometry

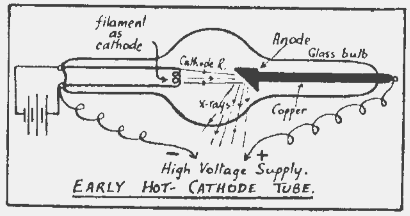
The measurement of deafness is long past the crude method of measuring the distance at which a ticking watch may be heard. Today, the frequency response of the ear may be determined with a fair degree of accuracy. The patient sits in a sound-proofed room and listens either to a good quality baffled permag. speaker placed at a standard distance, or to



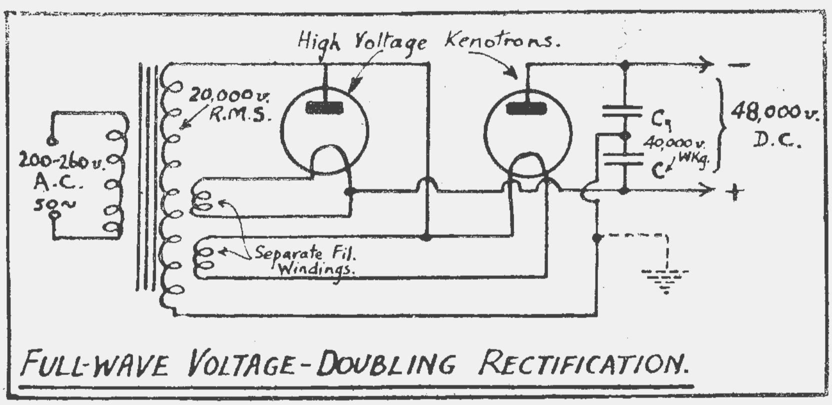
COLD-CATHODE X-RAY TUBE.

a single "hi-fi" moving coil earphone.

The signal to the speaker is supplied by a calibrated beat-frequency oscillator which is fitted with two volume controls. One volume control is actuated by a cam attached to the tuning shaft of the oscillator and is set so that either a constant acoustic output is obtained from the speaker, or else an output set to match a "standard ear" is used. The signal may be continuous or interrupted at second intervals. The patient signals to the operator by means of a lamp and push-button. In practice the volume at any one frequency is reduced until the patient signals he is no longer hearing it. Then the volume level is increased until it is just audible once more. If the two volume levels are not reasonably close, the experiment is repeated for that particular frequency. After a number of frequencies have been used (anything from six to sixteen are used in practice), the response of the patient's ear is reasonably well known and a suitable corrective device may be prescribed. Old people show a falling off in the high frequency response. Electronic devices for use as deaf-aids were considered in Part 1 of this article.



EARLY HOT-CATHODE TUBE.



FULL-WAVE VOLTAGE-DOUBLING RECTIFICATION.

"THERMAL" RADIO

In his usual end-of-the-year review of radio in America, David Sarnoff, president of the Radio Corporation of America, laid considerable stress on the application of radio-frequency heating. This application of radio technique is pre-war, but in its war role it has assumed greater importance and made remarkable advances.

Among the applications of "thermal" radio enumerated by Mr. Sarnoff are glueing, annealing, welding, riveting, and even de-activating enzymes. It is also claimed that rubber may, now be "radio-cemented" to wood or plastics.

Referring to television, Mr. Sarnoff stated that its laboratory status is a war secret, but those confident of the success that marks wartime developments expect television to emerge from this war to make a great post-war industry.

DESIGN FOR A POST-WAR RECEIVER

SET building is definitely "out" at the moment, such vital accessories as power transformers, converter valves, aluminium chassis, being unobtainable for some time now. However, experimenters have a certain amount of "junk" on hand and so circuits are still interesting. Anyway you can now be planning a super receiver for after the war. Well, here's a circuit of a 17-valve all-wave receiver featuring two R.F. stages (one untuned), two I.F. stages, high-gain audio system, noise reduction systems, beat-frequency oscillator, etc. Most of the tube types shown are Australian-made types, or are directly replaceable by Australian types.

Aerial Input Circuit

A number of aerial inputs are provided so that various types of aerial can be tried out, including noise-balancing systems. The second R.F. stage is aperiodic in order to reduce instability, simplify alignment and allow the use of only a 3-gang tuning condenser.

The converter is the 6J8G which, with a properly designed circuit, has quite a low noise level. The A.V.C. voltage is not applied to the converter, but there is plenty of A.V.C. action as the suppressor grids are tied to the A.V.C. line instead of to the cathodes. The screen voltages of the R.F. stages are lower and the bias resistors are larger to keep the gain down to reasonable levels (there's plenty of gain to spare with two R.F. and two I.F. stages), besides reducing the drain on the power pack.

Variable Coupling

Two of the I.F. transformers have variable coupling between the primary and secondary coils. This is of help in reaching out after "DX". For reception of distant stations, the coupling is reduced, giving extreme selectivity the "sideband cutting" being of comparatively small importance when considered against the decreased noise level and freedom from interference. It is noteworthy that the A.V.C. is taken from the first I.F. output and after amplification is fed to the second I.F. so that forward-acting A.V.C. is obtained as well as the usual backward-acting.

A kind of diode-biassing is used for the second detector, a 6G8G, the gain of which falls off at zero-bias giving a muting effect when signals are too weak for satisfactory reception.

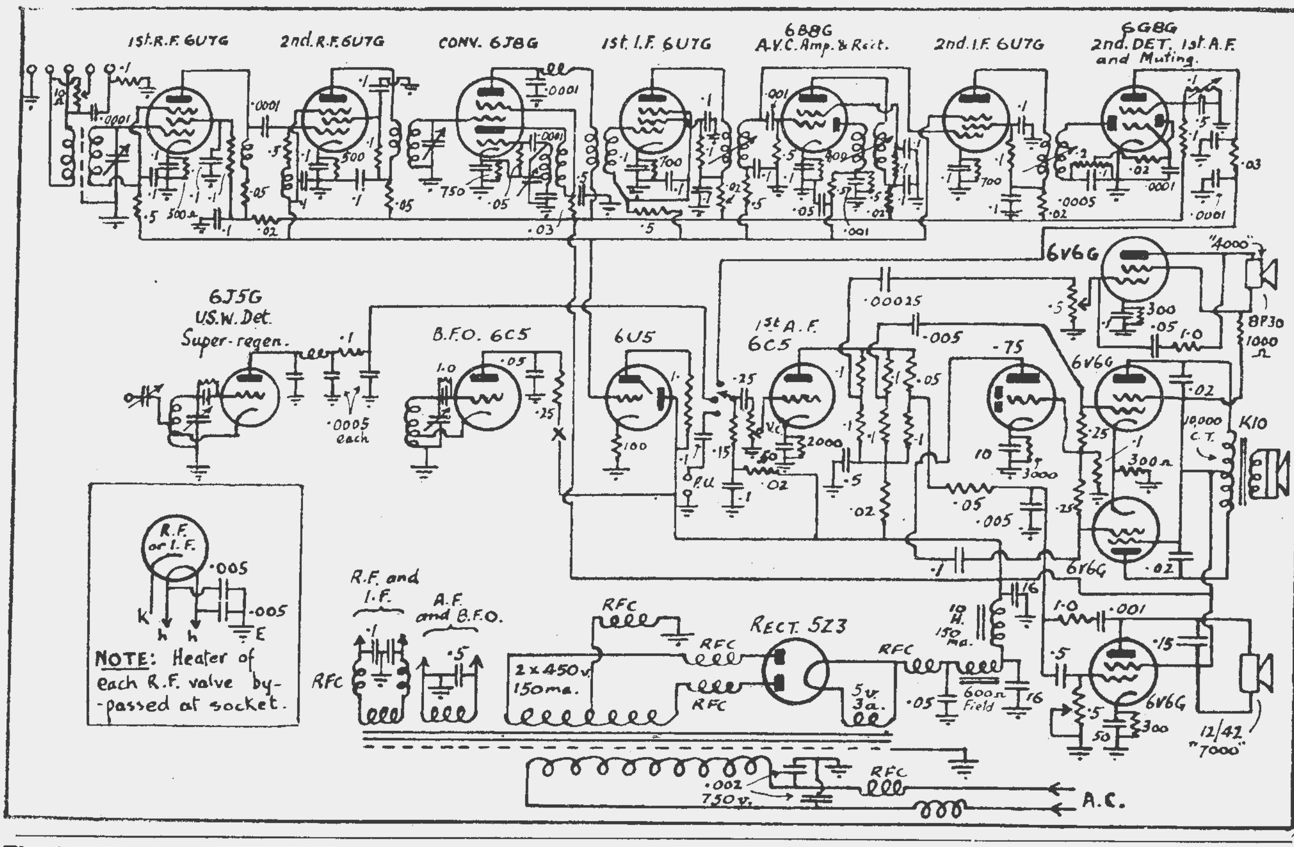
The audio amplifier finishes up with three channels, one of which is push-pull, and three speakers, two of which the woofer and tweeter, are permags. For distant reception when selectivity is increased, the low-frequency section is cut-off to reduce boominess. The middle frequency section has an output of about 12 watts and uses a floating paraphase driver system.

A large number of R.F. chokes is employed in the power pack to prevent "man-made static" coming in via the power line.

Filament Chokes

Similar R.F. chokes, (but wound with heavier wire) are in the filament circuits of the R.F. and I.F. valves. Not shown in the schematic is an adjustable trimmer wired in parallel with each section of the tuning gang. The oscillator trimmer gives a band-spread action, while the other two trimmers enable maximum gain on short-waves, or (by staggering) a wide-band reception from hi-fidelity locals.

In the plate circuit of the 6J8G is an R.F. filter which can be tuned to keep out the harmonics of a local BCB station, which might produce a growl or whistle in the I.F. section.



FULL STORY OF INVERSE FEEDBACK

CHARACTERISTICS, CIRCUITS AND DESIGN CONSIDERATIONS

Here is a helpful discussion of the principles and applications of inverse feed-back, a subject of special interest now that home experimenting is pretty largely confined to audio-frequency systems. While the circuits given are primarily intended to be illustrative, they are also practical, and the circuit values suggested furnish a basis from which further work can be carried on.

INVERSE or negative feed-back principles were set down quite a few years ago, but only recently have modern high-gain tubes made feed-back popular in the quest for better fidelity of reproduction, stability and noise reduction in audio circuits. In contrast to positive feed-back, which produces distortion, increased gain and oscillation, inverse feed-back offers:

(1) Improved linearity of response.
(2) Stabilised impedances.
(3) Reduced gain.
(4) Improved phase shift and phase distortion.
(5) Reduced harmonic distortion.
(6) Improved load capacity.
(7) Stabilised amplification with changes of circuit constants.
(8) Reduced noise.

To apply inverse feed-back in the general sense, a small portion of the output of an audio amplifier is returned to the input and added to the signal voltage, but in phase opposition so that degeneration rather than regeneration is produced. If the amplitude of this fed-back voltage approaches that of the signal input voltage, then the output waveshape of the amplifier will resemble the input waveshape more and more. Nonlinear components appearing in the output of the amplifier will be fed back and again amplified, but in a manner such that the original components will be largely cancelled. Because of this cancelling effect on amplitude excursions the linear response band will be extend in scope. Noise, distortion and other imperfections in the input signal will not be reduced by feed-back, since the corrective action is limited to those circuits over which the feed-back is applied. However, the application of feed-back to an amplifier will give it much improved fidelity of reproduction, so that the additive action of its own faults will be minimised.

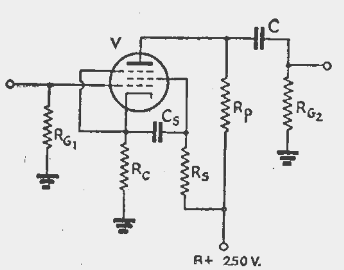


Fig. 1 — A single-tube current-controlled feed-back circuit.
V — 6J7, 6C6, etc.
C — 0.1 ufd, 450 v., paper.
Cs — 0.5 ufd., 450 v., paper.
Rg1, Rg2 — 500,000 ohms, ½ watt.
Rc — 2000 ohms, 1 watt.
Rs — 1.0 megohm, 1 watt.
Rp — 100,000 ohms, 1 watt.

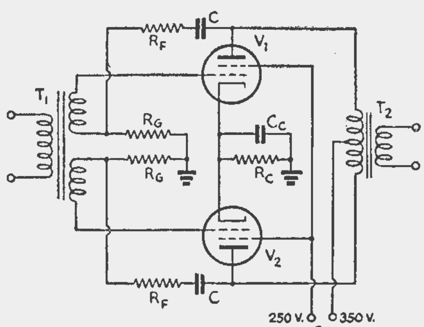


Fig. 2 — Voltage feed-back in a transformer-coupled push-pull stage.
V1, V2 — 6L6, 6F6, etc.
C — 0.5-1.0 ufd., high quality (preferably 1000 v. rating, although 450 v. will do).
Cc — 25 ufd., 50 v., electrolytic.
Rc — 250 ohms (Class AB1).
Rf — 500,000 ohms, variable. When feed-back is set, a fixed resistor of proper value may be substituted.
Rg — 25,000 ohms, 1 watt.
T1 — Driver plate or line to push-pull grids (split sec.).
T2 — Push-pull plates to line or v.c. (6600 ohms p-p).

Types of Feed-Back

Inverse feed-back may be subdivided into two fundamental types, voltage feed-back and current feed-back. A combination of the two is generally spoken of as "bridge" feed-back. Voltage feed-back occurs when the feed-back voltage is proportional to the output voltage. This, the most frequently used type, provides a reduction in the internal resistance of the amplifier, giving an effect similar to that resulting from lowering the plate resistance of the output tubes. When feeding a loudspeaker whose impedance varies greatly over the audio range, an impedance-stabilising effect is observed reducing cone resonance and "hangover" effects. Current feed-back occurs when the feed-back voltage is proportional to the output current. It has the effect of raising the internal resistance of the amplifier, and is much less desirable with a speaker load. It is of value in certain types of "gainless" phase inverters. Bridge feed-back is sometimes used for specific overall application, but it is not easy to proportion the amounts of each type without the use of laboratory instruments and reference to involved mathematics.

