THE AUSTRALASIAN

# Radio World

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MAY 15 ...... 1945

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## TO THE "N"th DEGREE

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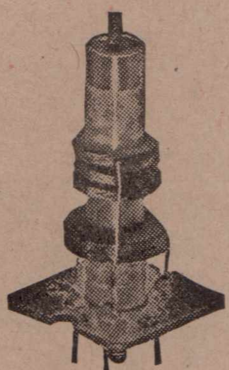

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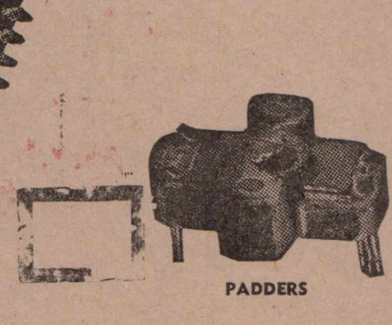

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**Vol. 9 MAY, 1945 No. 12**


## CONTENTS



## EDITORIAL

Now that censorship is being relaxed it is possible to tell some of the facts about the part which radio played in winning the war in Europe.

It is now freely admitted that the British supremacy in radiolocation was of tremendous help. In the Battle of Britain we were using radiolocation so effectively that every time a German bomber arrived over England there was a team of Spitfires and Hurricanes waiting for it and a few thousand feet above it. The Germans gained the impression that England had unlimited numbers of fighter aircraft, whereas it was the work of the British radio engineers which told the R.A.F. just where and when to expect the German bombers.

It has also been revealed that the Navy pays due tribute to radiolocation. It has been stated in English papers that the success of the Allied naval gunnery was due to the use of radar aiming and distance finding.

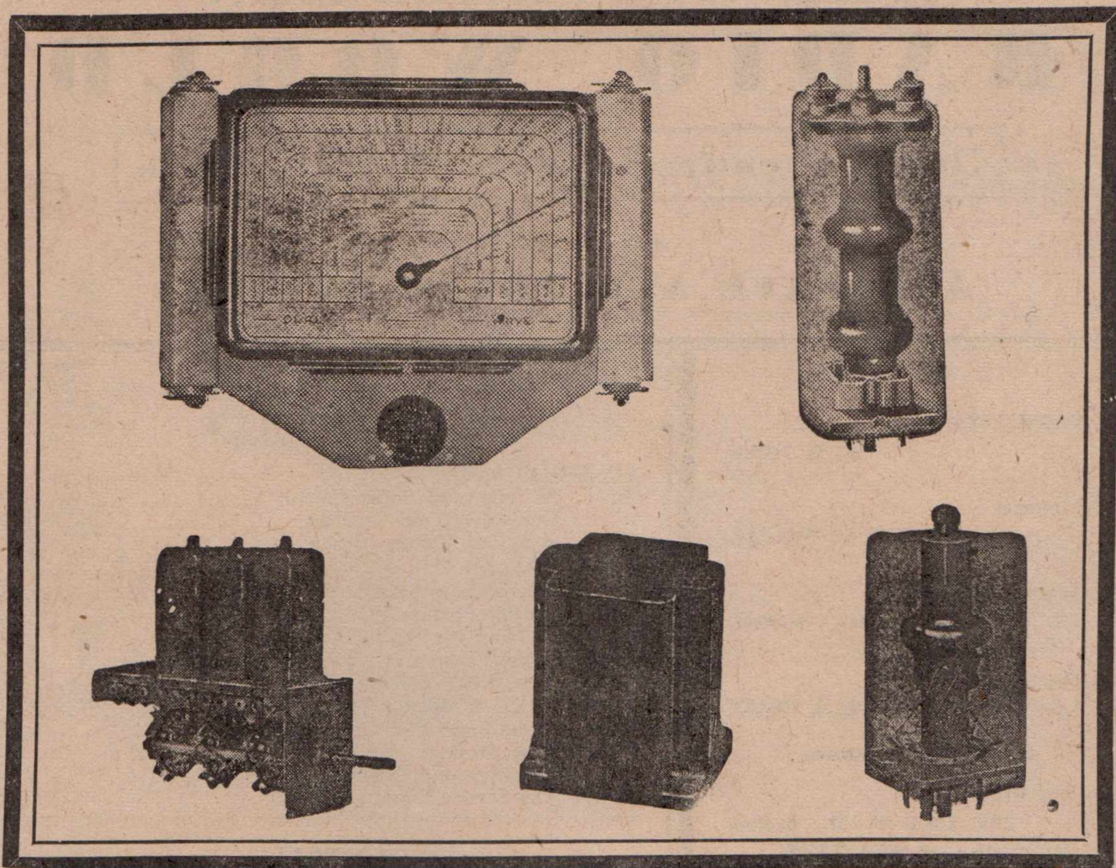
The scientific application of radio knowledge is given full credit for victory in the Battle of Matapan.

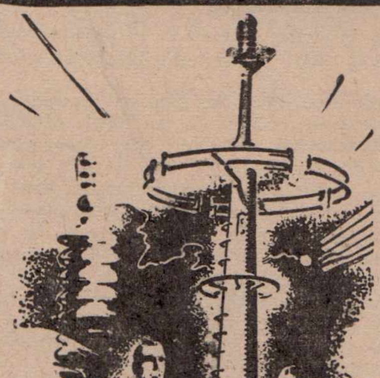
Directly and indirectly the radio enthusiast and the keen amateur transmitter have been responsible for the Allied supremacy in radar and communications. It is therefore only right and logical to expect the authorities to give every possible encouragement for the further development of radio as a scientific hobby.

So far there is every indication that this is so, but it is the duty of everyone interested to get behind the Wireless Institute of Australia, as the recognised mouthpiece of amateur radio, and make sure that the subject is kept clearly before the minds of those officials who have been appointed to control the ether.

—A. G. HULL.

# LOOKING BACK . . .





# . . . Yet Planning Ahead

In less than twenty years radio has grown from a schoolboy's hobby to a giant, world-wide industry . . . with ramifications that extend into every branch of radio-physics and every phase of our daily lives. And nowhere has this development been more marked than in the newly-discovered field of electronics . . . the door that opened the way to the miracle of radar . . . the endless possibilities of FM . . . and made radio-vision an accomplished fact.

Throughout this entire period R.C.S. Radio Pty. Ltd. has kept pace with world progress, so that, although the entire resources of the Company are today devoted to the output of urgently-needed defence equipment, the coming peace will find them ready to supply both the amateur set constructor and the trade manufacturer with the exact type of precision-built components required to build the circuits of the future. And, thanks to experience gained during the war years . . . improved manufacturing processes and facilities . . . and new type of plastic insulating materials . . . the quality of R.C.S. products will be higher than ever.

R.C.S

**R.C.S. RADIO PTY. LTD., SYDNEY, N.S.W.**

# TOLERANCE IN SET DESIGN

A DIFFERENCE between the old timer and the novice in the radio game is shown by the appreciation of tolerances. It is a big step forward when you know when a half-meg resistor has to be an actual 500,000 ohms, and when it can be anything between 100,000 ohms and 2 megohms without appreciably affecting results. We notice so often that a newcomer to radio theory will apply his knowledge working out the plate current of the valves in his battery set, then working out the correct bias voltages and being staggered to find that the bias resistor used is 400 ohms, whereas by calculation it should be 389 ohms! He even overlooks the fact that an ordinary resistor with a brand of 400 ohms is likely to be anything between 350 and 450 ohms.