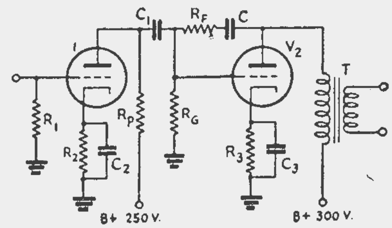


Fig. 3 — A simple voltage feed-back system for a single-tube output stage.
V1 — 6C5, 6J5, etc.
V2 — 76, 6P5G, etc.
C — 0.5-1.0 ufd., high quality (preferably 1000 v. rating, although 450 v. will do).
C1 — 0.1 ufd., 450 v., paper.
C2 — 25ufd., 25 v., electrolytic.
C3 — 25 ufd., 50 v., electrolytic.
R1, Rg —500,000 ohms, ½watt.
R2 — 3000 ohms, 1 watt.
R3 — 5000 ohms.
Rf — 500,000 ohms, variable. When feed-back is set, a fixed resistor of proper value may be substituted.
Rp — 100,000 ohms, 1 watt.
T — Plate to line.

Single-Stage Feedback

Figs. 1, 2 and 3 are examples of single-stage feed-back. In Fig. 1 the feedback occurs across the un-bypassed cathode resistor, Rc. This is an example of current feed-back; that is, feed-back which tends to maintain the output current constant with variations in inherent amplification. There is no improvement of frequency distortion (the range of flat frequency response is not extended) because the inherent variation in amplification reresults from the variation in load impedance with frequency, hence the output **voltage** of the amplifier varies with frequency even though the output **current** is constant. However, amplitude distortion is greatly reduced, as is the gain of the stage. This type of feed-back circuit is not suitable for use with an output transformer because it tends to make the magnetising current sinusoidal and thereby actually increases the distortion in the output voltage. Note that the suppressor grid and the screen by-pass condenser, Cs, are not returned to the cathode, so that feed-back is not also applied to these elements.

Taken from that "daddy" of all radio technical journals, "Q.S.T.", published by the American Relay League, this article by Philip C. Erhorn covers the whole subject of inverse feedback and answers all those questions which our readers have been asking us about this vital method of handling the distortion which would otherwise prove a drawback to modern pentodes and beam power valves.

Push-pull Circuits

Fig. 2 shows a push-pull stage in which the feed-back is taken off both plates and returned to the grid circuit. This is an example of voltage feed-back. Resistors Rf and Rg set the amount of feed-back used. The condensers, C, are blocking condensers of at least 0.5 ufd. and must be of good quality. In this circuit the distortion generated by the tubes and that caused by core saturation of transformer T2 are reduced. The low-frequency response is improved, but the leakage reactance of the secondary of T2 prevents the high frequencies from being improved. Fig. 3 shows another example of voltage feed-back, affecting the driver as well as the output stage. Amplitude distortion in V2 is reduced and the low frequency response improved. The feed-back voltage varies with frequency in a manner such that frequency distortion in V1 is also improved. Amplitude distortion is not reduced. In this case the feed-back resistor, Rf, must be larger in value than Rp and Rp must be less than Rg.

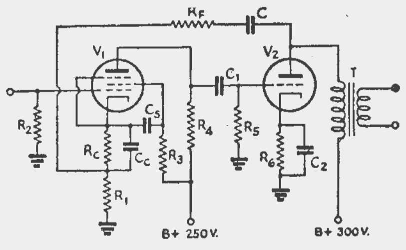


Fig. 4. — Feed-back over two stages.
V1 — 6J7, 6C6, etc.
V2 — 2A3.
C — 0.5-1.0 ufd., high quality (preferably 1000 v. rating, although 450 v., will do).
Cc — 25 ufd., 25 v., electrolytic.
Cs — 0.5 ufd., 450 v., paper.
C1 — 0.1 ufd., 450 v., paper.
C2 — 25 ufd., 50 v., electrolytic.
R1 — 100 ohms (may be varied).
R2 — 500,000 ohms, ½ watt.
R3 — 1.0 megohm, 1 watt.
R4 — 100,000 ohms, 1 watt.
R5 — 500,000 ohms, ½ watt.
R6 — 750 ohms, (Class A1).
Rc — 2000 ohms, 1 watt.
Rf — 500,000 ohms, variable. When feed-back is set, a fixed resistor of proper value may be substituted.
T — Plate to line (2500 ohms).

Feed-back Over More Than One Stage.

Figs. 4 and 5 are examples of feed-back over two stages. In Fig. 4, Rf and R1 form, in effect, a voltage divid-

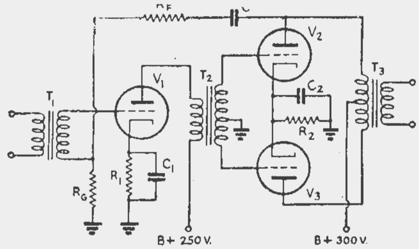


Fig. 5 — Feed-back over two stages in a transformer-coupled amplifier with push-pull output stage.
V1 — 6SF5, 6C5, etc.
V2, V3 — 2A3s.
C — 0.5-1.0 ufd., high quality (preferably 1000 v., rating, although 450 v., will do).
C1 — 25 ufd., 25 v., electrolytic.
C2 — 25 ufd., 50 v., electrolytic.
R1 — 3000-5000 ohms, 1 watt.
R2 — 750 ohms (Class AB1).
Rf — 500,000 ohms, variable. When feed-back is set, a fixed resistor of proper value may be substituted.
Rg — 10 ohms (may be varied).
T1 — Driver plate or line to grid.
T2 — Single plate to push-pull, centre-tap, 1:1 or step-down.
T3 — Push-pull plates to line, v.c. or Class-B grids, 5000 ohms p-p.

er. Rc is the normal cathode bias resistor and Cc a normal by-pass condenser. Less degeneration takes place in V1 than in the circuit of Fig. 1. Amplitude and frequency distortion are reduced in both stages and the circuit is quite stable. Fig. 5 shows a different method of returning the feed-back to the input circuit. Because the winding capacity of T1 is in shunt with Rg and some phase shift will be added by T2, the amount of feed-back which can be used is limited to a greater extent than in Fig. 4.

Fig 6 shows a circuit with feed-back over three stages. No blocking condenser is necessary since the feed-back voltage is picked off the secondary of transformer T2. To obtain the right polarity the proper end of the secondary of T2 must be selected; if oscillation occurs, reverse the feed-back and ground connections. Since the secondary of the output transformer, T2, is also included within the feed-back loop, both high- and low-frequency response will be improved: Amplitude distortion is greatly reduced. The use of a phase inverter tube, V2, obviates the necessity for an interstage transformer and helps reduce inherent phase shift. Resistor Rc2 is the normal bias resistor, and R1 and R2 are generally made equal in value. The large amount of current feed-back reduces the effective gain of the stage to unity, or somewhat less. The feed-back resistor, Rf, may be variable so that control over the amount of feed-back used can be easily secured. If the secondary of T2 is of voice-coil impedance, the low output voltage may limit the amount of feed-back obtainable before oscillations occur at the extremes of the frequency range. With line impedances (of the order of 500 ohms) sufficient output voltage should be available for all purposes.

Effect of Phase Shift

The gain of the amplifier as a whole will be reduced by feed-back, and to realise useful output the gain without feed-back must be in excess of the desired gain. The excess gain is then put to work producing feed-back. Loss of gain in a power amplifier where high power output is necessary may be offset by increasing the input signal. This can be done in the low-level speech stages where extra gain can be realised cheaply and with low distortion.

Loss of gain is not the real criterion for setting the maximum amount of usable feed-back. Because of practical design limitations an amplifier will produce phase shift at various frequencies in varying degrees, the harmonics lagging the fundamentals. The fact that phase shift is not linear as to frequency is the cause of phase distortion. Phase shift and phase distortion are usually considered of little consequence when associated only

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FEEDBACK
(Continued)

with audio-amplifiers, but in the case of a feed-back amplifier phase shift and its attendant distortion assume quite some importance.

The amplifier will have an inherent amount of phase shift which must be added to the shift caused by the feed-back network. It can be shown that if, for some arbitrary frequency, this combined shift equals 180 degrees, then the gain of the amplifier must have been reduced by feed-back to an extent that the product of this gain multiplied by the fraction of the output voltage applied to the input circuit is less than one, or instability in the form of oscillation will take place. Thus the usable percentage of feed-back is directly dependent upon the phase shift inherent in the amplifier.

Inherent Phase Shift

The causes of inherent phase shift in an audio circuit may be brought out by a specific example. The total cathode current of a tube with a by-passed cathode resistor is the sum of the currents in the resistor and the condenser. Vectorially it can be shown that the current in the by-pass condenser causes a phase difference between cathode current and cathode voltage. This phase difference, which will not be constant with respect to frequency, causes a phase shift between the signal input voltage to the stage and the signal output voltage. The result is phase distortion of the signal.

In a similar manner the plate-circuit decoupling condenser, the output condenser of the "B" supply, and a screen by-pass condenser will cause a phase shift to occur. "B" batteries, as they age, will produce the same effect as a condenser. Further, the inter-electrode capacities of a tube, particularly the output capacity, will cause a phase shift. Coupling condensers contribute unless their reactance is small compared with the value of the following grid resistor. Resonance in transformer windings, leakage reactance and stray capacities such as wiring capacities or the capacity of a condenser to its own grounded metal case, are all factors contributing to inherent phase shift. The design of an amplifier eliminating the disadvantages of these capacities can become involved, and is not to be taken up here. However, such design will bear investigation by the prospective builder who would use large amounts of feed-back.

Corrective Action

A fact which should be emphasised is that for proper corrective action feed-back should take place not only over the audible range of frequencies but also at the harmonics of these frequencies, many well out of the audible range. Hence a large phase shift at some super- or sub-audible frequency can become of real consequence if the harmonic voltage of some audio frequency is present in any amount. The application of inverse feed-back will tend to reduce phase shift and phase distortion over a wide response band, but a large shift at a remote frequency where the gain is fairly substantial will still have a limiting effect on the usable feed-back, since the amplifier must not be allowed to oscillate at any frequency audible or inaudible.

Reduction of Distortion and Noise

Because of non-linearity of tube characteristics and associated devices, harmonics and combination frequencies are generated within an amplifier. When the amplifier is operated well within its limits of power output the total distortion will be reasonably small, and ordinarily only the second harmonic will be of any importance. An amplifier on the verge of overloading will have higher order harmonics present, even in amounts exceeding the second harmonic.

Inverse feed-back reduces the percentage of all harmonics present by a proportion effectively equal to the reduction of overall amplification. It can be shown that, because of distortion and cross-modulation of the harmonics fed back in an amplifier operated at its overload point this is not strictly true, although the overload point will be extended by feed-back. For an amplifier in its general application to use, however, the first statement holds.

The output of an amplifier may be increased as the square of the gain reduction due to feed-back, for the same percentage distortion allowed without feed-back. For example, if 1 per cent distortion is allowed without feed-back and feed-back reduces the gain of the amplifier three times, then the output can be increased nine times for the same 1 per cent distortion with feed-back, provided the extreme capabilities of the amplifier are not exceeded. Do not forget that any distortion produced in the external circuits supplying the increased signal voltage necessary for increased output will not be reduced by this feed-back.

Examining a power amplifier with intent to apply inverse feed-back, several interesting facts may be brought out. The power output stage itself is the source of a large percentage of noise and distortion. Feed-back over this stage alone should produce marked improvement in the output. However, if the feed-back loop is returned to the input of the power stage, any amount of it will reduce the gain to such an extent that the output of the driver must be excessive and the distortion produced therein may offset the benefits given by feed-back. Much more satisfactory results will occur if the feed-back is applied over the driver stage as well, relying on the speech amplifier to supply the gain lost. Since the speech amplifier generally has to supply voltage output rather than actual power output, it may be assumed that little distortion arises. However, since nothing is to be lost except gain, feed-back may also be applied over at least three stages of the speech amplifier. The linear-response range will be increased and any distortion present will be reduced. If after such application of feed-back the output level of a microphone or pick-up head is too low for the gain remaining, a pentode stage external to the feed-back loop may be added. This should give enough gain for the usual purpose. Where feed-back is desirable over more than three stages, considerable trouble with instability will occur. To get around this trouble the feed-back may be split, applying one loop around two stages and another around the remaining stages. In a somewhat remote case, a third loop could then be added over all of the stages.

Equalising

The flat frequency-response range resulting from the application of inverse feed-back may be modified to give more pleasing response to the ear, particularly if the signal source is a poorly equalised pick-up. By suitably altering or adding to the constants of the feed-back loop itself, feed-back may be reduced for both high and low frequencies with negligible reaction of one on the other. The gain at these frequencies will be increased, giving a peaked response easily adjustable to the individual taste. Referring to Fig. 6, if a condenser and an inductance of suitable values are tied across the cathode resistor of V1 in parallel, the condenser will by-pass some of the high-frequency feed-back to ground, and the choke will similarly reduce the low-frequency feed-back. This method of equalisation has none of the distortion and loss characteristics so generally found with usual bass and treble boosting circuits. Unless tremendous boosting is wanted, there will still be a small amount of feed-back present at the boosted frequencies.

While feed-back has its best corrective action for amplifiers with pentodes or beam tetrodes such as the 6L6 in the output stage, there is no reason why it should not be used with a triode output amplifier, particularly if Class-B triodes are used and a power-type driver is required. If equalisation is wanted in an amplifier set-up feeding a speaker and used for record play-back, or for feeding a cutter and used for instantaneous recording, excess gain might be incorporated in the pre-amplifier. The pre-amplifier is then equalised by means of a selective feed-back as just pointed out. This practice will allow a maximum amount of feed-back to be used over the power amplifier where it is needed greatly at all frequencies. In an ideal arrangement, the gain may be controlled by a "T" pad inserted in the line between the output transformer of the pre-amplifier and the input transformer of the power amplifier.

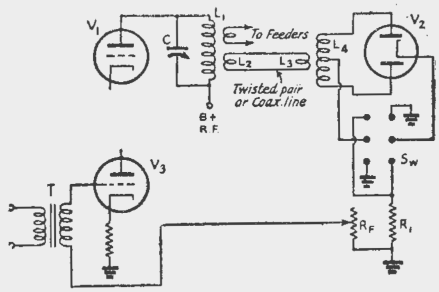


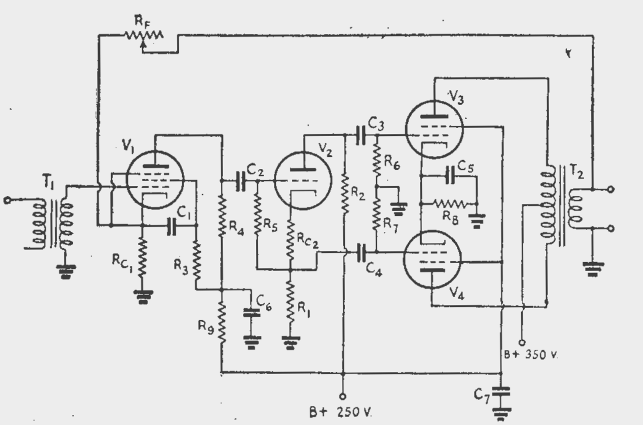
Fig. 7 — Application of negative feed-back to a transmitter.
V1, C, L1 — Final r.f. output stage.
V2 — 84/6Z4 (must be located near V3).
V3 — Speech amplifier stage.
R1 — 10,000 ohms, 1 watt.
R7 — 10,000 ohms, variable to set amount of feed-back.
L2, L3 — 1- or 2-turn loop coupled to "cold" end of tank coil and to L4 with twisted pair of coaxial line.
L4 — Centre-tapped coil broadly tuned to carrier frequency.
Sw — D.p.d.t. polarity reversal switch. If "singing" occurs reverse switch.

Negative Feed-Back at R.F.

Although generally only used in commercial applications, feed-back may be applied over an entire radio-telephone transmitter. A small percentage of the carrier signal is rectified and introduced into one of the speech input stages. This is known as r.f. inverse feed-back, and Fig. 7, illustrates a simplified circuit suitable for amateur use. The rectifier must be free from hum and distortion, not only to produce a balanced output representative of the carrier,

(Continued on next page)

Fig 6 — A three-stage amplifier with over-all feed-back loop.
V1 — 6J7, 6C6, etc.
V2 —6J5, 76.
V3, V4 — 6L6, 6F6, etc.
C1 — 0.5 ufd., 450 v., paper.
C2, C3, C4 — 0.1 ufd., 450 v., paper.
C5 — 25 ufd., 50 v., electrolytic.
C6, C7 — 8.0 ufd., 450 v., electrolytic.
R1, R2 — 50,000 ohms, 1 watt.
R3 — 1.0 megohm, 1 watt.
R4, R6, R7 — 100,000 ohms, 1 watt.
R5 — 500,000 ohms, 1 watt.
R8 — 250 ohms, Class AB1.
R9 — 25,000 ohms, 1 watt.
Rc1 — 2000 ohms, 1 watt.
Rc2 — 3000 ohms, 1 watt.
Rf — 500,000 ohms, variable. When feed-back is set, a fixed resistor of proper value may be substituted.
T1 — Low-impedance mike, p.u. or line to grid.
T2 — Push-pull plates to line or v.c. (660 ohms p-p).



FEEDBACK

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but also because any noise and distortion originated by the rectifier will have a return path to appear on the carrier signal. If the rectifier is balanced, the carrier frequency will be cancelled in its output to the audio circuits. Because of the possibility that large amounts of phase shift will be present in the various stages within this feed-back loop, only quite small amounts of feed-back may be used. To make available somewhat large amounts the linear response band must be widened. This may be done easily for the audio circuits by applying separate feed-back to them. The problem of widening the r.f. stages is much greater, but generally may be brought about by raising the L/C ratio of the tuned circuits, so long as too low a value of circuit Q does not result. It is easier to apply r.f. inverse feed-back to a high-frequency transmitter than a low-frequency one, since the frequency where a sizable envelope phase shift occurs will be very high and will have a more remote effect. Class-B modulators are a considerable source of phase shift and distortion, and usually rectified r.f. feed-back is applied only to transmitters using grid-bias modulation. As pointed out previously, **audio** feed-back will provide a very worthwhile improvement for Class-B stages, and the tubes will tend to adjust themselves to the linear operating portion of the dynamic characteristic curve regardless of ageing and bias voltage variations.

In a feed-back amplifier the plate supply voltage may vary over a considerable range without materially affecting the amplification. Constants of the circuits may be changed in value and the tubes themselves may be replaced without serious effect on the output, either in quality or quantity. Voltage regulation of the power supply need not be other than ordinary, and noise, in the form of hum from a poorly-filtered supply feeding the power output stage, is greatly reduced. However, it must be noted that hum and other noises, such as microphonics, induced in low-level stages will be only very slightly reduced by feed-back if there is any amount of gain after the stage where the noise occurs.

All the foregoing has served to present a few interesting and vital facts concerning the practical uses of feed-back. For mathematical and more thorough theoretical treatment, the appended bibliography will serve as an excellent guide. Several practical articles are also included.

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A SIMPLE WHEATSTONE BRIDGE

Practical details for the construction of a simple bridge for the measurement of resistance.

LAST month we discussed various methods of resistance measurement, some based on Ohm's Law (I equals E/R, therefore R equals E/I), others using the balancing of potentials in a Wheatstone network. The latter method is the more accurate in practice and the simple device described here enables comparisons to be made to within one per cent if care is taken. Under good conditions, an accuracy of one part in a thousand may be obtained. The apparatus consists of four parts:

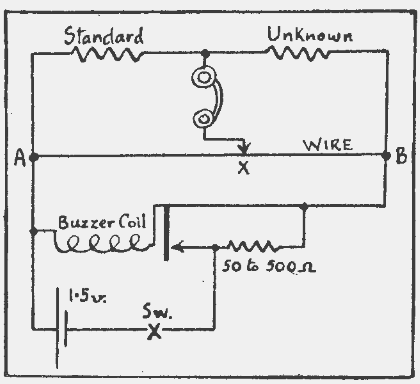
1.—A current source.
2.—The Bridge.
3.—A Standard Resistor.
4.—A detecting device.

If a battery is used as a source of current, the detecting device must be sensitive to D.C. and a galvanometer is suggested. A good quality 0 — .1 milliameter is quite suitable.

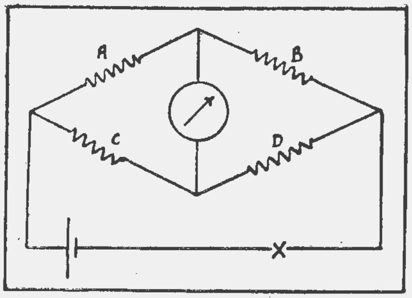
For those people not lucky enough to possess such an instrument, we suggest that an A.C. source be used and that the detecting device be a pair of earphones. A really good A.C. source may be made from a buzzer and a dry cell, the buzzer being enclosed in a soundproof box and preferably shielded. Anyway we'll have more to say on these points later on.

Design of the Bridge.

The bridge consists of a length of uniform resistance wire, together with a slider or movable tap. A scale divided into either 100 equal parts or divided according to a "bridge" scale, is fastened beside the wire. The parts of the wire on each side of the movable contact, form two resistances in the Wheatstone net. The other two resistances consist of the "standard resistor" and the resistance to be measured. The accuracy of the result depends on the accuracy of the standard resistor. Resistors correct to within 2 per cent are usually obtainable at a price only slightly more than for an ordinary plus or minus 20 per cent resistor. Resistors correct to one half of one per cent are also easily obtained. Further accuracy is not necessary for most radio work and, in any case, would be useless as the bridge itself introduces some error.



The resistance wire must be uniform as we are going to take the ratio of its lengths as the ratio of its resistances (measuring in each case



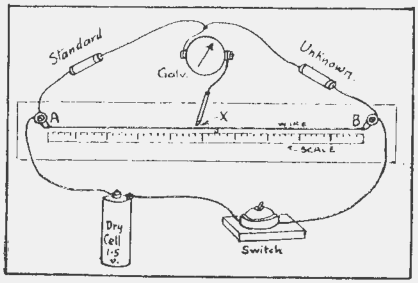
from the movable contact). The careful unwinding of a 30 ohm rheostat or a 100 ohm wire-wound potentiometer will provide a good length of suitable wire.

Construction

Having obtained the length of resistance wire, the actual usable length must be decided. This should be either one metre (the scale is then one metre long and is divided into cm and millimetres) or 20 inches (the scale is marked off in inches and tenths of inches). The wooden base-board to carry the wire must be about 6 inches longer than the usable length, and 4 to 6 inches wide. It must be quite rigid and quite dry. A coat of shellac varnish is a help. The wire is tightly stretched between two solder lugs which must be spaced so that the length of wire **between** the lugs is correct. The pieces of wire embedded in the solder on the lugs are not counted in the length. At each end a pair of flexible leads, each fitted with a **good** quality alligator clip should be soldered. The movable contact may consist of a piece of brass rod or thick copper wire. One end is rounded so as to form a "smooth point." To the other end are soldered three insulated wires with alligator clips. The scale must be close to the wire and may be underneath it.

Using the Bridge.

The ends of the bridge (A and B



in the diagram) are connected to the current source (the dry cell or the dry cell-plus-buzzer). The standard resistor is connected between one end (A) and the unknown resistor which is connected to the other end (B). The detecting device (galvanometer or phones) is connected between the movable contact, which for the time being is left off the wire and the junction of the standard and unknown resistances. The movable contact is touched lightly on the wire and a current is registered by the galvanometer (or phones). The movable contact is **now** moved along the wire until finally a position is found at which the galvanometer (or phones) does not indicate a current. (Position X in the diagram.) The distances AX and BX are measured and the unknown resistance is calculated as follows:

Unknown equals Standard res. ×

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BX ÷ AX, i.e., the ratio of the unknown to the standard is the same as the ratio of BX to **AX.**

It is advisable to have several standards as the nearer BX and AX are equal, the more accurate is the Bridge. If "balance" is obtained very close to one end of the wire, then it is a sign that the standard resistor value is far too low or too high.

The Galvanometer.

If a galvanometer is used, it should be "shunted" by a length of copper wire (say a foot of 30 gauge) until balance is nearly obtained. Otherwise the unbalance of potentials will send sufficient current through the galvanometer to ruin it. When the balance is nearly obtained, the "shunt" may be removed. A quarter-ohm filament resistor may be used as a shunt.

Phones.

These should be standard good-quality radio phones wound to about 2000 ohm D.C. resistance. Ear-pads of sponge rubber are a help as they keep out extraneous noises including sound from the buzzer, besides making the phones more comfortable to wear.

Buzzer.

If a buzzer is used as a source of A.C. voltage, it must be in some sound absorbing container. A good way is to mount it in a close-fitting cardboard box which is in turn mounted in a cardboard box with a layer of cotton-wool in between. The second box is then placed in a wooden box and the outer gap filled with sawdust. The two cardboard partitions and the wood reflect back part of the sound whilst the cotton wool and the sawdust absorb most frequencies to a large extent.

The buzzer (and sound-absorbing box) can be enclosed in a metal case which is earthed, thus helping to prevent A.C. being picked up directly by the phones via induction. If there is a direct pick-up of A.C., there is no position on the wire for zero sound, only a minimum position is found. Connecting a resistor between the contacts of the buzzer improves the note but may tend to stop it from working. Best results were obtained with a special buzzer using carbon contacts (actually a simple type of microphone!) with a 50 ohm resistor across the carbon contacts.

Increasing the Sensitivity

Interchanging the position of current source and detector sometimes improves the sensitivity and allows a sharper balance to be obtained.

A high-pitched buzzer gives better results than a low-pitched one.

A large number of standards covering the range to be measured is also very helpful. It is a good idea to make not one, but a dozen measurements and take the average, thus reducing "experimental" error.

The Story Of The Electrolytic Condenser

ANY condenser consists of three parts: two conductors which are usually of metal and an insulator called the "dielectric," between them. When a potential difference (i.e. a voltage) occurs between the two conductors, a certain charge of electricity is stored in the condenser. The ratio of the charge to the voltage is called the capacity of the condenser.

Mathematically: $Q = V \times C$ where
Q=charge stored in coulombs,
V=voltage across condensor,
C=capacity in farads.

The farad is a very large unit of capacity and most capacities are measured in micro-farads (millionths of a farad) or even in micro-micro farads for very small condensers.

Capacity of a Condenser

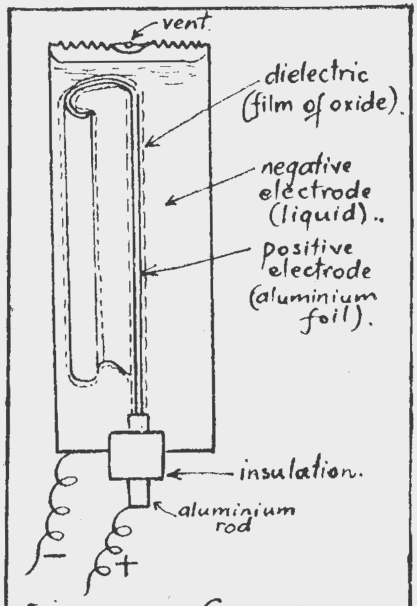
The capacity depends upon the size (area) of the conducting surfaces, the distance they are apart and the nature of the dielectric between them. If both conducting surfaces have the same area (and they usually do), then the capacity may be found from the rule:

$$C = A \times K \times .0976/D$$

where C=capacity in micro-micro-farads,
A=area of one surface in sq. centimetres.
D=distance between surfaces in centimetres.
K="dielectric constant," a number depending upon the dielectric material.

Large Capacities

If a condenser is to have a very large capacity, then one of three things must occur: The conducting surfaces must be large, the dielectric must be thin, so that the surfaces can be close together, or the dielectric constant must be high. Unfortunately there is a limit to the size of the surfaces — we can't use a room just to hold a condenser! — most dielectric constants are between 1 and 20 and if the dielectric is too thin, voltage breakdowns occur. In an electrolytic condenser, high capacities are obtained in a most ingenious way. One conducting surface (or electrode) is a piece of aluminium foil which has its area increased by "etching" fine grooves and wrinkles in it. The other surface (or electrode) is a liquid, either a solution of boric acid or of some salts and presses very close to the aluminium foil electrode. The only thing preventing them from touching is an exceedingly thin film of aluminium oxide which covers the aluminium foil.



ELECTROLYTIC CONDENSER.

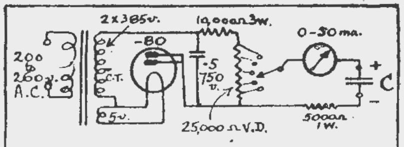
This aluminium oxide acts as the dielectric. Luckily, it is quite a good insulator — a film only a ten-thousandth of an inch thick will withstand many volts — and besides the dielectric constant is fairly high (about 10. The liquid and foil are enclosed in a container of waxed cardboard or aluminium. The container is **not** an electrode! If a cardboard container is used then two pieces of aluminium foil are used, but only one is covered with an oxide film—the other is bright and clean to make contact with the liquid.

Making the Condenser.

When first assembled the positive foil has no coating of oxide. The assembled "condenser" is connected in series with a limiting resistor to a supply of direct current. At first a fairly large current flows and the liquid is electrolytically decomposed, the water becoming a mixture of oxygen and hydrogen gases. The oxygen unites with the positive foil to form the oxide film. As the film is formed the current decreases until finally only a minute current can leak through the oxide film. The film is now said to be "formed" and may have a resistance as high as one megohm. The thickness of the film depends on the temperature, the current density and the composition of the liquid. If a thick film is formed, the capacity is low and vice versa.