### Specifications

It has always been a point of wonder to some people that specifications covering condensers usually allow a tolerance of 20 per cent at least, so that a .1 mfd. condenser can be anything between .08 mfd. and 50 per cent greater capacity than that figure. To the engineer who is used to working out tolerances of plus or minus five-thous. of an inch the radio business is very sloppy. But why make things difficult? If it is possible to design circuits which will eliminate critical component values why not do so? That is probably the answer and it will be seen that the circuits which have enjoyed popularity over the years have always been those where some sort of compensation comes into the picture, thereby eliminating the need for critical tolerances.

### Unsound Design

It has always been considered the best policy to avoid circuit designs which call for exact values, and one which has been followed as far as possible by "Radio World." It is possible to design circuits with critical values, in fact often hard to dodge that point, but it always spells trouble in the long run if the tolerances on components have to be finer than about 20 per cent.

### Some Examples

Let us take a typical stage of amplification and consider the components individually. First of all we have the valve itself, and you will find that the plate current for a given bias voltage is clearly stated on the valve charts, but not nearly so clearly defined in practice. To-day the valve manufacturers are pretty good at keeping the valve characteristics within bounds, but a few years ago one of the American valve charts carried the inscription "Plate current should be within 50 per cent of the figure shown."

### The Grid-Leak

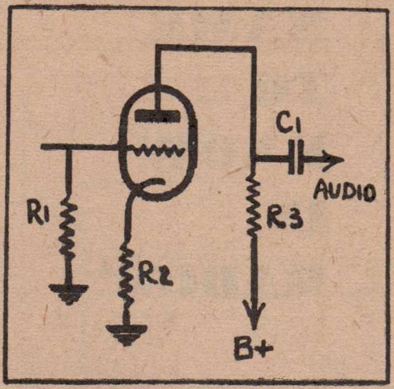
The main purpose of the resistor R1, the grid-leak as we used to call it in the good old days, is to tie the grid to earth so that in its static condition the grid is at earth potential. Since normally no grid current should flow through this resistor there is no voltage drop across it and the value can be anything from 100,000 ohms to 2 megohms without seriously affecting operation. According to the preceding coupling condenser and plate load values so the value of the grid leak will affect the reproduction a shade, the lower values cutting the bass response a bit and the overall gain a trifle. For highest gain and best low note response the highest values should be used, the limit being the allowable d.c. resistance in the grid circuit as specified by the valve makers. With ordinary amplifier valves a couple of megohms is the high limit, but certain amplifier types, especially such as the 50 type power triode, need much lower values and from 100,000 ohms to 500,000 ohms should be used. The low note response can be maintained with low grid leak values by having higher capacity for the coupling condenser and keeping the plate load resistor on the low side, not greater than half the grid leak value at maximum.

From the above remarks it will be evident that the grid leak value seldom needs to have a tolerance finer than plus or minus 50%.

### The Bias Resistor.

Automatic bias has achieved almost universal favour, and very rightly so. It is fully self-compensating and allows wide tolerance.

Fundamentally the scheme is simple enough—we want to have




the grid maintained at a negative voltage in respect to the cathode. So we go about it slightly differently and keep the cathode at a positive potential in respect to the grid, which is actually the same thing in the long run. Keeping the cathode at a positive potential to the grid is carried out by having the grid at earth potential by the use of the grid leak just dealt with, and then putting in the cathode bias resistor, R2, through which the plate current of the valve flows, also the screen current if the valve is a screen grid type. This current through the resistor gives a suitable voltage drop.

### Self-balance

Now to explain the self-balancing feature—if the grid bias tends to be insufficient, then the plate current tends to be greater than normal. This will give a greater voltage drop and a higher bias, tending to cut back the plate current. Similarly, if the bias resistor is of a higher value than normal there will be a tendency to too much bias, but this will cut down the plate current, thereby lower the voltage drop in the resistor and try to bring conditions back to normal. Anyone keen enough on mathematics can calculate the practical effects of off-value bias resistors, but in practice this is again a point where a tolerance of plus or minus about 50% is near enough in practice.

### The Plate Load.

The plate load resistor, R3, carries the plate current from high tension to the valve, the static cur-

**(Continued on next page)**

## TOLERANCES

(Continued)

rent being considerably lower than given by the normal valve chart, thereby often tricking the novice. The valve chart may give the plate current as 5 milliamps for a high tension voltage of 250 on the plate. So when the student sees a circuit with a 250,000 ohm plate load he tries to work out how much drop there will be across the quarter-meg resistor. If he works out the figure by Ohm's Law he thinks he has stumbled across an impossibility. If he tries to measure the actual plate voltage with a voltmeter of comparatively low internal resistance he will be still further mystified, for current will flow through the meter, being drawn through the load resistor and make things seem even crazier than before. The explanation lies in the effective plate voltage being much lower than the 250 volts mentioned in the valve chart. In practice it may be around half that voltage, and can only be measured with a high-resistance meter such as a vacuum-tube voltmeter, or calculated by measuring the plate current with a milliammeter and working out the drop in the load resistor by Ohm's Law. Not that it matters really what the actual plate voltage is in practice, the soundest plan being to consult one of the resistance-coupled amplifier data charts and adhere to the recommendations.

To return to the subject of tolerance, with the plate load resistor we find the same balancing feature as with the bias resistor. The actual plate current is influenced by the actual plate voltage, so that if the value of the load resistor is lower than normal, the tendency will be for the drop to be less, and the actual plate voltage higher. But if the plate voltage is higher the plate current is greater and the voltage drop greater, so that we are back to where we start, like the dog that chases its own tail.

### The Coupling Condenser.

The value of the coupling condenser, other factors being the same, will affect the reproduction. The other factors being mainly the plate load resistor and the grid leak of the following valve. If the capacity is insufficient the low notes may be attenuated. But the matter is not critical. With a quarter megohm plate load and a half-megohm grid leak, as is, more or less, standard practice in commercial receivers, the value of the capacity can be anything between .01 and .5 mfds., and even satisfactory tone can be obtained with mantel models if the capacity is only .005 mfd. Worked out in terms of a tolerance percentage these figures would support the contention that the capacity value is not critical.

### The Exceptions.

As with most rules there are exceptions, and so we find that there are cases where critical tolerances are necessary. A wise radio designer does his best to avoid them.

The shunt resistors for multimeters are critical, of course, if the meter readings are to be accurate. We could write still another chapter on why meters need NOT be accurate, but it would probably be a waste of space as most radiomen take a pride in having as much accuracy as possible in their meters and test equipment.

A caution sign is the use of any pairing of resistors, as in audio oscillators and some types of push-pull. The actual resistance values may not be critical, but there is usually a definite need for matching. In other words, it doesn't do to match up two 1-megohm resistors if one is plus 20% and the other is minus 20%. It may be highly desirable to have them both the same value, whether at, above or below their rated resistance.

Voltage divider networks should also be watched with care, especially with phase-changers of the paraphase type. We noticed a recent phase-changer circuit in which the signal for the out-of-phase valve is picked off from the junction of two resistors, one having a value of 1 megohm and the other 1.1 megohms. Needless to add, the tolerance would have to be watched carefully, as otherwise the 1.1 megohm resistor might have an actual resistance considerably less than that of the 1 megohm, thereby upsetting the balance completely.

Such cases are to be watched carefully and only a thorough knowledge of radio theory and its practical application can give the radioman a clear guidance in the doubtful cases.

# AN IMPROVED REFLEX CIRCUIT

## USING CATHODE-FOLLOWER PRINCIPLES

IN the search for a good ¾ Superhet. design, several methods are being used in order to obtain the necessary audio lift. High-gain output pentodes with no first audio stage—using the triode of a 6F7 or similar combination tube as first audio—and using a reflex circuit in which the same pentode section of a diode-pentode acts as I.F. amplifier and audio amplifier, seem to be most used.

Of these the reflex circuit similar to that shown in Fig. 1 has been the most commonly used; it is the "hottest" method of those mentioned insofar as it uses a pentode as amplifier at both audio and intermediate frequencies. However, it has several drawbacks, the more important being:—


By
G. McLEOD
15 Knight Street,
Arncliffe, N.S.W.


- (a) The audio loads in the grid and plate circuits must be by-passed for I.F. This leads to a compromise. I.F. efficiency and stability against audio high note response;
- (b) The audio plate load reduces the plate voltage to such an extent that the voltage handling capabilities of the tube are seriously impaired at a time when the tube is needed to handle both audio and I.F. signals;
- (c) Because of the low plate voltage, the amplifier section of the tube easily becomes overloaded, passing its output directly to the audio tube. This makes the normal diode load volume control inoperative at low settings and causes the effective selectivity of the receiver to be severely reduced on strong signals.

In an effort to overcome these drawbacks, the circuit in Fig. 2 has been developed. The amplifier section of the tube is used as a normal I.F. amplifier, not as a cathode follower for audio. The audio is fed from the cathode circuit through a high ratio transformer to the output tube; this is made quite practicable by the fact that the output impedance of a cathode follower can be considered to be the reciprocal of the tube's mutual conductance. A tube such as the EBF2 would have an internal impedance of $\frac{10^6}{1800} = 555$ ohms across the primary winding of the transformer.

Because of this low impedance the plate circuit bypass, C5, across the cathode impedance now can be made quite large without danger of high note cutting; .002 mfd. is a good value in practice.

The diode load bypass C2 and grid bypass C1, are taken direct to the cathode. They are both 100 mmfd., and in normal circuits act effectively in parallel across the parallel resistors R1 + R2 and R5.

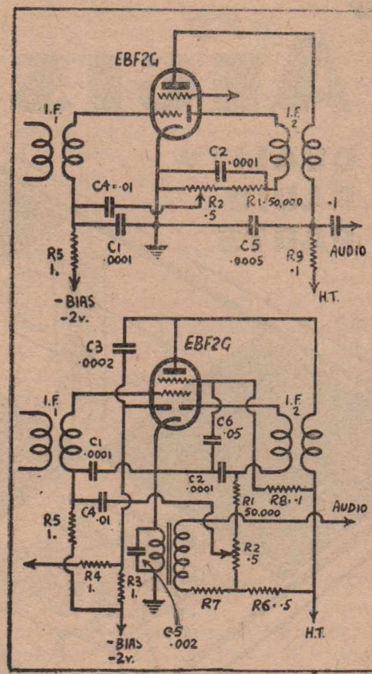
### Retaining Fidelity

While their effect on high audio frequencies would not normally be serious with these values it is sometimes found that higher values which would affect audio response are necessary to obtain stability. This would particularly apply if an I.F. much lower than 465 K.C. were used. However, in a cathode follower, capacities effectively between grid and cathode are reduced in their effect across the input impedance to a negligible value.

The D.C. resistance of the low impedance transformer primary is so low that the loss in H.T. voltage is under one volt. It is, incidentally, imperative that this D.C. resistance be kept low, because the voltage drop across the primary puts a negative bias on the diode unless a voltage divides circuit (R6, R7) is used.

### The Transformer

The D.C. resistance of the primary winding of the transformer we use is a 180 ohms. The transformer, however, is not one wound especially for this use, but is a high grade interstage transformer




as used some years ago, except that now the three primary pi's are connected in parallel instead of in series. While this has increased the turns ratio to at least 10 : 1, it should be able to reduce the primary inductance still further and so increase the gain of the transformer without losing lower note response. In midget receivers, where bass response cannot be reproduced anyway, this ratio could be further increased.

### Making Your Own

For those who are interested in rewinding the primary of an audio transformer, 900 turns on the half inch square core of a Philips' gave a measured inductance of two henries, sufficient for average quality in this circuit.

An audio gain of 10 or so is realisable with high fidelity and higher gain with little loss in that respect. For response this is better than circuits using the triode portion of a converter as first audio, and at least equals 4/5 circuits using

(Continued on next page)

## REFLEX CIRCUIT
(Continued)

a medium mu diode-triode as R.C. first audio.

It has the advantage over normal transformer coupled circuits that the same primary current has to flow through a smaller number of turns of larger wire, lessening both the flux density of the core and the tendency to burn out.

The tube is working with optimum voltages for I.F. amplification and because of this there is no distortion caused by overloading due to both audio and I.F. voltages being handled at once, particularly because, compared to former reflex circuits, the added audio voltage in the plate circuit is reduced in indirect proportion to the transformer ratio for the same output. For an audio voltage of 20 across the secondary of the transformer and a turns ratio of 10, the audio voltage in the plate circuit of the amplifier is 2 with the D.C. plate voltage 250. With the previous circuits the added audio voltage would be 20 and the plate voltage figures show an improvement of 25 times in this one regard. This would make the circuit suitable for driving a cathode-follower output tube.

In a practical receiver, we use a 6J8G converter, an EBF2GT as described, and two EL3HG's in floating paraphase.

* * *

## "X-RAY" BOMBSIGHT

According to a recent announcement one of the war's most closely guarded secrets, details of which have lately been released, is the "X-ray" bombsight, which has been developed with the aid of radar. All Allied bombers and fighters are now fitted with this invention which enables airmen flying in dense cloud or fog to "see" their targets. The pilot simply switches on his set, and a continuous wave is transmitted from the plane to the ground. The wave hits the ground and rebounds, while in the cockpit of the plane there appears on a small screen an image of the target. The picture is not as clear as a television picture, but the outlines are present in sufficient detail to permit of accurate bombing.

# ONE-VALVE TEST OSCILLATOR

SOME time ago it was decided to see if a cheap and compact signal generator could be produced using only one valve, and using easily obtainable parts. Naturally, it was not possible to produce anything like a sub-standard instrument, but the final result is a useful piece of equipment for many purposes. RF and IF frequencies from 15 Mc/s down to 250 kc/s are available modulated or

**By K. W. MITCHELL, BSc.**

unmodulated, and an audio frequency may also be obtained.

### Circuit.

The valve used is a 6A8G heptode frequency changer. This valve has a negative mutual conductance between the signal grid and the oscillator anode. A transitron RF circuit was therefore chosen using these electrodes. This allows the use of untapped coils, and simplifies range switching.