Voltage Rating

The breakdown voltage of the condenser depends on the quality and thickness of the oxide film. If the oxide layer is coarse and granular liquid can get between the particles and cause a "short", or leakage. A fine, uniform layer is the most efficient. It is difficult, however, to make a thick layer of fine particles because as soon as the thin layer is formed the current shuts off.



TESTING ELECTROLYTIC CONDENSER for LEAKAGE.

Electrolytic condensers are to a certain extent self-healing. If the oxide film breaks down at one point, a fairly large current flows, producing a new film at that place. Because of this self-healing capacity, electrolytic condensers can be operated nearer to their test voltages than paper or mica condensers. It is safe to run the voltage across a condenser up to three-quarters or seven-eighths of its 'peak' voltage, e.g., a 500-volt electrolytic condenser may be considered to have a maximum safe working voltage of around 400 to 440 volts.

Semi-dry electrolytic condensers, i.e., electrolytic condensers in which a pair of positive and negative foils are closely wrapped and immersed in a jelly-like "electrolytic" are not usually self-healing, because when breakdown of the film occurs, the foils actually touch, giving rise to a complete short.

Testing Electrolytics for Leakage

The quality of a condenser is best found by applying a suitable voltage across it and measuring the current flowing. A series resistor should be in the circuit just in case the condenser has broken down — meters are expensive these days. The voltage applied should be comparable with the working voltage or the peak voltage. A leakage tester may be made from a power transformer with the entire high-tension secondary connected as a half-wave winding. The rectifier may be an 80 (yes, it's slightly overloaded but leakage testers aren't used continually and, anyway, the current is quite small).

Electrolytics in Series

Where an extremely high d.c. voltage is to be smoothed, or where utmost freedom from breakdowns is required, a pair of electrolytics may be connected in series. Two 8 mfd. .525 volt condensers in series are equivalent to a 4 mfd. 750 volt condenser (or 1050 volts if each condenser is shunted by a .05 meg. 5 watt bleeder). This is very handy for high-power amplifiers and transmitters where high voltages are commonly used. (The reduction from 1050 to 750 volts is to allow for differences in leakage current by a statistical method).

RESISTORS---RESISTANCE

RESISTANCE, when used in connection with electrical circuits, denotes the property of a material to oppose the flow of an electric current. A **resistor** is the name given to the component which is specifically designed to possess resistance. The two terms are often misused; resistance is not a component any more than a resistor is a property of a circuit.

We speak of an electric circuit having certain resistance—and there is a law connecting resistance with voltage and current, known as Ohm's Law.

The unit of resistance is the ohm, but when dealing with radio circuits this is too small or too clumsy to express resistance when hundreds of thousands of ohms are concerned. A grid-leak might have a value of 1,000,000 ohms, which, if written in full, would not only look terrifying to the beginner, but it would also take up space and time. To remedy this a larger unit is used, namely, the **megohm**, which is simply another way of writing 1,000,000 ohms.

Supposing a resistor has a value of 500,000 ohms, well, this can be expressed far more neatly and quicker as a decimal part of a megohm. Now 500,000 ohms is exactly half of 1,000,000 ohms, or 1 megohm, therefore, we simply write it as 0.5 megohm. Carrying this example further, 250,000 ohms is 0.25 megohm; 100,000 ohms is 0.1 megohm; 50,000 ohms is 0.05 megohm; and so on. Now for a simple conversion tip. If the value in ohms consist of **six** figures simply put a decimal point in front of it to convert it to a decimal part of a megohm. If **five** figures form the value in ohms then put put 0.0 in front of it.

Voltage Drop

Ohm's Law will show that the resistance in a circuit will produce a voltage drop, the value of which will depend on the current flowing and the value of the resistance. This is important in radio, where high values of resistance are often encountered. In the majority of calculations one usually has to measure the current flowing in milliamps (mA.s), one milliamp representing the 1,000th part of an ampere—the unit of current. To calculate the voltage dropped by the resistance of the circuit, or by any resistor introduced into the circuit when current is expressed in milliamps, and the resistance as so many thousand ohms simply multpily the thousands figure or figures of the resistance value by the current figure. Example, a resistor of 50,000 ohms is in a circuit in which is flowing 5 mA.s; what voltage will be dropped? Answer: $50 \times 5 = 250$ volts. This simple form of calculation will be found useful when dealing with decoupling resistors, voltage dropping resistors in eliminators, and so on.

Wattage

Resistors are many in various types each of which is intended to satisfy some particular requirement. In addition to their various forms, each resistor has a certain wattage rating — this is specified by the manufacturer, and should not be ignored. If a circuit calls for a 1 watt resistor, which, incidentally, could be of any value as regards its resistance, then it would be asking for trouble to use a resistor having a ½ watt rating, as it would be, so to speak, overloaded, and would soon be destroyed.

The wattage required can be calculated quite easily if the resistance and current are known. This is the formula: Watts $= I^2 \times R$ when I represents the current in amperes and R the resistance in ohms. If the current is in milliamps then decimals must come into use again, remembering that mA. is equal to 0.001 ampere, i.e., one thousandth.

An alternative method is:

$$\text{Watts} = \frac{\text{Milliamps}^2}{1{,}000{,}000} \times \text{R}.$$

So you can take your choice.

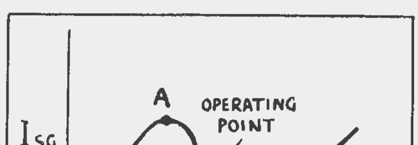
It does happen that one gets hold of a resistor of known resistance and wattage rating, and wants to find out the maximum current which can be passed through it. In this case the following calculation can be applied:

$$\text{Milliamps} = 1{,}000 \times \sqrt{\frac{\text{Watts}}{\text{Ohms.}}}$$

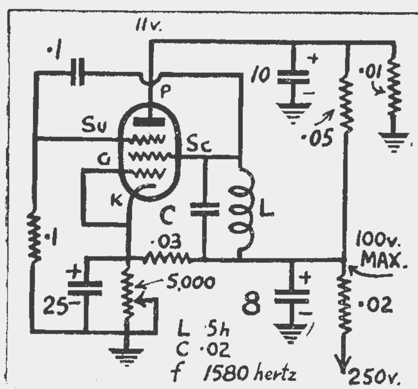
—Practical Wireless, (Eng.)

A TRANSITRON OSCILLATOR

When the anode voltage of a screen-grid valve is less than that of the screen, the valve may have a negative mutual conductance over a certain range of grid voltage. This negative mutual conductance is due to secondary emission and may be used as the basis of an oscillator — the **dynatron** oscillator. Unfortunately, suitable valves are not obtainable for that type of circuit, but pentode valves also have a range of negative mutual conductance under certain conditions. Here the negative transconductance is due not to secondary emission, but to the screen-grid (now the output electrode) taking electrons from the cathode-to-anode supply. If the voltages are correctly adjusted, then the circuit will oscillate if a tuned circuit is connected between the control-grid and cathode and some signal is fed back from the screen-grid to the control grid. Such an oscillator circuit has many definite advantages,) the most obvious one being that only one untapped coil is required. The circuit is very stable as regards frequency, small variations in the H.T. supply voltage having only a negligible effect due to a balancing process.



Waveform is excellent, providing there is not too much feedback, the circuit being unusually free from harmonics.



Applications of this "transitron" oscillator lie in superhet oscillators, modulated oscillators, audio-frequency oscillators, etc. For low frequency work, the frequency may be controlled by resistance-capacity networks in place of the tuning coil and condenser.

A simple modulated oscillator may be built up by using a single pentode valve as a transitron oscillator and supplying its anode and screen with A.C. instead of D.C., thus saving a rectifier and obtaining 50-cycle modulation at the same time. If space allows, we may describe such an oscillator in the future.

THE SUPER SPACE-LICKER TWO

By
PHILIP A. G. HOWELL

THE constant demand for news since the outbreak of war has caused many to ask for a cheap and easily constructed short-wave receiver for speaker use, to which the Super Space Licker Two is the answer. The primary purpose of this receiver is to run a 6 or 8 inch magno-dynamic speaker on the main shortwave stations of the world and to bring in the local broadcast without the expense and difficulty of R.F. stages or superhet construction, however, because of the flexibility of the 33 tube, with a little extra expense of a band-spreader condenser and isolantite sockets it can be made into a regular DX receiver, and it is for this reason that the band-spreader C1 is shown in the circuit diagram. For phone work not more than a total of 45 volts will be needed, while for speaker work 90 to 135 volts is needed and because of the range a table of voltages is included.

The Circuit.

This is built round the type 33 tube because of (a) its range as a detector — it will operate from 9 to 90 volts down to 15 or even 10 metres if quality components are used in construction, and (b) the power that may be obtained if so desired from the audio stage. Quite contrary to popular belief the plate drain is not necessarily excessive, and may be altered to suit the constructor by variation of the screen voltage, owing to the internal spacing of the elements. A striking example of the extreme range of the tube was the logging of many American and Hawaiian stations on phone with only 9 volts on the plate of the detector running straight into the phones, the audio stage being disconnected. W6BKY was actually verified as evidence.

The regeneration is accomplished as in this set's forerunner "The Space Licker Two" by a variable condenser of .0005 capacity and low minimum capacity, wired across the 5 megohm gridleak. This makes oscillation so smooth that a much higher voltage can be applied to the detector screen grid without fringe howl occurring, the result of which is tremendous gain in the detector stage providing more than sufficient driving power for the audio stage. Improved selectivity is also obtained for the set can be kept right on the verge of oscillation without experiencing the customary instability. Should the audio gain be too high, however, and distortion result, a resistor about .25 megohm wired across the transformer secondary will usually correct the trouble.

Construction

If plug-in coils are bought even the newcomer to short-wave may attempt this set, while anyone who has built the Hiker's One and amplifier should experience no trouble in getting the maximum performance from it. At first sight the 5 controls will probably worry the constructor, but it should be borne in mind that only 3, or 2 of them if the loudspeaker is omitted, will be in constant use, for the aerial trimmer and potentiometer will be set to suit each coil and left untouched while the stations are being tuned in. These extra controls should be no more bother than the tone control and wave-change switch of a large receiver.

If only phone work with the low voltage (45 volts) is contemplated a 1-5 audio transformer may be used with noticeable gain.

In building, all parts should first be mounted on the metal chassis and panel. All wiring inside the dotted line enclosing the grid circuit should be kept above the chassis and kept as short and direct as is practicable. Note none of this wiring should be run close against the metal chassis or panel and if it is necessary to pass any of it near a hot lead, that is, any lead in the screen or plate circuit, it is advisable to run it at right angles, otherwise losses may occur or undesirable feed back take place.

All wiring should be done with fairly heavy gauge tinned copper wire, and the earth returns hooked to a busbar soldered in several places to the chassis and run to the earth terminal.

Coils.

Those are wound on 1¼-in. formers, 4 pin, of the ribbed type. All windings are wound in the same direction.

There are two windings starting with the reaction at the bottom of the former, all windings are close wound and the grid coils should be separated by approximately 1/8-in. gap from the reaction coils. The leads are brought out through the hollow brass pins of the former and anchored with a drop of solder. Be careful to clean any flux off the pins.

The Winding Data

Wavelength.	16-50 metres	40-metres up.	Broadcast
S.W.G.	26 D.S.C.	26 D.S.C.	32 enam.
Grid Coil Turns	5	15	100
Reaction Coil Turns.	5	7	25

If oscillation is too fierce widen the gap between the windings, if it is too weak, lessen the gap.

Voltages.

Battery connections: For operation with phones.

For maximum power.

C— connect to A—, B+1 22.5 volts, B+2 45 volts, B+3 22.5 volts, B+4 45 volts.

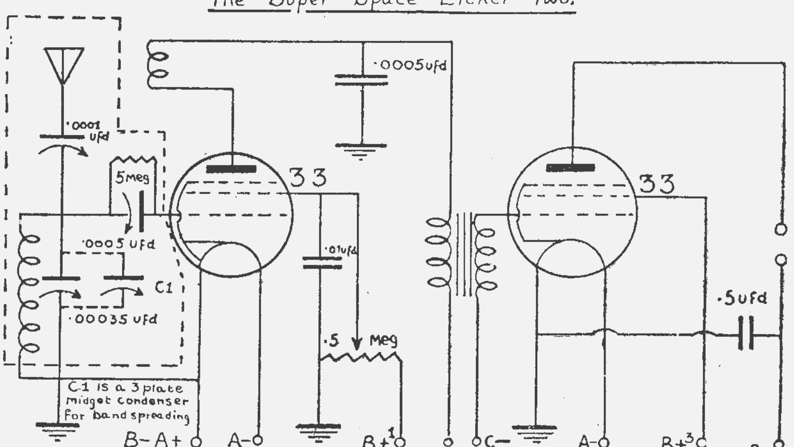
For economic speaker operation.

C— to 10.5 volts, B+1 45 volts, B+2 90 volts, B+3 67.5 volts, B+4 90 volts.

C— to —18 volts, B+1 45 volts or 67.5 volts, B+2 90-112½ volts,

(Continued on page 26)

The Super Space Licker Two.



Shortwave Review

CONDUCTED BY L. J. KEAST

NOTES FROM MY DIARY—

I am sure readers will be pleased to find we are able to give the full list of Allied and Neutral Countries Schedules in this issue.

Several of the BBC transmitters that are so far without a call sign have been included and I have given . . . — until such times as the engineers in the British Broadcasting Corporation are satisfied that the frequencies being used are reaching the territories for which they are intended, when doubtless the powers that be will find a suitable call sign for them.

Space does not permit of listing the times that all different languages are used in the . . . — series, but under Shortwave Notes will be found some schedules as well as the times that America calls the various countries of Europe.

Sun Interference

I did not notice any particular variation in signal strength or clarity during the partial eclipse of the sun, but I think our old Solar friend was suffering from spots on or about August 9, as that was one of the poorest days for reception I remember.

Sort Them Out

A little while ago reporters were moaning about the few stations to be heard of a night. Very shortly it will be a matter of difficulty to sort them out. Indications are at present that even the badly behaving 19 metre band will join in with the others and give us a still further choice of finding entertainment. A little early to expect consistent signals from the 16 metre band, but this will come in due course and by the time the really warm weather has reached us we will be able to comply with the BBC request to use the 13 metre band. No doubt, the coils that permit of this are worthy of inclusion in any receivers, even if only to give us those glorious free-from-static signals for a few weeks.

Diamond Jubilee

Heard the 75th edition of "Command Performance" on August 9, and the M.C. was Bing Crosby.

Anzac Hour

The U.S. Office of War Information advise Anzac Hour will be heard on Sundays from 5.45 till 6 p.m. over KWID, 9.57 m.c., 31.35m.