Three ranges of frequency were chosen as follows:—

Range 1.—250 kc/s to 750 kc/s.
Range 2.—700 kc/s to 2,000 kc/s.
Range 3.—5 Mc/s to 15 Mc/s.

These ranges cover most requirements, and the use of harmonics allows continuous coverage up to more than 30 Mc/s. If desired, a lower frequency range than Range 1 could be added, using a long-wave tuning coil. Coils suitable for the ranges given may be made as follows:—

Range 1.—800 uH, 200 turns of 34 SWG enam. wire close wound on a 1½in. former.

Range 2.—100 uH, 100 turns of 34 SWG enam. wire, close wound on a ¾in. former.

Range 3.—2uH, 15 turns of 22 SWG enam. wire wound on a ¾in. former spaced to occupy 1in. length.

Range switching requires a single-pole 3-way switch, and tuning is by a 0.0005 uF variable condenser.

### Output Transformer

A low output impedance was chosen to simplify the construction of the attenuator, and an RF transformer is used in the anode circuit of the valve. A screened all-wave RF choke was obtained, and one of its winding sections isolated and used as the secondary winding of a transformer. The remainder of the choke then becomes the primary winding, and a step-down ratio of about 10 or 15 to 1 is obtained. The section used as the secondary should be at the HT end of the choke to avoid capacity coupling to the anode lead.

### Attenuator.

The attenuator may be quite simple, and may be assembled as shown in the diagram. Eaeh section is screened from the next, and screened leads are used to connect the tapping points to the coarse attenuator switch. This switch should be of the low-capacity type if possible, or the minimum output obtainable may be rather large, especially at the higher frequencies. Composition carbon resistances are very suitable for the attenuator network. A blocking condenser is included in the output lead in case the signal is accidentally applied to a point of high voltage. This condenser should be completely screened, and to ensure freedom from stray pick-up, the whole instrument should be in an earthed metal box, with RF filters in the power supply leads.

### Audio-Frequency Oscillator.

The AF side of the generator uses a back-coupled circuit connected between the screen and the oscillator grid. An old intervalve transformer is very suitable for this, and the pitch of the note obtained may be adjusted by connecting a suitable condenser across one of the windings. This condenser should not be too large or the circuit will fail to oscillate. Modulation is switched on and off by a shorting switch across the HT side of the

(Continued on page 11)

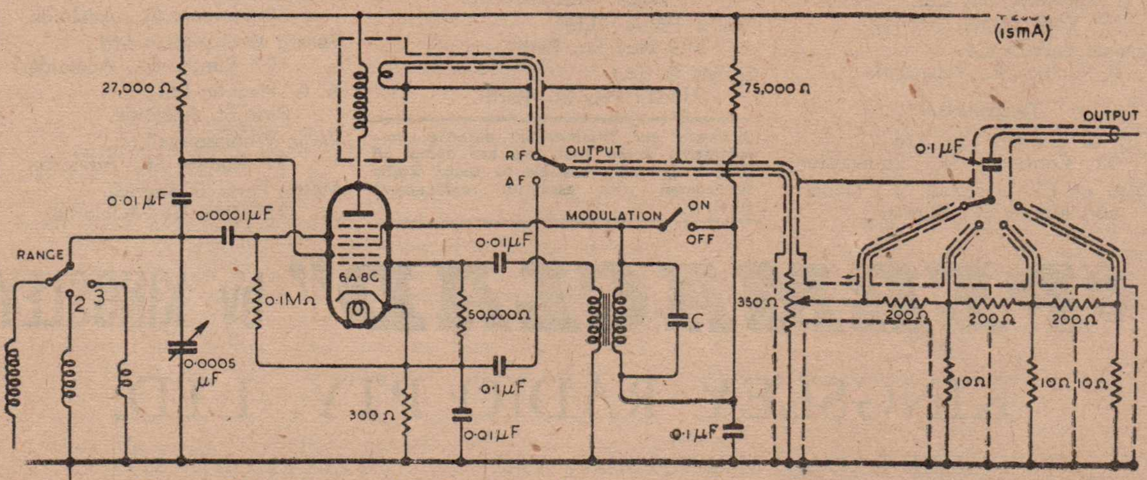



Fig. 1. Circuit diagram of single-valve modulated test oscillator. The value of condenser C should be chosen to give a convenient AF note with the transformer used.

## TEST OSCILLATOR

**(Continued)**

transformer. Screen voltage should be kept down to a value about half that of the oscillator anode, or it may be found that the RF oscillator only oscillates when the modulation is switched on. Depth of modulation tends to be excessive with this circuit, but may be adjusted to some extent by adding a damping resistance to the AF transformer. For most purposes, however, the degree of modulation is not very important. An audio frequency output may be taken from the cathode circuit, a small resistance being included for this purpose. The cathode by-pass condenser serves to remove RF from the audio output.

### Calibration.

Before attempting to calibrate the ranges fully, make sure that the output frequencies are approximately correct by checking one or two points. An all-wave receiver which is known to be fairly accurately scaled is the easiest standard to check against, and may also be used for the final calibration.

Range1.:

Direct calibration may be used for the portions 250-350 kc/s (1,200-860 m.) and 550-750 kc/s (545-400 m.), since most sets will receive these frequencies. The gap may be bridged by picking up the second harmonic of the generator output. The frequencies 350-550 kc/s will have their second harmonics from 700-1,100 kc/s (429-273 m.).

Range 2:

From 700-1,500 kc/s (429-200 m.) may be calibrated directly against the medium-wave band. The remainder must be done on the short-wave band using harmonics of the generator output, as follows: Tune in a harmonic of 1,500 kc/s, the fourth at 6 Mc/s (50 m.) will do well. Alter the receiver tuning slowly towards the higher frequencies and change the generator tuning at the same time so that the receiver and generator "keep in step." When the receiver tuning is 6.4 Mc/s (46.9 m.), the generator output will be 1.6 Mc/s. Continue moving the receiver and generator together until the receiver is 6.8 Mc/s (44.1 m.). The generator fundamental frequency will now be 1.7 Mc/s. In this way the remainder of the range may be calibrated.

Range 3:

This range may be calibrated directly against the short-wave range, except for a small portion near 5 Mc/s (60 m.), which can be done by using its second harmonic (10 Mc/s, 30 m.).

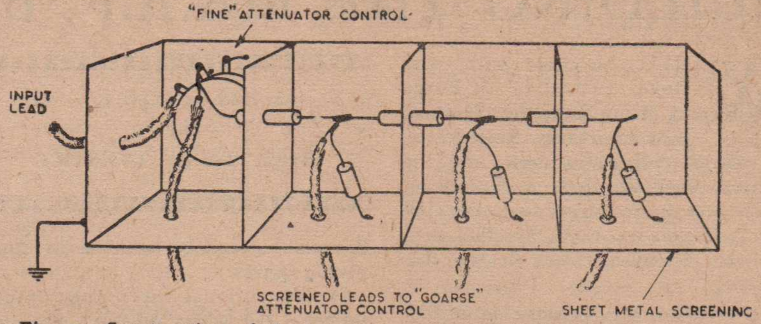



**Fig. 2. Construction of the attenuator. An "L"-shaped cover should be made to enclose the two open sides of the screening assembly.**

### Notes.

Before winding the coil for Range 1, see if there is an old coil from a 465 kc/s IF transformer about. It would quite likely do.