??? KGEI ???

"Since I was so early done for, I really wonder what I was begun for." This might quite easily apply to KGEI, who, after a brief spin on 15.33 m.c. was put back on to 11.79 m.c. On Sunday 15 at 1.15 p.m. I heard, "In response to requests, beginning on Sunday we will broadcast on 11.79 m.c. from 3 till 6.45 p.m. San Francisco time. This replaces the present 15 m.c. during the evening hours." Well, sure enough, today, 16 inst., back they were on 11.79 m.c. I'm sorry as it will most likely mean it will be nearly 2 p.m. before they show up in this district .

WLWK, Cincinnati

Mr. Walker, of Applecross, W.A., tells me he heard WLWK called at 9 a.m. on 15.25 m.c., 16.67m. This is the Spanish session for South America, closing at 2.15 p.m.

Added Attractions for Australia

Continuously anxious to improve programmes for the United Nations' Forces, the Special Division of the War Department of the U.S.A. have made some alteration in transmissions beamed to this country. They are:

KROJ, 9.89 m.c. 30.31 m.: From 9.05 till 9.30 p.m. Sundays: Great Moments in Music Wednesdays: Musical America. Thursdays: Minstrel Melodies. Fridays: Bob Crosby and Company. Saturdays: Bennie Goodman's Orchestra.

KWV, 10.84 m.c. 27.68 m.: From 4.15 till 4.45 p.m. Mondays: Johnnie Mercer's Music Shop.

KROJ, 30.31m. and **KWID**, 9.57 m.c. 31.35m.: From 7.30 till 8 p.m. Tuesdays: Johnnie Mercer's Music Shop.

Tete-a-tete

Had a call from Ted Whiting and as can be imagined, the ether was combed and several "doubtfuls" were run to earth. Great afternoon and some fine records were entered up.

Another meeting I enjoyed was with friend J. G. Du Faur, a Sydney man now stationed in Melbourne. Used to be a great DX-er, but as he is doing a very important war job, is excused for not sending regularly as he was wont to do, some fine lists of loggings.

Ceases Publication

Was very grieved to read that "Globe Circler" was to cease publication owing to lack of support due to the International situation. This is unfortunate, as after 113 consecutive issues, each and every one cramful of great information, it will leave a big gap for those who still, through avocation or as a hobby, are still able to "dial around."

We cannot complain of any lack of support; as a matter of fact, sales have never been higher, but we could do with a few more reports each month.

Let us have these reports — you most likely have tuned to the very station we want to know about.

ALL-WAVE ALL-WORLD DX CLUB

Application for Membership

The Secretary,
All-Wave All-World DX Club,
243 Elizabeth Street, Sydney.
Dear Sir,

I am very interested in dxing, and am keen to join your Club.

Name ....

Address ....
(Please print both plainly) ....
....

My set is a ....

I enclose herewith the Life Membership fee of 2/– (Postal Notes or Money Order), for which I will receive, post free, a Membership Certificate showing my Official Club Number. NOTE—Club Badges are not available.

(Signed) ....

(Readers who do not want to mutilate their copies can write out the details required.)

Shortwave Notes and Observations

Australia

VLW-3 25.36m. good on closing at 11.45 pm; VLG-6, 19.69m. for U.S.A., was better than VLR-3, 25.25m. at noon; in fact, equal to VLQ-3 (Gaden). VLG-9 25.21m very good here in broadcast to S.E. Asia at 12.15 am; VLQ--2 41.58m. heard opening at 5.30 pm — good; VLQ now back on 7.24 m.c. 41.44m. heard at good strength at 6.30 am (Cushen).

Oceania

Do not know if they were having crystal trouble or not, but I heard FK8AA on approximately 6.20 m.c. 48.39m., from 5.17 pm till they suddenly left the air at 6.27. During the time I listened I did not detect any mention of change in frequency — L.J.K.

America — U.S.A.

At 11 am and 1 and 5 pm and midnight, the wave-bands on which news in English is to be heard over "The Voice of America" is given. Pressure on space prevents list being given, but it can be heard easily on WLWK 39.6 m. at 5 pm—L.J.K.

Was surprised at fine volume of KROJ, 30.31m. in Alaskan transmission the other afternoon; other tophole 'Frisco stations were KGEI, 41.38m. and KES-3, 28.25m. (Gaden).

WLWK, Cincinnati on 9.59m. is spoilt by Delhi; KROJ, 30.31m. is very good from as early as 1 p.m. and can be followed right through (Cushen). Heard a call around 9.30 am something like WOO4 on 28.55m. (Gillett). This would be WOA-4, New York, on 10.51 m.c., 28.53 m. who was heard for several weeks at that time, but seems to be missing nows.—L.J.K.

KWID is still unsurpassed on 31.35 metres in the late afternoon; KWY is R-6 at 10.30 pm; KWV splendid around 5.30 pm and WRUW, 49.66m. is the best signal on the 49 metre band except FK8AA, Noumea. KGEI, 41.38m. is R-6 as also WLWK, 39.6m and WRUL, 38.4m is R-5 with a bad morse on him around 5.45 pm; WRCA on 25.27m is very good at night; WKCS fair at 5.15 and KWID 41.49m is R-6 in Oriental programmes at night (Gillett).

KGEI, 15.33 m.c. has been heard consistently since it opened and from noon can be relied on to give a good signal. KROJ, 9.89 m.c. excellent most days in afternoon to Alaska. KWV excellent throughout transmission. KES-3, 10.62 m.c. R-6-7, but noise about. KRCA, 9.49 m.c. always good signal. WNBI 11.89 m.c. good in French at 8.42 am. WRUW, 11.73 m.c. good solid signal at 8.45 am today (August 16); have not heard him before this week. WKLJ, 9.75 m.c. News in English at 8 a.m., relayed by United Nations Radio at Tunis on 345 m. KES-2, 8.93 fair most night with R-6 signal. WKLJ 7.56 m.c. heard in what I think was Dutch and Belgian at 6.15 pm. KWY, 7.56 m.c. excellent at 7 pm (Whiting).

KWID 31.35m. roars in here of an afternoon and KROJ 30.31m is good; WLWO, 39.6 m. and KWY, 39.6 m. are both very fine (Pepin)

I have been hearing WLWK on 19.67m. closing at 7.15 am (Hallett).

Mexico

XEWW 9.50 m.c. good all morning and audible even when closing at 4 pm. (Walker). (Excellent afternoon station here.—L.J.K.).

XEQQ, 9.68 m.c. Never very strong, but is there at 9.30 am (Walker.

XEXA, 6.17 m.c. Physical jerks at 11 pm. Weak signal (Walker).

Central America

Received very fine verification card from TIPG, San Jose, Costa Rica. (Gillett).

America — South
Eucador

HCJB, Quito, 12.45 m.c., 24.11m., Really delightful at present from 9 am onwards, and on 30.12m. also surprisingly good at the same time, only weaker (Walker).

HCJB very good here at 1 pm on 30.12 and fair on 24.11m. They now broadcast in 9 languages in 84 programmes weekly with over 50 speakers. I got a verification for the 9.965 outlet recently .(Cushen, N.Z.).

AFRICA

Algeria

AFHQ Algiers 8.96 m.c. 33.48 m.: "This is The United Nations speaking from Algiers, French North Africa," is often heard. This week they were heard with news from BBC at 2 am., "The Voice of America" at 3 am; station signs at 3.15 am. They open again at 6 am (Hallett).

Morocco

CNRI, Rabat, 8.035 m.c., 37.34m.: Relays English edition of news from Algiers at6 am—fair signals, easier to follow that AFHQ.

Musical programme 6.45—7 am. with French announcements (Hallett).

Iran

EQB, Teheran, 6.15 m.c. 48.74m.: Programme for American Forces in Persian Gulf, 2.45—3.30 am. News at 2.45. Heard clocking striking 9 (3.30 a.m. our time). Foreign programme followed (Hallett).

Great Britain

Through the BBC "America calls Europe" in English from 6.15 till 6.30 pm on: 49.59, 48.98, 48.43, 42.46, 41.32, 41.01, 31.88, 31.61, 31.25, 25.58 and 24.80 metres.

"America calling France" in French 10.30 till 10.45 pm, 42.13, 41.75, 31.83, 31.75, 31.25, 30.96, 25.15, 25.09, 24.80 and 16.95 metres.

From 7.30 till 7.45 am on 49.92, 49.42, 48.98, 41.96, 46.75, 41.49, 31.55 metres.

(Continued on next page)

"America calls Germany" in German from 5 till 5.15 a.m. on 49.92, 49.42, 41.96, 41.32, 31.88, 31.75, 30.53, 25.64, 25.15 metres.

The above are daily transmissions. America also, through the BBC calls other European countries on certain days, but space is not available in this issue for details. (L.J.K.).

Georgie Henschel told us, on Sunday, August 15, GVQ is the call sign for 16.92 metres.—L.J.K.

British Mediterranean Station, broadcasting to the Balkan States, is now on the air in news and talks in English, 1.15—1.30 am. Dial 11750 kc. (25.53m.) (A.B.C. Weekly).

Heard London on 25.64m. around 11 pm with news in English, fair signal (Gillett).

India

VUD-6, Delhi on 11.79 m.c. 25.45m. is very god at 11 pm — march, then "This is The United Nations calling the Far East from Delhi." Then comes the news. (Cushen).

Vatican City

HVJ is R-8 at 6.20 a.m. in English on 50.26m. (Gillett).

BBC now broadcast to Japan 11.78, 15.43 and 15.38 m.c. on Tuesdays and Saturdays in English at 7.30 pm and news in Japanese on other days (Cushen). At conclusion of news in English (9.45 pm) on Fridays the BBC remind listeners, among other things, to be sure, before turning off their radios, to tune to a Japanese, or Japanese controlled station to prevent a possible discovery by the enemy that the BBC programme had been listened to (Hallett).

Portugal

CSW-7 Lisbon, 9.735 m.c. 30.82m. is quite good in its session from 10 till 11 a.m. (Walker).

NEW STATIONS

KGEI, 'Frisco, 15.33 m.c. 19.57m.: As it is long since KGEI used this frequency it can be classed as a New Station, and although beamed to the Americas, it is being heard at great strength from around 11 a.m. and the signal is maintained till they close at 2.45 p.m. This General Electric Station is evidently anxious to know how they are being received, as requests on reception are made every fifteen minutes. Reports are to be sent to the Fairmount Hotel, at which address also is The United Network to be found who would be pleased to know how the programmes appeal. Do not forget, however, the programme is intended for Mexico, Central and South America.

KGEI, 'Frisco, 15.13 m.c., 19.83m.: Actually this is not a new station, but for some reason or other I have omitted to include it before. Beamed to Latin America it is on the air from 3.15 till 4.15 a.m.

——, Berne 7395 k.c., 40.56m.: This is a outlet for the Swiss Government and is heard from 1.15 till 1.47 am. Opens in French: at 1.15 Italian is heard and French again at 1.20 till 1.25 when Swiss-Dutch is used. From 1.31 till 1.35 a drum is beaten and at 1.35 in French comes the announcement: "Ladies and gentlemen, This is Radio Suisse." At 1.45 an Anthem and at 1.47 wave-length in Franch and Italian and stations goes off. Signal is R-5 but noise is high.

——, Cairo, 7.50 m.c., 40m.: First report on this Egyptian station comes from Stan Maguire of Earlwood. Heard opening at 2.45 am with "Here is Cairo calling." News in English follows and at 2.55 "You are listening to the news from Cairo." At 5.29 "Here is headline news for benefit of those who missed beginning." After a short musical item station goes off.

WKTS, New York, 6.12 m.c. 49.02m.: Another "Voice of America" station heard for quite a while now. Schedule appears to be 4 till 7 pm and is heard at various times in company with WCBX (48.62m.).

WKTS, New York, 7575 kc., 39.6m.: This new one is submitted by Mr. Walker of Applecross, W.A., and he is hearing it around 10 am till midday. That is a noisy spot for me, but I thought I could just discern them at 10.18 am on Wednesday, August 18. I did hear WKRX (30.31m.) say at 10.15 that V. of A. could be heard over WKTS in 39 metre band.

KWIX, 'Frisco, 9.57 m.c. 31.35m.: First heard at 3.49 pm on August 18. Not sure of opening time, but think it may be 2 pm. When closing at 4.45 pm says, after usual reference to owners, etc., "Will be heard again at 8.15 am PWT (1.15 am Sydney) on same frequency." And it does, but is badly heterodyned. The call sign KWIX is apparently given to prevent confusion with KWID which, during the afternoon session is also transmitting on 19.62m. and during the early morning programme is on 31.35m. KWIX, during the time I have listened, maintained on R-4 Q-3 signal and employed several Eastern languages.

U.S.S.R.

Heard Radio Centre, Moscow, on 11.83 m.c. 25.36m. at 1 am — good (Cushen). Moscow is good here of a morning with news and talk at 7.15 on 19.73m. and at 9.40 pm on 31.43 and 28.72m. Puts in fine signal on 30.43m. from about 10 pm—L.J.K.

West Indies

Our West Australian reporter, Lindsay Walker, has been capturing the Cubans.

Cuba

COCH, 9.43 m.c. Has re-appeared in the am and is fair only, at 10 am.

COBC, 9.37 m.c. Quite nice at 9.30 am; morse often offends.

COCX, 9.27 mc. Very loud now, but almost ruined by morse 9—11 am.

COBZ, 9.03 m.c. Weak, but audible around 9 a.m.

COHI, 6.45 m.c. Signs in English at 10 a.m. and on every hour gives frequency and wave length in English.

COCW, 6.33 m.c. Quite good at 8 am.

(Readers must remember W.A. time is 2 hours behind that shown, and will account for them being heard at an hour when it is unlikely they would be audible here.—L.J.K.).

Allied and Neutral Countries Short-Wave Schedules

These schedules which have been compiled from listeners' reports, my own observations, and the acknowledged help of "Globe Circler" and "Universalite" are believed to be correct at time of going to press, but are subject to change without notice. Readers will show a grateful consideration for others if they will notify me of any alterations. Please send reports to: L. J. Keast, 23 Honiton Ave. W., Carlingford. Urgent reports, 'phone Epping 2511.

Loggings are shown under "Short Wave Notes and Observations."

Symbols: N—New stations; S—Change of Schedule; F—Change of frequency.

Call Sign	Location	Mc.	M.	Time: Eastern Australian St'dard
GRZ	London	21.64	13.86	9—11.15 pm
GSH	London	21.47	13.97	8.30—1.15 am
OPL	Leopoldville	20.04	14.97	8.55—10.15 pm
—,	L'poldville	19.20	15.63	2.45—3.30 a.m.; 4.30—4.45 am; 9.15—9.30 pm;
HBH	Berne	18.48	16.23	Tues. & Sat. 11.45 pm—1.15 am
GVO	London	18.08	16.59	2—2.15 am
GRQ	London	18.02	16.64	8.45 pm—12.30 am; 2—2.45 am
EIRE	Athlone	17.84	16.82	10—11.30 pm; 3.30—4 am; News 2.45 am.
WCDA	New York	17.83 S	16.83	11 pm—4.30 am
WCRC	New York	17.83	16.83	7.15—9.15 am
GSV	London	17.81	16.84	3.45—4.45 pm; 8.45 pm—1.15 am; 1.30—3.15 am
WLWO	Cincinnati	17.80	16.85	11pm—2.30 am
GSG	London	17.79	16.86	8.45—10 pm; 1.30—2.45 am
WRCA	New York	17.78	16.87	11 pm—2.45 am
OPL	Leopoldville	17.77	16.88	8.55—10.15 pm; 4.30—6.30 am
KROJ	'Frisco	17.76	16.89	Not in use at present
WRUW	Boston	17.75	16.90	1—3.15 am
GVQ	London	17.73	16.92	5—7 pm; 11.30 pm—1 am
LRA-5	B'nos Aires	17.72	16.93	Sats. 6.45—7.30 am
—,	Brazzaville	17.71	16.94	6.30—8 am
GRA,	London	17.71	16.94	6 pm—2.45 am; News 7 pm
HVJ,	Vatican City	17.44	17.20	Mon. Wed. & Sat.: 11 pm—1 am; Tues, 11 pm—1.20 am; Fri. 11 pm—midnight.
WCW	New York	15.85	18.93	3 am—7 am
—,	Mascow	15.75	19.05	9.40—11.30 pm
WCB	Hicksville	15.58	19.28	7.15—8 am.
GRD	London	15.45	19.42	5.45—7pm; 8.45—10.30 pm
—	Accra, G. Coast	15.42	19.45	8—8.30 pm; 3—4 am.
GWE,	London	15.42	19.44	5.45—7 pm; 8 pm—1.15 am
GRE	London	15.39	19.50	5.45—7 pm; 10.15 pm—1 am; 1.30—5 am
KWU	'Frisca	15.35	19.53	Daily except Thurs. 6.30—8.15 am (Mon 7—8 am). Daily except Mon. & Thurs. 9.45—11.30 am
WRUW/L	Boston	15.35	19.54	8 pm—3.15 am; 3.30—4.30 am
FGA	Dakar	15.34	19.55	5.15—7 am
WGEA	Schenectady	15,33	19.57	7.30—9.45 am
KGEI	'Frisco	15.53 N	19.57	11 am—2.45 pm
WGEO	——	15,33	19.57	10.15 pm—5.30 am.
VLI-3	Sydney	15.32	19.58	3.10—3.40 pm; 8.15—9.45 pm
GSP	London	15.31	19.60	5—7 pm; 8—10.45 pm; 11—11.30 pm; 11.45 pm—12.45 am; 2—2.30 am; 2.45—3 am
HER-6	Berne	15.30	19.60	Testing Tues. and Sat. from 6.30—8 pm.
KWID	'Frisco	15.29 S	19.62	3.30—11 am; 3—4.45 pm
LRU	B'nos Aires	15.29	19.62	9.15—10.15 pm
VUD-3	Delhi	15.29	19.62	1.15—2.5 pm; 3—6.15 pm; 8.30—10.15 p.m.
WCBX	New York	15.27 S	19.64	9 pm—6.45 am; 7—9.45 am
GSI	London	15.26 S	19.66	4—7 pm; 8.45 pm—1.15 am; 1.30—6.45 am
WLWK	Cincinnati	15.25 S	19.67	4.45—7.15 am; 7.30—9 am; 10.30 pm—1 am
VLG-6	Melbourne	15.23	19.69	11.45 am—1.30 pm; (Sun. 12 noon—1.50 pm); 1.55—2.30 pm; 3.10—3.40 pm.
—	Moscow	15.22	19.70	7.15—7.40 am; 8.48—9.30 am; 11.15—11.40 am; 1.15—1.40 pm
WBOS	Boston	15.21	19.72	10.15 pm—1 am; 1.15 am—2.45 pm.
XGOY	Chungking	15.20	19.73	8—9.30 pm. Signal erratic but improving
TAQ	Ankara	15.19	19.74	7.30—9 pm; 11.30 pm—12.45 am
KROJ,	'Frisco	15.19	19.75	6.15—7.45 am; 8—9 am
XGOY ..	Chungking	15.18	19.76	Wed. only, 10—10.45 am
GSO	London	15.18	19.76	8.45—9 pm; 10.15—11.15 pm; 1.30—1.45 am; 3.30—4 am.

Call Sign	Location	Mc.	M.	Time: Eastern Australian St'dard
TGWA	Guatemala	15.17	19.78	3.45—4.55 am; (Mon. till 8.15 am)
PRE-9	Fortaleza	15.16	19.78	7—11.05 am
VLG-7	Melbourne	15.16	19.79	6.30—8.10 am (Sun. 6.45—8 am)
SBT	Stockholm	15.15	19.80	1—4.15 am. News 1.01 am.
WNBI	New Yark	15.15	19.81	10 pm—7 am.
GSF	London	15.14	19.82	8.45 pm—1.15 am; 3.30—3.45 am
KGEI	'Frisco	15.13 N	19.83	3.15—4.15 am
HVJ	Vatican City	15.12	19.84	Mon. 10—10.15 am; 10.30—10.50 am; 11—11.20 am; Wd. 1.25-2.25 am; Fri 2-3.20 am
—	Moscow	15.11	19.85	7.15—7.40 am; 8.48—9.30 am; 11.15—11.40 am; 1.15—1.40 pm; 9.30—10.20 pm
HVJ	Vatican City	15.09	19.87	Thurs. m/n. to 1 am Fri.; Fri. m/n to 1 am Sat.
GWC,	London	15.06	19.91	3—7 pm
PSE	R de Janiero	14.93	20.07	Fri. 7—7.30 am;10—10.30 am
WDO	N.Y.	14.47	20.73	11 pm—6 am
—	Malaga	14.45	20.75	11 pm—Midnight
—	Tunis	14.40	20.83	9—11 pm; 3—7 am
—	Dakar	13.34	22.48	No schedule
WKRD	New York	12.96	23.13	8.45 pm —2.45 am; 3—4.45 am
CNR	Rabat	12.83	23.38	9.30—11 pm
FIA	Douala	12.70	23.61	8.45—9.30 pm; 5.15—5.45 am
HCJB	Quito	12.45	24.11	9.45—11.45 pm; 2.30—5.30 am; 8 am—12.45 pm
—	Brazzaville	12.27	24.45	4.30—6 am.
—	Moscow	12.26	24.47	1 pm to 2 am (this is all Russian—for Home Service)
TFJ	Reykjavik	12.23	24.54	3.15—3.30 pm
—	Moscow	12.19	24.61	7.45—9.23 am; 10—10.50 am
—	Moscow	12.17 ..	24.65	6—8 am; 2.40—3.45 pm; 4.45—5 pm; 7.30—8.50 pm; 11—11.15 pm; 12.30—12.45 am; 1.15—1.45 am.
R. France	Algiers	12.12	24.75	2.30—4.30 am; 5—7.30 am; 7.45—8.15 am.
ZNR	Aden	12.11	24.77	2.13—3.30 am
GRF	London	12.09	24.80	8 pm—2.45 am
GRV	London	12.04	24.92	3.45—6.45 pm; 8.45—9 pm; 10.15—11.30 pm; 11.45 pm—2.30 am; 2.45—4.45 am; News 4.15 and 6 pm.
CE1180	Santiago	11.97	25.04	9.30pm—m/n; 2.30 am—2 pm
FZI	Brazzaville	11.97	25.06	5—7.30 am; News 5.45 am; 1—2 pm; 3.55—4.40 pm; 9.15—10.30 pm; 2—3 am
ZPAS	Encarnacion	11.95	25.10	8.30—10 am
. . . —	London	11.95 N	25.09	7.15 pm—12.30 am; 1.30—am; (Eng. 11—11.30 pm)
. . . —	London	11.93 N	25.15	7 pm—12.30 am; 1.30—6 am; (Eng. 7.15—7.45 pm; 11—11.30 pm.
XGOY	Chungking	11.90	25.21	Midnight—2 am.
VLG-9	Melbourne	11.90	25.21	12.15—12.45 am.
CXAIO	Montevideo	11.90	25.21	9.25 am—12.10 pm
WRCA	N.Y.	11.89	25.22	6—10.45 pm; 3—6.45 am; 7 am—1.30 pm
VLR-3	Melbourne	11.88	25.25	11.45 am—6.15 pm (Sun. 12.50 pm—6.25 pm)
H13-X	Trujillo City	11.88	25.25	8.30 am—12.15 pm.
VLI-2	Sydney	11.87	25.27	4.55—5.25 pm
WBOS	Boston	11.87	25.27	8.15—10 pm; 3—7.15 am; 7.30 am—2 pm
HER-5	Berne	11.86	25.28	10.55—11.30 pm; 6.50—7.35 am; 11.45 am—1 pm
GSE	London	11.86	25.29	1—1.15 pm; 1—1.30 am; 2.30—7 am.
WGEA	Schenectady	11.84	25.33	10 pm—7.15 am.
CXA, 14	Colonia	11.84	25.35	7 am—2 pm
VLG-4	Melbourne	11.84	25.35	7.25 pm; 7.30—8 pm; 8.15—9.45 pm
VLW-3	Perth	11.83	25.36	8.30—11.45 am; 1.30—8.45 pm (Sun. 8.45 am—8.45 pm)
—	Moscow	11.83	25.36	8.30—9.30 pm; 10.30—11 pm; 12.30—12.50 am.
WCRC	N.Y.	11.83	25.36	9.30 am—2 pm.
WCDA	N.Y.	11.83	25.36	8 pm—8.30 am
GSN	London	11.82	25.38	3—5.30 pm; 5—6.45 am
XEBR	Hermasillo	11.82	25.38	11—3 pm
COGF	Matanzas	11.80	25.41	2.30—5 am
KGEI	'Frisco	11.79	25.43	7 am—2.45 pm