It has not been possible to try valves other than that specified, but it seems likely that any type of heptode frequency changer having a similar internal construction could be used.

—"Wireless World," England.

# A HIGH-FIDELITY HINT

If a sudden, brief impulse is applied to the grids of a pair of 6L6's whose plates drive a loud speaker, the voltage on the voice coil of the speaker will not be a similar impulse. It will be a damped wave which may pass through half a dozen cycles before it dies out. This gives the same effect to the ear as holding down the sounding pedal of a piano, and generally slurs over musical passages. Reproduction is "muddy."

It can be minimised by damping the speaker by means of a shunt resistor across the voice coil. Of course, if an actual resistor is wired across the terminals, it will waste too much power to be tolerated, but fortunately, the plate resistance of the tube can be used for this purpose. The 6L6's mentioned above, being pentodes, have very high plate resistance and, consequently, little damping. Degeneration has the effect of reducing plate resistance, and this is very effective in damping the speaker. In fact, this is the greatest virtue of degeneration in our experience. In using degeneration, bear in mind that only voltage controlled feed back reduces plate resistance. Current-controlled feed back, such as from an unbiased cathode resistor, **increases** plate resistance.

For the best possible reproduction, we feel that the old-fashioned push-pull Class A triode output stage has no superior. It has low plate resistance and low distortion. It can be driven from a high impedance stage and does not require good regulation in the power supply. It has the disadvantage of relatively small power output, which has caused it to fall in disfavour.

Triodes have low plate resistance, which provides the damping for the speaker. However, there is a great difference between tube types, and a type should be selected which has a low plate resistance compared to its load resistance. The output transformer which steps up the voice coil impedance to match the tube

**(Continued on page 26)**

# BUILDING THE R.A.A.F. BROADCASTER

As told in "Q.S.T."
by
Ralph Turner (VK5TR)

WHILE serving with the Royal Australian Air Force at Milne Bay, New Guinea, S./Ldr. Harry Shirley, an ex-commercial radio man, and the writer decided that a broadcast station was required to serve the many receivers used by the men of the Allied Services in the district.

Owing to the extreme humidity, normal commercial receivers were almost useless, since a few weeks' operation in this area decreased their sensitivity to well below a workable value. Some idea of the conditions may be gathered from the following example: A five-tube vibrator-type receiver was tested and found to have a sensitivity of 12 microvolts for normal output. This set was then allowed to operate under normal conditions for seven days. At the end of this time the receiver was again tested, and it was found that the sensitivity had dropped to 20 microvolts. This set was a typical commercial receiver, not created for tropical conditions, and was an example of the type made available to service men.

Only a good solid signal of local origin seemed likely to provide radio entertainment, so it was decided to produce a transmitter. Overtures to various sources of supply failed to produce anything in the form of a suitable transmitter, and we decided that the only thing to do was to build one ourselves. Plenty of bits and pieces for a c.w. transmitter were available, but the necessary gear for 'phone operation appeared extremely difficult to obtain.

### Transmitter.

The whole job was built along ham lines and the U.S. Signal Corps, U.S. Navy and the Australian Army Signals materially assisted in supplying parts.

A conventional three-stage transmitter (250 watts output) was decided on, and of the tubes available, the following were selected: 6V6 e.c. oscillator, 807 buffer and a pair of 813s push-pull final amplifier. A pair of 805s were used in Class-B modulation.

Having decided on plate modulation, it was necessary to produce the required transformers. One of the transformer cores was obtained from a half-kw. power transformer, and the other from a receiver.

The winding of these transformers improved our vocabulary to some extent. An improvised winding machine, with an old automobile speedometer as a turns-counter, provided all the difficulties necessary to transform a normally sane bloke into a raving lunatic. Matters were not helped by well-meaning visitors to the workshop making all sorts of impractical suggestions, usually resulting in their being consigned to the nether regions.

Interruption in transformer production was caused by a downpour of rain—some 26 inches in 24 hours. This flooded the whole place and reels of wire and like equipment had to be salvaged from the mud and dried before construction could proceed. After a few mishaps such as this, the transformers were eventually finished, and surprisingly enough, they worked!

### Control and Mixer Amplifier.

Unfortunately, Harry Shirley had been associated with broadcast stations only in an administrative capacity and the technical difficulties involved in making a mixer unit, like the R.C.A. job, never occurred to him. First, it was thought that two pick-ups and a microphone input would suffice, but no—Harry must have a receiver input for the news broadcast. Then he wanted a second mike input from the mixer to operate the local camp amplifier system. There were so many knobs and switches on that mixer, it looked like a Fortress bomb selector switchboard, but it did a fine job with Harry at the controls.

### Land Lines.

A land line was installed as the transmitter was located some two miles from the studio. Twisted-pair telephone cable was run through the jungle and coconut palms.

It is surprising just how many scatter-brains there are, with a surplus ammunition, who can't find a better target to snipe at than an inoffensive land line. Bulldozers also seem to delight in tearing down trees on which the Signal Corps have attached lines. You have no idea how exhilarating it is to plough through a mile of dense undergrowth to locate a broken line, particularly when the outfit responsible for the line-break rings the studio to know why the station isn't on the air.

A humorous interlude was provided one evening when the studio land line shorted across an adjacent telephone line. A voice crashed out over the air—"When in the blankety blank are you going to change that frequency on 'A' watch?" The studio line had apparently crossed the 'phone line from the local signals office.

### Studio.

The studio set-up consisted of two Presto turntables (supplied by the Australian Comforts Fund) plus two dynamic microphones, the mixer unit and a short-wave receiver for relaying short-wave news broadcasts.

The entire staff was drawn from surrounding units and all volunteered to assist on their own time. Several commercial announcers were found and were very pleased to get back into the old business. Three Australian news sessions and the San Francisco news were broadcast daily.

Programmes were supplied by the Australian Broadcasting Commission—2UW, Sydney—and the U.S. Special Services Division, and the programmes have provided news entertainment to thousands of men and women of the Allied Fighting Services.

# A Sound Design for an Audio Oscillator

**Radio enthusiasts are progressing at a rapid rate these days and everyone worthy of the name has an audio frequency generator of some kind. Unfortunately there are many suggested designs which are not thoroughly reliable, or which call for unusual gear, such as four-gang condensers with insulated spindles. But here is a thoroughly sound design, taken from "Q.S.T." (U.S.A.).**

AN audio oscillator which covers more than the normal audio-frequency range has many uses around the laboratory or service shop. Audio systems of receivers, p.a. amplifiers, speech amplifiers, and modulators may be tested with such an oscillator. In an f.m. system, the oscillator is useful in testing band-pass and fidelity of the audio system, off-resonance response of the r.f. tuned circuits, and sideband width in transmitters, including carrier-current outfits. To a certain extent, video amplifiers may be checked

**By**
**CHARLES J. LEIPERT,**
**W6ROA**

similarly, but the range of the test oscillator here described is not great enough, because video circuits respond normally up to approximately four megacycles. However, if the oscillator range is extended by means of doubler stages, the entire video spectrum may be covered. Another possibility along this line is the use of an R-C audio oscillator to control a ham transmitter on a low-frequency band. Since the stability of R-C oscillators is very good, something close to crystal-control performance possibly may be achieved, along with the flexibility of an e.c.o. Here is a quality which also makes the outfit ideal for use as an interpolation oscillator with which frequency measurements may be made. Frequency stability of the unit here described is enhanced by the use of a temperature-controlled box, the construction of which is simple and quite inexpensive. Also in other parts of the circuit, easy-to-get components are used, and this is a relief, since priorities are becoming harder to obtain.

### Circuit Design

In Fig. 1, the R-C elements are shown to be two identical groups of resistors, R1-R4 and R5-R8, along with condensers, C1 and C2. The ganged switch, S, allows resistors of equal value from both groups to be selected simultaneously, and it is by this method that a desired frequency range is chosen. The spectrum from 16 to 85,000 cycles is covered in the following steps: 16-150; 150-1500, 1500 - 10,000, and 10,000 - 85,000 cycles A frequency ratio of approximately 10-to-1 exists for each setting of the switch, and these figures represent the end calibration points with no gaps over the full range.

Condenser C1 is a broadcast-type four-gang unit, and not four separate single sections, as it may appear from the diagram. The usual leaf-type mica trimmers are mounted on each section, but are not shown in Fig. 1. Two of the sections connected in parallel are used to tune across the upper set of resistors (R1-R4), while the other two tune across the R5-R8 group. C2 is a very low-capacity, low-drift, fixed mica condenser which makes up for the added capacity of the two lower sections of C1 with respect to the chassis. By this means, the capacity element of the R-C tuned circuit is kept in balance.

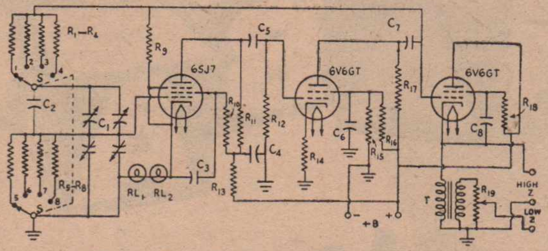



*Fig. 1* — Circuit diagram of the R-C audio oscillator.

$C_1$ — 4-gang broadcast-type variable, 365 μμfd.
$C_2$ — 75-μμfd. midget mica, low-drift.
$C_3$, $C_5$ — 1-μfd., 450-volt paper.
$C_4$, $C_6$, $C_7$, $C_8$ — 8-μfd., 450-volt electrolytic.
$R_1$, $R_5$ — 10 megohms, ½ watt.
$R_2$, $R_6$ — 1.25 megohms, ½ watt
$R_3$, $R_7$ — 150,000 ohms, ½ watt.
$R_4$, $R_8$ — 20,000 ohms, ½ watt.
$R_9$ — 2,500 ohms, 1 watt.
$R_{10}$, $R_{12}$ — 0.5 megohm, ½ watt.
$R_{11}$, $R_{13}$ — 100,000 ohms, ½ watt
$R_{14}$ — 200 ohms, 10 watts.
$R_{15}$ — 40,000 ohms, 1 watt.
$R_{16}$ — 50,000 ohms, 1 watt.
$R_{17}$ — 10,000 ohms, 10 watts.
$R_{18}$ — 25,000 ohms, 10 watts.
$R_{19}$ — 1,000-ohm potentiometer, carbon volume-control type.
$RL_1$, $RL_2$ — 120-volt, 6-watt lamps (G. E. Mazda type S6). The same type is used for the beat-indicator pilot light.
S — Ganged 2-section, 4-point wafer-type switch.
T — Universal output-to-voice-coil type transformer.

### Feedback Used

Oscillation is maintained by feedback from the plate circuit of the second tube in the line-up to the cathode-suppressor connection on the first tube. A 6SJ7 tube is in the R-C tuned circuit, followed by a 6V6GT which, in turn, is followed by another 6V6GT as a final amplifier. Feedback energy is coupled through the common cathode-return path and resistor R9. Degenerative voltage is developed across the two lamps, RL1 and RL2 in series. The positive resistance - temperature characteristic of these lamps causes the voltage across them to rise more rapidly than does the increase in current through them. Degenerative voltage therefore appears on the 6SJ7 control grid simultaneously with the regenerative feedback voltage through R9, so that oscillations are better stabilised.

### Stability Assured

If the load is hooked right onto the oscillator output, frequency variations are bound to occur, and this is **not** what is wanted. An easy way out of this little difficulty is to use a stage or two of amplification following the oscillator, so that the oscillator frequency is not affected by changes in load impedance. This is done in the unit here described. Either high- or low-impedance loads may be connected to the output of the second 6V6GT

**(Continued on next page)**

## AUDIO OSCILLATOR
**(Continued)**

tube in the circuit from terminals on the front panel. The isolating amplifier circuit is built around the middle 6V6GT tube. Across the high-impedance terminals, the audio voltage reading is 19 volts. Across the low - impedance binding posts, the voltage averages about 1.25 volts, with a slight taper at 25,000 cycles. These figures represent maximum readings. A 1,000 ohm attenuator is used across the low-impedance terminals, but there is none across the high-impedance side. It is believed that adjustment of the volume level may be made more conveniently at the load circuit in the case of high-impedance output.

The power supply is not made a part of the oscillator unit because in that position it has been found to affect the stability of the oscillator. Power for the rig therefore is "piped" in through a cable and plug.

Metal tubes are preferable because they are shielded, but essentially the same results may be achieved with glass tubes and shields connected to the cathode pins. The 6V6GT tubes are so constructed internally, and are so placed in the circuit, that they could be left unshielded, but complete elimination of hum pick-up and of unwanted feed-back makes it preferable that tube shields be used.

**Construction Details**

Salvaged metal is used in several parts of the lay-out. A rusty 1/8-in. steel plate with 82 holes in it, for example, was converted into the front panel shown in the accompanying photograph. A welding torch was used to fill in the holes, after which the plate was ground, sanded, and given a wrinkle-over finish paint job. Actually, the family cook-oven was appropriated for the baking part of the paint job (while the family kindly evacuated for the time being), and the finished product hardly resembles the old rusty plate from the junk pile.

The chassis is a hole-ridden relic, also from the junk pile, which was finished up and pressed into service. It is an odd-shaped affair of 1/8-in. brass with the following dimensions: 9½ inches across the forward edge, 11¾ inches deep, 10¼ inches across the back edge, and a clearance underneath of two inches for the mounting parts. Some of the large holes in the chassis are entirely too big for the tube sockets, but the required diameter is obtained by mounting socket washers on top of the chassis instead of underneath. Other smaller holes are not filled in because they serve to ventilate the components when the unit is mounted inside the temperature-controlled box.

The main oscillator gear is enclosed fully by the temperature-controlled box except that, as previously mentioned, the power supply is in an independent external unit. Another junk-box item made of 1/8-inch iron forms the temperature-controlled box and it has the following dimensions: 12¼-inches wide, 12-inches deep, 9-1/8 inches high, with a flat range made so that the box may be screwed flush with the main rack.

**Chicken Thermostat**

For a thermostat, one which is

designed for use in chicken incubators does very well. Even though a thermostat of this type is somewhat large, it is not hard to find a way to mount it inside the temperature box. A more scientific model virtually is impossible to obtain because of priority restrictions. The one used cost approximately two dollars, and it works well enough to keep the temperature within plus or minus one degree. The accuracy of the circuit components themselves with respect to temperature is no greater than this. For further heat insulation, an outside covering of ½-inch Celotex is used around the box. The Celotex is cut to size and given three coats of black paint. Black is chosen because of its heat-retentive properties. If any trouble is experienced in making the Celotex joints tight, linoleum glue is recommended for the purpose.