Call Sign	Location	Mc.	M.	Time: Eastern Australian St'dard
WRUL	Boston	11.79	25.45	3.30—8 am; 8.15—9.25 am; 9.30 am—4 pm
GVU	London	11.78	25.47	3—5.30 pm
HP5G	Panama	11.78	25.47	11.15 pm—12.30 am; 2.45—6 am.
ZYB8	Sao Paulo	11.76	25.50	7 am—noon.
VLR-8	Melbourne	11.76	25.51	6.30—10 am (Sun. 6.45 am—12.45 pm)
GSD	London	11.75 S	25.53	11.15 am—2 pm; 3—7 pm; 1.15—1.30 am; 1.30—6.45 am.
—,	Moscow	11.75	25.53	9.30—9.55 am.
HVJ	Vatican City	11.74	25.55	Tues & Thurs. 5—5.30 pm; Mon. Wed. & Sat. 6—6.30 pm.; Wed. 1—1.30 am.
COCY	Havana	11.73	25.56	11 pm—4.15 pm
GVV,	London	11.73	25.58	5—7 pm; 1.30—6.30 am
WRUL,	Boston	11.73	25.58	9.15 am; 2—4 pm
KGEI	San F'cisco	11.73	25.58	7 am—12.45 pm (Think has been withdrawn).
ZPA-2	Asuncion	11.72	25.60	8.30 am—12.10 pm.
—,	Leopoldville	11.72	25.60	8.55—10.15 pm; 4—6.30 am
PRL-8	R de J'niero	11.72	25.60	5 am—1.10 pm.
—,	Lisbon	11.72	25.60	10 pm—midnight
—,	Geneva	11.71	25.60	9.45—11.15 am
YSM,	San Salvador	11.71	25.62	4—5 am
VLG-3	Melbourne	11.71	25.62	3.55—4.40 pm; 4.55—5.25 pm; 5.30—5.50 pm.
WLWO	Cincinnati	11.71	25.62	5.45—7.15 am
CXA-19	M'tevideo	11.70	25.63	9—10 pm; 8 am—1 pm
SBP	Motala	11.70	25.63	1—4.15 am; 7.20—7.40 am; 11 am—noon
CBYF	Montreal	11.70	25.63	9.30 pm—1.30 pm
. . . —	London	11.70 N	25.64	1.30—2 am. Italian: 2.15—6 am. Various languages.
HP5A	Panama City	11.70	25.64	11 pm—3 am; 11.10 am—3 pm
CE1170	Santiago	11.70	25.64	10 pm—midnight
GRG	London	11.68	25.68	3—7 pm; 4.30—6.45 am
—,	L'poldville	11.67	25.71	5.15—5.30 am; 2—3 pm; 6.30—6.45 pm
COK	Havana	11.62	25.83	2 am—2 pm (Mon. 3—9 am)
CSW6	Lisbon	11.04	27.17	4—8.30 am; 8.45—10.45 am.
KWV	San F'cisco	10.84	27.68	4—6.30 pm.
VQ7LO	Nairobi	10.73	27.96	12.45—5 am.
CEC	Santiago	10.67	28.12	10—10.15 am
KES-3	Bolinas	10.62	28.25	3—8 pm
VLN-8	Sydney	10.52	28.51	Idle at present.
WOA-4	New York	10.51	28.53	8—10 am; 6.45—8 pm.
—	Moscow	10.44	28.72	6 pm—1.45 am (often news at 9.40 pm).
PSH	R de Janiero	10.22	29.35	10.30—10.48 am
HH3W	P't-au-Pr'ce	10.13	29.62	2.30—8.45 am; 9 am—1.30 pm
SUV	Cairo	10.05	29.84	4.30—5 am; 8.45—9.30 am
—	Brazzaville	9.98	30.06	4—5.20 am; 7—7.30 am
HCJB	Quito	9958	30.12	9.45—11.45 pm; 2.30—5.30 am; 8 am—12.45 pm; (Sunday 10 pm—7.30 am
WRX	New York	9905	30.29	8 am—2 pm; 2.15—7 pm.
WKRD	New York	9897	30.31	6.45—8.30 pm; 5—7 am
WKRX	New York	9897	30.31	8—10.45 am
KROJ,	'Frsco	9.89	30.31	1—5.45 pm; 6—11 pm;11.15 pm—2.45 am
LSN-2	B'nos Aires	9890	30.33	Noon—12.30 pm
EAQ	Madrid	9860	30.43	4—5 am; 9.50—11 am. News 4.15 am and 10 am.
—	Moscow	9860	30.43	8.48—9.23 am; 10—11.50 am; 2—3.45 pm
CR7BE	L. Marques	9843	30.48	3—4 am; 7.30—10 am.
COCM	Havana	9833	30.51	9.45 pm—3 pm
GRH	London	9825	30.53	3—6.30 pm
—	Moscow	9770	30.71	10—10.30 am
ZRO	Durban	9755	30.75	Midnight—7 am
WKLJ	New York	9750	30.77	6.45—8 pm 8—11 am.
T14NRH	Heredia	9740	30.80	10—11 pm (Wed. Fri. & Sun. 1.30—3.30 pm)
CSW-7	Lisbon	9735	30.82	11 am—noon (not heard here lately).
CE970	V'paraiso	9730	30.82	9.30—11 pm; 7.30 am—2.30 pm
XGOA	Chungking	9720	30.86	9 pm—1 am. News midnight
OAX4K	Lima	9715	30.88	8.30 am—2.20 pm.
WRUW	Boston	9.70	30.93	4.45—9 am; 2—4 pm
FIQA	Tananarive	9700	30.93	12.30—2 am
GRX	London	9690	30.96	3.30—6.15 pm
TGWA	Guatemala	9685	30.96	11.50 am—2.45 pm (Mon. 10 am—2.45 pm).
LRA-1	B'nos Aires	9688	30.96	1.30—4 am; 5.30—6.30 am; 7 am—noon
XEQQ	Mexico City	9680	30.99	Midnight—4.45 pm.
VLW-5	Perth	9.68 S	30.99	9 pm—1.30 am
WNBI	New York	9.67 ..	31.02	7.15 am—4 pm.
VLQ-3	Brisbane	9.66	31.05	11.45 am—5.15 pm. (Sun. 11 am—5.15 pm)
LRX	B'nos Aires	9.66	31.06	8.30—9; 10.30 pm—1.10 pm (Sundays 3 pm).
HVJ	Vatican City	9.66	31.06	Tues., Thurs., and Sun. 1—2 am 2.30—4 am; Sun 7.30—8 pm; Wed. 3.30—4.15 am.
HHBM	P't-au-Pr'ce	9.65	31.06	10.30—11 pm; 3—4 am; 9 am—12.30 pm.
WGEO	Schenectady	9.65	31.08	Not in use at present.
WCBX	New York	9.65	31.09	1.45—4 pm.
COX	Havana	9.64	31.12	2.50 am—2 pm.
XGOY	Chungking	9.64	31.10	11.30—2.15 am: News midnight 12.30, 1 and 2 am.
LRI	B'nos Aires	9.64	31.12	7.57—10 pm; 3.30—4.30 am; 5 am—1 pm.
. . . —	London	9.64 S	31.12	7.15—8.45 am; 3.30—7 pm
CXA-6	Montevideo	9.62	31.17	1—9 am
—	Addis Ababa	9.62	31.17	1.40—2.30 am
VLI	Sydney	9.61	31.12	Not in use at present
XERQ	Mexico City	9.61	31.21	11.30 pm—1 am; 9 am—3 pm
ZRL	Capetown	9.60	31.22	5.15 pm—12.30 am.
HP5J	Panama City	9.60	31.23	10 pm — 4.30 am; 11.30 am—1.30 pm; Sun. 11 pm—1 pm Mon.
CE960	Santiago	9.60	31.24	9 am—2 pm.
GRY	London	9.60	31.25	7.15—8.45 am; 3—4.45 pm; 1—7 am; News 6.45 am, 4.15 pm, 2 and 4 am.
—	Athlone	9.59	31.27	7.05—7.25 am; News 7.10 am
VUD-4	Delhi	9.59	31.28	11 am —1.35 pm; 3—6 pm; 7.30—7.45 pm; 8.30—11.35 pm; 12.15—1 am; 2.30—4 am. News 11.45 om; 1.30, 5, 10 pm and 12.50 am
WLWO	Cincinnati	9.59	31.30	9.15—2 pm.
WLWK	Cincinnati	9.59 N	31.30	9—11 pm
VLR	Melbourne	9.58	31.32	6.45—11.30 pm (Sun. from 7 pm)
VLG	Melbourne		31.32	1—1.45 am for N America (W States)
GSC	London	9.58 S	31.32	7.15 am—2.45 pm; 3—4.45 pm
KWIX	'Frisco	9.57 N	31.35	2—4.45 pm; 1.15 am
KWID	'Frisco	9.57	31.35	5—8.15 am
—	Khabarovsk	9.56	31.37	5.30—7.12 am; 7 40—8.45 am; noon—1.12 pm; 1.45—2.40 pm; 6—9.30 pm; 10.30 pm—midnight
OAX4T	Lima	9.56	31.37	11 pm—midnight
XETT	Mexico	9.55	31.39	Continuous
. . . —	London	9.55 S	31.41	5.30—7 am; 6.15—7 pm; 1.30—4.30 am
WGEA	Schenectady	9.55 N	31.41	3—8 pm
XEFT	Vera Cruz	9.54	31.42	11 pm—4.15 pm
—	Moscow	9.54	31.43	9.40—10.20 pm; 12.15—12.30 am
VLG-2	Melbourne	9.54	31.45	10—10.45 pm for N. America (E. States) 11 pm—midnight for Asia (French & Thai)
SBU	Stockholm	9.53	31.47	7.20—7.35 am; 11 am—noon, News 7.20 and 11 am.
HER-4	Berne	9.53	31.47	9.45—11.15 am. Except Sundays
WGEO	Schenectady	9.53	31.48	5.45—7.15 am; 7.30 am—2 pm
ZRG	Joh'burg	9.52	31.50	5.30 pm—12.30 am
COCQ	Havana	9.51	31.53	10 am—1 pm; 8.20—11 pm
GSB	London	9.51	31.55	3—6.30 pm; midnight—1.15 am, 4.15—7 am; 7.45—8.45 am, 9 am—12.45 pm.
PRL-7	R de Janeiro	9.50	31.57	8 am—1 pm
XEWW	Mexico City	9.50	31.58	11.58—5.45 pm
OAX5C	Ica	9.50	31.58	Think off the air.
. . . —	London	9.49 N	31.61	5.30 pm—12.30 am; 1.30—8.45 am
KRCA	'Frisco	9.49	31.61	3 pm—3 am
WCBX	New York	9.49	31.61	9.50 am—1.30 pm
—	Moscow	9.48	31.65	4—5 pm; 8.30 pm—12.45 am; 1.45—2.15 am.
CR6RA	Loanda	9.47	31.69	9.30—10.45 pm; 5.30—7 am
TAP	Ankara	9.46	31.70	12.15—5.47 pm; News 2.15 am
GRU	London	9.45	31.75	3—8.15 am; 1.45—.3.15 pm; 1—1.15 am
COCH	Havana	9.43	31.80	8.45 am—3.15 pm
—	Moscow	9.43	31.81	7—7.25 am; 2.15—2.45 pm; 3.30—4 pm
GRI	London	9.41	31.86	2.45—8.30 am; 5—7.45 pm
FGA	Dakar	9.41	31.88	3—4.15 am.
—	Moscow	9.39	31.95	9.30—11 pm; 1.30—3 am; 10 am—1 pm
COBC	Havana	9.37	32.00	11 pm—3.15 pm
OAX4J	Lima	9.34	32.12	9 am—4 pm; 11 pm—midnight 3—6 am
LRS ..	B'nos Aires	9.32	32.19	8 am—noon, 10—11 pm; 4—4.30 am
COCX	Havana	9.27	32.26	10.45 pm—3 pm
HC2ET	Guayaquil	9.19	32.64	10.30 pm—3.30 pm
CNIR1	Rabat	9.08	33.03	4—8.50 am; 4.30—4.50 pm; 9.30—11 pm
COBZ	Havana	9.03	33.23	10.45 pm—2 pm
—	Kuibyshev	8.99	33.37	5.50—6 am
AFHQ	Algiers	8.96 S	33.48	2—3.15 am; 6—9.15 am
KES-2	'Frisco	8.93	33.58	8.15 pm—3 am

Call Sign	Location	Mc.	M.	Time: Eastern Australian St'dard
—	Dakar	8.83	33.95	5.15—6.45 am; 5.30—5.50 pm; 10.15—11 pm.
COCQ	Havana	8.83	33.98	8.20 pm—2.15 pm
COCO	Havana	8.70	34.48	7.30 pm—3.30 pm
COJK	Camaguey	8.66	34.62	2.30—3.30 am; 6.30—9 am; 11—11.30 am;
WOO4	New York	8.66	34.64	10 am—4 pm; 4.15—7 pm
—	Kuibyshev	8.05	37.27	1—1.30 am; 2—4.15 am; 7.15—8.45 am
CNRI	Rabat	8.03 N	37.34	4—9.45 am; 3—6 pm
FXE	Beirut	8.02	37.41	11 pm—7 am
FIA6	Douala	8.00	37.50	4.45—5.45 am; 8.45—9.30 pm
PSL	R de Janeiro	7.93	37.81	Sundays 9—10 am
YSD	San Salvador	7.89	38.00	10 am—1.30 pm
SUX	Cairo	7.86	38.15	3.30—4.30 am; 5.15—7.45 am
WKRD	New York	7.82	38.36	7.15 am—2 pm; 2 pm—6.30 pm
WKRX	New York	7.82	38.36	7—10 pm
WRUL	Boston	7.80 N	38.44	4.15 pm
YNDG	Leon	7.66	39.16	9 am—1 pm
YNLAT	Granada	7.61	39.40	9.30 am—1.15 pm
WLWK	Cincinnati	7.57	39.6	5—6.30 pm
WDJ	New York	7.56	39.66	9.15 am—6 pm
KWY	'Frisco	7.56	39.66	6.45—9.05 pm; 10.30 pm—12.30 am
WKTS	New York	7.57 N	39.6	10 am—noon
—	Moscow	7.56	39.68	1—6.30 am; 8—9 am; 11.10—11.30 am
YN2FT	Granada	7.49	40.05	10 am—1 pm
GRJ	London	7.32	40.98	5—7 am; 2.15 pm—5.15 pm
—	Moscow	7.30	41.10	2—9.30 am; 10—11 am; 1—3.45 pm; 4.30—5 pm
ZOY	Accra	7.29	41.13	2.15—5.15 am
VUD-2	Delhi	7.29	41.15	8.30—11.25 pm
VLI-9	Sydney	7.28	41.21	10—10.45 pm
VUM-2	Madras	7.26	41.32	6—6.40 pm; 9.45—11.30 pm; 12.45—12.50 am. News 10 pm and 12.45 am
GSU	London	7.26	41.32	4.30—10.30 am; 1.45—6.30 pm; (Eng. 6.1'5—6.30 pm)
KGEI	'Frisco	7.25	41.38	1 pm—2.45 am.
VUB-2	Bombay	7.24	41.44	4.15—5.10 pm; 9.25—10.45 pm. News 5, 9.25 and 10 pm
VLQ	Brisbane	7.24	41.44	6—10 am.
KWID	'Frisco	7.23	41.49	8.30 pm—3.05 am
GSW	London	7.23	41.49	5.15—8.45 am; 1.45—4.45 pm
VLI-4	Sydney	7.22	41.55	Not in use
VUC-2	Calcutta	7.21	41.61	5—5.55 pm; 8.30—9.20 pm
VLQ-2	Brisbane	7.21 N	41.58	5.30—11.30 pm
—	Moscow	7.21	41.61	7.50—9.30 am
—	Madrid	7.20	41.63	6—9 am
YSY	San Salvador	7.20	41.65	10.30 am—2 pm
CM21	Havana	7.19	41.72	8 am—2 pm; midnight—3 am
GRK	London	7.18	41.75	
XGOY	Chungking		41.80	8 pm—3 am; 4.30—7 am
—	Moscow	7.17	41.80	5.20—6.30 am; 7.15—9.55 am; 10—10.30 pm; 1—4.30 am
GRT	London	7.15	41.96	9.15 am—2 pm; 3—4.45 pm
EAJ-9	Malaga	7.14	42.00	6—9.05 am
HC4FA	Porto Viejo	7.14	42.02	7 am—1 pm
—	Ovideo	7.13	42.05	5—7.30 am
GRM	London	7.12	42.13	10.45 am—2.45 pm; 3—6.30 pm
EA9AA	Melilla	7.09	42.31	Heard around 7 am
GRS	London	7.06	42.41	4—8.45 am; 11.45 am—2 pm
EAJ24	Cordoba	7.04	42.61	6.40—8 am
EAJ-3	Valencia	7.03	42.65	6—10 am
—	Ponto Delgada	7.02	42.74	5—6 am
EAJ47	Valladolid	7.00	42.82	6.30—7.15 am.
WGEA	Schenectady	7.00	42.86	10 am—2 pm
FO8,AA	Papeete	6.98	42.95	Wed. & Sat. 1.57—2.45 pm
—	Moscow	6.98	42.98	2 am—9.23 am; 10—10.30 am
YNOW	Managua	6.87	43.67	10 am—2.30 pm

Call Sign	Location	Mc.	M.	Time: Eastern Australian St'dard
HIH	San Pedro	6.77	44.28	10—11.30 am; Mon. 8.20—9.40 am
YNDS	Managua	6.76	44.28	3—6 am; 8 am—2.30 pm; 10 pm—midnight
—	Oran	6.73	44.56	6.30—7 am
ZLT-7	Wellington	6.71	44.68	8 pm in news session only.
TGWB	G'temala	6.54	45.87	9.30 am—3 pm

Latin-American and other stations seldom, or unlikely to be heard, have been omitted.