Almost any type of thermometer will do. In the original gear, a bathroom-type for measuring water temperature was obtainable, and it served well enough, since a scientific model was not to be had. If the glass tubular type with graduations etched on the stem is used, a single hole drilled into the box is good enough for holding it. Another hole of appropriate size is needed in a convenient spot on the box for mounting the fuse base. A screw-type fuse is used. "Heat On," is indicated by the illumination of a 120-volt, 6-watt Mazda lamp behind a one-inch jewel. Beneath the jewel is an on-off switch for controlling that portion of the heater resistance which is connected through the thermostat.

The two lamps, RL1 and RL2 which control the amount of degeneration, are mounted between the main tuning condenser and the back of the front panel. They are of the 120-volt, 6-watt variety. Both of them are mounted in ceramic sockets, and their connections are brought to the cathode of the first 6SJ7 tube.

The range-setting gang switch is mounted on the left-hand side of the chassis, as seen in the bottom view. Above it, on the same side, is the 1,000-ohm potentiometer with which the low-impedance output level is varied.

Six fixed condensers are used in the layout. Four of these are of the 8-ufd., 450-volt dry electrolytic cartridge variety, two of which are mounted with copper straps to the side of the chassis. The other two are wrapped in empire cloth and mounted between the two resistor blocks. Two condensers of 1-ufd., 450-volt rating also are mounted on the inside of the chassis with copper straps.

Leads from the external power supply to the chassis come in to a six-connection male plug which is mounted on a stand-off metal strip in such a way that it protrudes through a hole in the heater panel.

**Calibration**

There are several means by which the oscillator may be calibrated. The zero-beat method is the simplest and perhaps the most familiar because the average ham knows how to bring a local oscillator to zero beat with a given carrier or standard-frequency signal. The visual

(Continued on page 26)

# A SHORT COURSE IN RADIO

## PART 4 . . . THE TUNED CIRCUIT

**When an inductance and capacitance, represented by a coil and condenser, are connected as shown in Fig. 29, what is tchnically known as an oscillatory circuit is formed.**

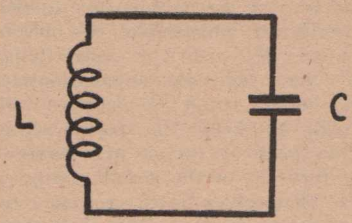



FIG. 29.

IF a battery, with a resistance in series to limit the current, is connected across the coil as shown in Fig. 30, and the switch closed, the resultant current in passing through the coil will set up a magnetic field around the latter. (Fig. 31).) The action will not be instantaneous, due to the inductive reactance of the coil impeding the current flow.

As long as the switch remains closed, the magnetic field surrounding the winding will remain constant. At the instant it is opened, however, the field will commence to collapse, thus returning the energy stored in it back to the circuit.

### Stored Energy

The field, in collapsing back on the coil, tends to maintain through "L" a current in the same directon as that originally applied. The current flows into the condenser "C", which then becomes charged as shown in Fig. 32. At this stage there is no magnetic field, energy that was entirely stored by the latter being transferred in the form of a charge to the plates of condenser "C".

This is obviously not a stable condition, and the condenser discharges through "L", the resultant current through the winding again setting up the opposite direction, the original north pole of the winding now becomes the south, and the original south pole the north, Fig. 33.

When the condenser is completely discharged, thus fully establishing the field, the latter again commences to collapse, until it disappears, although, leaving "C" charged once again, but in opposite polarity to that shown in Fig. 32.

If it were not for the fact that a circuit always contains resistance in one form or another, this process would continue for ever. The current would never cease surging in and out of the condenser, travelling backwards and forwards through the coil all the time. As it is, the resistance present dissipates as heat, some of the energy transferred during each cycle, and the process finally stops as there is no longer energy to sustain it. In practical circuits, energy to overcome this damping, as it is called, is supplied in a manner to be explained later.

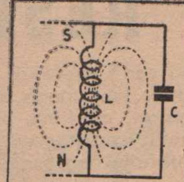



FIG. 33

### Frequency Factors

It follows logically that the larger the coil (the greater its inductance) the longer time it will take for the condenser to discharge through it. Similarly, the larger the condenser, the longer it takes to charge and discharge. Hence, the smaller the coil and condenser, the higher will be the frequency of oscillation.

### Resonance

The resonant frequency is the natural frequency of oscillation of any oscillatory system. An excellent mechanical analogy to illustrate this point is afforded by the tuning fork. If this is struck and then held near a piano, the string in the piano which is tuned to the same frequency as that of the fork will vibrate in sympathy with the latter, obtaining the energy to do so from the air waves set up by the vibration of the fork.

### Tuning-in

A similar effect occurs in the tuning circuits of a receiver when the dial is rotated to bring in a particular programme. Every radio station operates on a different frequency, and this frequency is picked out from all the rest by adjusting the variable tuning circuits in the receiver until their frequency of oscillation coincides with the frequency on which the wanted transmission is being made. When the tuning adjustment is correct, the voltages across each tuning circuit reach their maximum values for the particular programme being received.

Fig. 34 illustrates the process graphically. As the natural frequency of the tuned circuit approaches that of the wanted transmission, the current in the circuit increases as shown, reaching a maximum when resonance is obtained. If the tuning dial is rotated

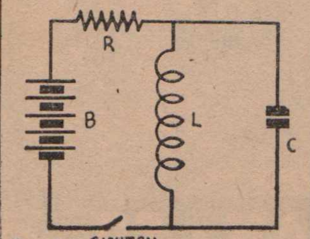



FIG. 30 SWITCH

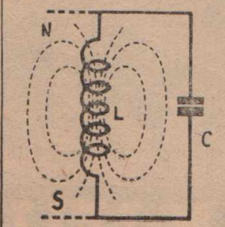



FIG. 31

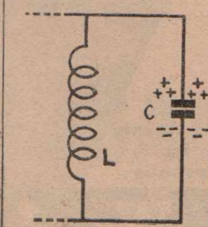



FIG. 32

# FUNDAMENTALS - - By CHAS. ASTON

still further, the current decreases rapidly as illustrated.

### Ohm's Law for A.C.

When a circuit is purely resistive, which is one that does not contain any inductance or capacity ohms law may be applied as in direct current calculations. As explained before, inductance and capacity have reactance, which offer an impedance to A.C.

The impedance of a circuit containing resistance, inductance and capacity in series may be calculated from the formula:—

$$Z = \sqrt{r2 + (XL - Xc)2}$$

where

Z = impedance in ohms

r = resistance in ohms

XL = inductive reactance in ohms ($2\pi fL$)

Xc = capacity reactance in ohms $\left(\frac{1}{2\pi fC}\right)$

To assist explain this we will now work out an example for a circuit as shown in Fig. 35. The inductance has a value of 20 henries, the capacity 5 mfd.; the resistance 5 ohms; and the frequency of the supply is 50 c.p.s

$$XL = 2\pi fL = 6.28 \times 50 \times 20 = 6280 \text{ ohms}$$

$$Xc = \frac{1{,}000{,}000}{2\pi fC} = \frac{1{,}000{,}000}{6.28 \times 50 \times 5} = 639 \text{ ohms (approx.)}$$

$$Z = \sqrt{5^2 + (6280 - 639)^2} = 5641 \text{ ohms (approx.)}$$

The values are taken for illustrative purposes and a choke with an inductance of 20 henries would probably have a higher resistance than 5 ohms.