Call Sign	Location	Mc.	M.	Time: Eastern Australian St'dard
WKTM	New York	6.38	47.01	5.15—7 pm
SUP-2	Cairo	6.32	47.47	4—7 am
GRN	London	6.19	48.43	5.45—6.30 am; 9.30 am—2.45 pm; 5.20—5.35 pm; 2.15—2.30 am; 3.30—3.45 am
VUD-2	Delhi	6.19	48.47	9.30—10.15 pm; 11 pm—1.35 am; News 10 and 11.45 pm
XECC	Puebla	6.19	48.47	From 2—4 pm
WGEA	Schenectady	6.19	48.47	2.15—4.10 pm
LRM	Mendoza	6.18	48.51	8.30 am—1 pm
GRO	London	6.18	48.54	5—10.45 am; 2.40—7.45 pm
WCBX	New York	6.17	48.62	2.15—5 pm
FK8AA	Noumea	6.16	48.62	5.18—7 pm; News 6.18 pm
HER-3	Berne	6.16	48.66	4—7.45 am
HJCD	Bogota	6.16	48.70	Around 2 pm
Call Sign	**Location**	**Mc.**	**M.**	**Time: Eastern Australian St'dard**
CBRX	Vancouver	6.16	48.70	11.30 pm—4.30 pm
CS2WD	Lisbon	6.15	48.74	5.30—8 am
EQB	Teheran	6.15 S	48.74	2—6 am; News 2.45 and 5.15 am.
WBOS	Boston	6.14	48.86	6—8 pm
CXA4	Montevideo	6.12	48.98	Around 2 pm
. . . —	London	6.12 N	48.98	6 am—noon; 1.45—6.30 pm
HP5H	Panama City	6.12	48.99	9 am—2 pm
YV3RN	B'quisimeto	6.12	49.02	Around 1.30 pm
XGOY	Chunking	6.12	49.02	9.35 pm—2.30 am
XEUZ	Mexico	6.11	49.02	Around 2—3 pm
WKTS	New York	6.12	49.02	4—7 pm
GSL	London	6.11	49.10	9.30 am—4.45 pm; News 11—6 am; 12.45 and 2.30 pm
CBFW	Montreal	6.09	49.25	9.30 pm—1.30 pm
ZNS-2	Nasau	6.09	49.25	11—11.15 pm; 3.45—4.15 am
WLWO	Cincinnati	6.08	49.34	2.15—5 pm
GRR	London	6.08	49.34	1.45—6.30 pm. News 5.30 pm
CKFX	Vancouver	6.08	49.34	11.30 pm—4.30 pm
CFRX	Toronto	6.07	49.42	9 pm—3.30 pm
—	Moscow		49.42	6.30—7.30 pm
. . . —	London	6.07 N	49.42	3.45 am—noon; 1.45—5.45 pm
SBO	Stockholm	6.06	49.46	Try around 7.30 am
VQ7LO	Nairobi	6.06	49.50	2—5 am
WCDA	New York	6.06	49.50	9.30 am—4 pm
GSA	London	6.05	49.59	8.45—10.45 am; 1.45—6.30 pm News 5.30 pm
XETW	Tampico	6.04	49.66	10 pm—4 pm
WRUW	Boston	6.04	49.66	2.15—6 pm.
HP5B	Panama City	6.03	49.73	9 am—1 pm; 1.30 am—5 am
—	Moscow	6.03	49.73	9.40—10.19 pm
CJCX	Sydney (Nova Scotia)	6.01	49.92	9 pm—4.30 am; 8 am—1 pm
VUD-3	Delhi	6.01	49.92	10.25—11.35 pm
GRB	London	6.01	49.92	8.45—10.45 am; 1.45—6.30 pm
ZRH	Joh'burg	6.00	49.95	1—7 am
CFCX	Montreal	6.00	49.96	10 pm—1.15 pm
HP5	Colon	6.00	49.96	10 pm—4 am; 8 am—2 pm
ZOY	Accra	6.00	49.96	8.30—9.15 pm; 2.15—5.15 am. News 5 am.
XEBT	Mexico City	6.00	50.00	1 am—3.30 pm
WKRD	New York	5.98	50.12	5 to 7 pm
VONH	St. John's	5.97	50.25	10.30 pm—4.30 am; 7—11.35 am; News 7.30 am
HVJ	Vatican City	5.96	50.26	4.30—6.30 am
—	Khabarovsk	5.93	50.54	8 pm—midnight
—	Moscow	5.89	50.90	8 pm—6 am

A HANDY HINT

It frequently happens when building or making adjustments to a set that a small nut or terminal drops on to the baseboard in such a position that it is not easily recovered with the fingers. A pair of nail scissors of the thin blade type have been found most useful for this purpose, especially those with curved blades. They are also useful for holding a nut in position while screwing it on to a terminal in an awkward place.

—Radiogram (N.Z.).

VARIATION OF POWER WITH LOAD

In the July issue, we showed how the power output and distortion of triode and pentode valves varied with load impedance. To supplement that article and to give amateur designers working data, we are publishing extra valve data from time to time.

This month we show the effect of load on a 6L6G valve working in ordinary class A operation with "250 volt" ratings. In the graphs, it is assumed that the signal voltage is sufficient to produce zero grid voltage on the positive peaks, i.e., the signal voltage is $1/\sqrt{2}$ of the grid bias or 10 volts R.M.S.

In practice the variation of power with load is quite important, as speaker impedances are not constant over the entire frequency range. In the chart it will be noticed that the anode voltage is specified as being slightly lower than the screen voltage. This is to allow for the voltage drop due to the resistance of the speaker transformer winding and is quite normal.

SPEEDY QUERY SERVICE

Conducted under the personal supervision of A. G. HULL

Q.—What Is an electron? Is it something real or just a theory?

A.—An electron is a minute particle having a negative electric charge and only a very minute mass (weight). Electrons are thrown out somewhat as a gas by red hot bodies. Their electric charge has been accurately measured by several different methods. They have also been weighed. It is possible to measure the velocity with which electrons move in a cathode-ray tube. (A cathode ray is a stream of electrons moving at high speed.) No one has ever seen an electron — it's smaller than the wavelength of light, but it's been weighed and measured. The path of an electron can be tracked through a fog of water particles. The anode current of a radio valve is, while it is inside the valve, just a flow of electrons. An electric current in a wire is a flow of electrons through the copper particles in the wire.

●

Q.—Where can I find the valve base connections for an ML4 valve and what is its equivalent.

A.—We are publishing two alternative socket connections which have been used for the ML4. The connection using the central cathode pin is the "English Bose." The ML4, made by the Marconi Osram valve people, is a 4 volt 1 amp indirectly heated small power valve. Equivalents in the Philips and Mullard ranges are E409 and the 104V. The maximum power output and maxmum safe anode voltage depend on the year when the valve was made. Early valves had a maximum anode voltage of 180; later it was raised to 200 and finally, we believe, to 250.

SUPER SPACE LICKER

(Continued from page 19)

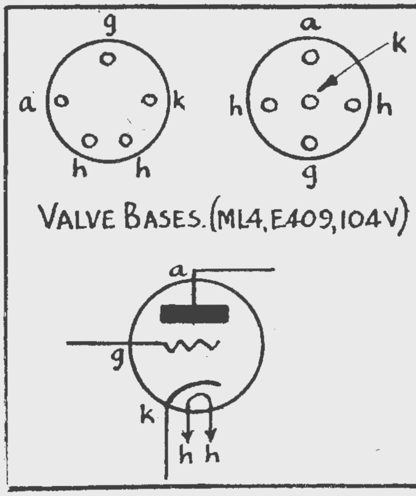
B+³ 90 volts or higher, B+4 135 volts.

It will be necessary to use a double pole on/off switch to prevent leakage of B+¹'s voltage through potentiometer to earth.

Operation

It is essential for good results on short-wave that a good aerial and earth system be used with a fairly tight lead-in. The aerial should not be loose and flapping. After switching on and adjusting the coils, the positions that the arrow knobs on the aerial trimmer and potentiometer points to should be marked 1, 2 and 3 so that these controls may be returned instantly to the point of max. operation for each coil when changing bands.

—N.Z. Radiogram.



VALVE BASES.(ML4,E409,104V)

Q.—The Wonder One battery set (see Australasian Radio World, March 1940) has been built up and works well, except that stations "run together." What is the cure?

A.—The "Wonder One", a set giving loud-speaker results with only one tube, has only one tuned circuit. Consequently if the set is used very close to a powerful broadcast station there will be an overlapping of stations. This can be reduced in a number of ways, the simplest being to shorten the aerial or put a small condenser (say .00005 mfd.) in series in the lead-in. A quick way is to cut the lead-in wire about 10 feet from the set and join it up without removing the insulation). If only one station is interfering then a tuned wave-trap can be fitted in the aerial lead. This wave-trap consists of a coil shunted by an adjustable condenser, and is tuned to the interfering station. Another and better solution is to have a preselector tuning circuit connected between the aerial and your tuning coil. This preselector circuit is only for broadcast-band use and requires tuning at the same time the set is tuned. Preselection was very popular with T.R.F. designers just before the superhet made its revival.

●

Q.—How can you calculate the gauge of wire to carry a certain current?

A.—It sounds as if you are joining the ranks of those who are trying to wind their own chokes and power transformers. There's a table of gauges and current capabilities in this issue. If enough people are interested we'll give a complete set of tables for transformer design.

●

Q.—How can the amount of second harmonics in a speaker be measured.

A.—If a pure sine wave signal is being supplied to the audio amplifier, the amount of even harmonic (which is mainly second) is found by reading the **peak** A.C. voltage in each direction across the speaker with a suitable diode voltmeter. The fraction of even harmonic is equal to the difference between the readings divided by the sum. Multiply by 100 to get the percentage.

●

C.C. (Caulfield) favours the 50 type triode and cannot understand why they are not more popular for amplifier work.

A.—The 50 is an excellent triode and is and always has been a most popular valve for amplifier work. It was really the first decent output valve ever introduced for radio work, somewhere about 1927 or so, when the average set had a power output ability of about 50 milliwatts. The 45 was introduced shortly afterwards and proved more popular for commercial sets, purely on account of its lower price, and the lower cost of the necessary power supply, filter condensers, etc.

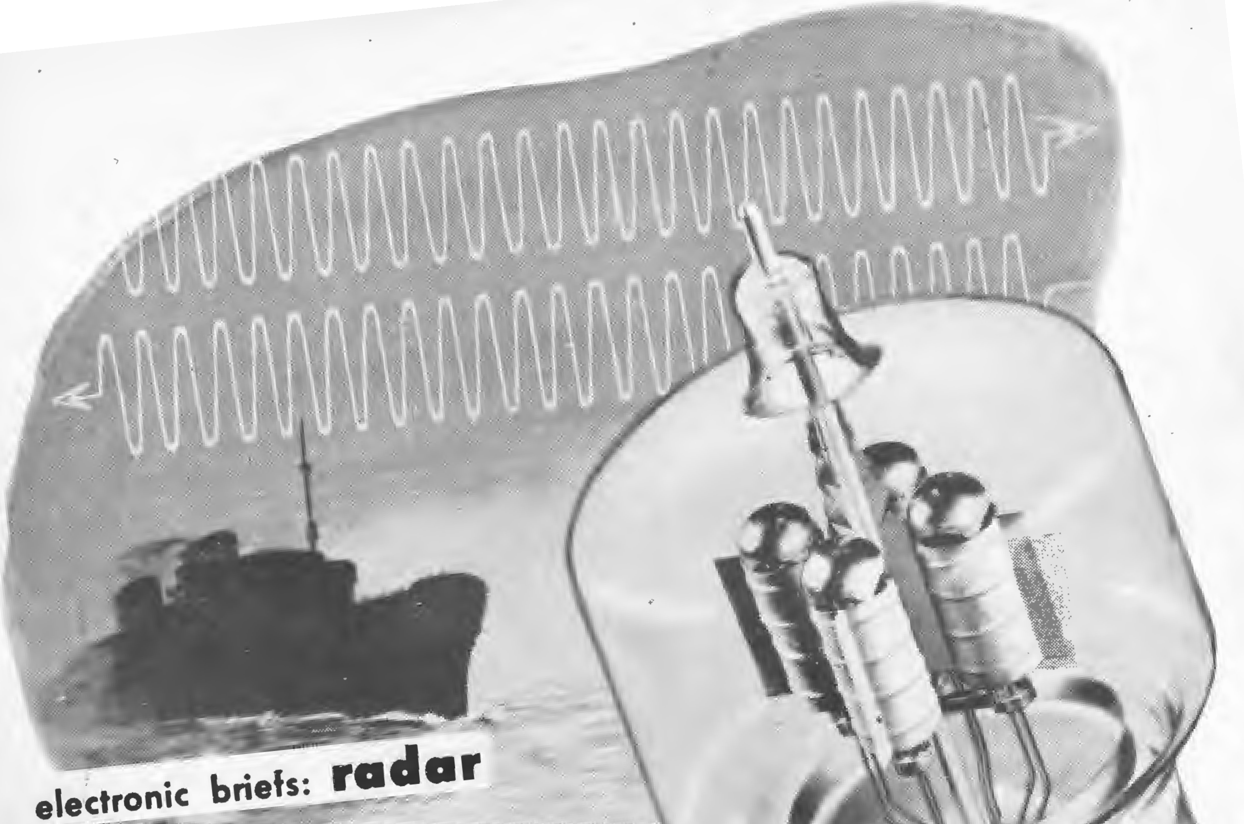
Today the big drawback to considering the 50 is this same problem of high voltage. Standard power transformers seldom go beyond 385 volts, and even these are hard to get. Filter condensers of the electrolytic type are not suitable for high voltages than this either, making series-parallel banks necessary.

COPPER WIRE TABLE.

GAUGE. (S.W.G)	Ohms per Yard.	Max. Current at 2000a/□"	Turns per inch. (Enamelled)
20	·024	2 amp.	26
22	·039	1¼ amp.	33
24	·063	¾ amp.	42
26	·094	½ amp.	51
28	·139	345 ma.	62
30	·199	241 ma.	75
32	·262	183 ma.	85
34	·361	133 ma.	100
36	·529	91 ma.	120
38	·849	57 ma.	151
40	1·327	36 ma.	189

To get the best from the 50 it is desirable to exceed the maker's ratings a bit, usually running with a h.t. supply of 600 volts, split up between plate voltage and bias.

Low resistance is desirable in the grid circuit, together with big signal input. This tends to make resistance coupling difficult, although it can be done. One of our outstanding amplifier designs of 1933 used a pair of 50 output valves with resistance-coupling and a phase-splitter. In practice the 50 sound better than could be expected from theoretical considerations, but we have never seen this fully explained. Other triodes never seem to quite equal a good pair of 50's.



LOOK WHAT A.R.C. HAS DONE FOR THESE MEN

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H.B., Western Australia.

I am writing to let you know that I, who took your service engineering course, am now in camp with the 1st Corps, HQ Sigs of the 2nd A.I.F. I am in as a radio maintenance man and instrument (radio) mechanic. Because of the training I received from you, I am able to take my place as engineer in a wireless station or mobile van radio station. Because of the training I have had I am able to pass tests set by the instructors where many fail, and it will probably mean two or three stripes for me as N.C.O. in charge of full transmitting equipment.

C.T.S., Melbourne.

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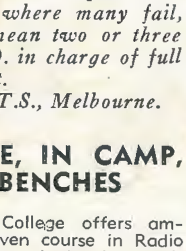

To L. B. GRAHAM,
Principal of Australian Radio College.

Dear Sir—

Please send me, without obligation on my part, the free book, "Careers in Radio and Television."

NAME ....

ADDRESS ....

................A.R.W.

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