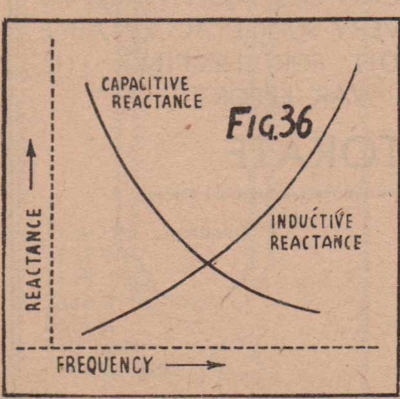


FIG. 36

From the above formulae it can be seen that the impedance offered by a coil to an alternating current increases with frequency of oscillation. For a condenser the opposite holds, or in other words, capacitive reactance decreases as the frequency of the oscillatory current increases.

It is thus apparent from the above that in any coil and condenser combination there must be a point at which the inductive and capacitive reactances are equal. Since they oppose each other, they cancel, leaving only the resistance in the circuit to impede the flow of current, Fig. 36.

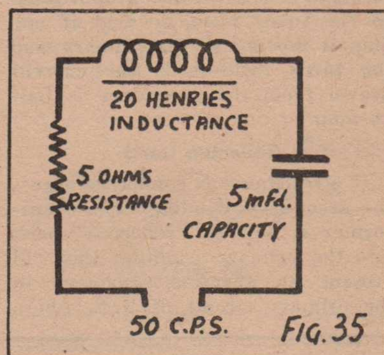


FIG. 35

At the resonant frequency then, $2\pi fL$, the inductive reactance, must equal $1/2\pi fC$, the capacity reactance.

Hence:—

$$f = \frac{1}{2\pi LC}$$

Thus another way of explaining what happens when a receiving circuit is tuned is this. By varying the capacity in the circuit by means of the variable condenser the circuit is adjusted so that its total reactance is at a minimum for the incoming frequency. In this way the natural frequency of oscillation of the receiving circuit is made to coincide with the frequency of the wanted signal, and there is resonance.

### Magnification

We have seen how in a series circuit at resonance, the inductive and

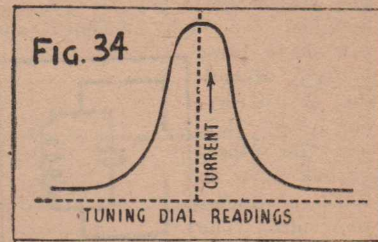


FIG. 34

capacity resonances cancel, so the current is equal to E/R, where R is the effective resistance of the circuit; now the voltage drop across the inductance will be:

$$= 2\pi fLI = \frac{2\pi fLE}{R} = \frac{2\pi FL}{R} \times E$$

which simply means that the voltage across the inductance is $2\pi fL/R$ times larger than the applied voltage and it is this $2\pi fL/R$ that is called the magnification of the circuit, it is usually represented by the letter "Q", which is defined as the ratio of inductive reactance to circuit resistance.

This series type of circuit is called an "acceptor circuit," for at its resonant frequency it "accepts" current most easily.

### Parallel Circuit

It can be shown that the resonant frequency of a parallel circuit as shown in Fig. 37 is also equal to $1/2\pi\sqrt{LC}$, but at this frequency the impedance of the circuit is almost infinite, and if it were not for the circuit resistance would be. be.

This circuit is known as a rejector circuit for obvious reasons.

### Transformers

Under the heading of Mutual Inductance we learnt how an EMF can be induced in a coil that is placed in a suitable position with regard to another coil through which is passing an alternating current. An instrument that is designed to utilise this effect is called a "transformer."

Three types of transformers may be met in a radio receiver; the

(Continued on next page)

## FUNDAMENTALS

**(Continued)**

power transformer to operate at the "mains" frequency, 50 cps, it is designed for high efficiency and may have three or four secondary windings, one for H.T. and the others usually have an EMF of under 10 volts. The audio transformer, which may be required to handle the audio frequency voltages over the whole range with equality. This, in common with the power transformer, is used with an iron core.

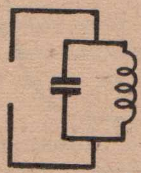


FIG. 37

### R.F. Transformers

Radio frequency transformers are designed to be used with frequencies of 50 kcs. up and are used with an air core or one of the special "iron dust" type, which was described in "Inductances."

A transformer has the ability to increase or reduce voltages depending on the relative number of primary and secondary turns. The ratio of the number of secondary turns to the number of primary turns is known as the "turns ratio." The primary and secondary windings are close coupled, the voltages are proportional to the turns; for example, if the voltage applied to a primary winding of 50 turns is 100 and the secondary has a winding of 200 turns the voltage induced in this winding will be 400. This is known as a "step up" transformer; if the number of turns on the secondary were less than the primary, the voltage induced in the secondary would be less than the primary voltage and would be known as a "step down" transformer. Unfortunately, a transformer cannot create energy so the maximum power that can be taken from the secondary is no more than is put in the primary, so that the current drawn from the secondary is inversely proportional to the turns ratio, so that if one amp is flowing in the primary and the turns ratio is 2, the current drawn from the secondary is half an amp.

### Reflected Load

If a resistance is connected across the secondary winding of a transformer it will be "reflected" back into the primary winding; this will present an effective resistance in the primary circuit of $R/t^2$, where

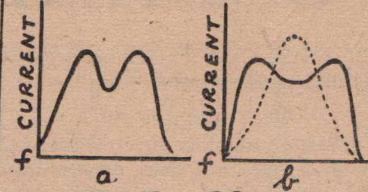



FIG. 38

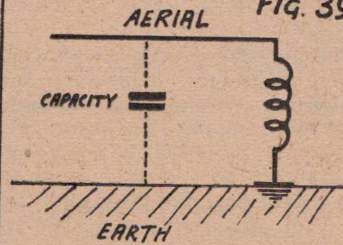



FIG. 39

t is the turns ratio. This property of a transformer "matches" one circuit to another. As a simple example of this principle: a loud speaker has a voice coil resistance of 5 ohms and the valve feeding it works most efficiently into a load of 5,000 ohms, it can be seen that the primary would have to consist of a thousand times as many turns as the secondary.

### Coupling

In a transformer the two windings are said to be magnetically coupled. A frequency response curve, for two circuits tuned to the same frequency, magnetically coupled, is shown in Fig. 38a, the curve can be seen to have a double hump. If the coupling between the two circuits is reduced the humps will tend to be reduced and a curve similar to Fig. 38(b) may result, if the coupling is still further reduced it is possible to produce a curve with one peak only. When maximum selectivity is required in the tuned circuits of a receiver the single peak curve is desirable; when it is desired to pass a wide band of frequencies the circuits are coupled for a double hump curve.

### H.F. Radiation

If in Fig. 30 the switch was closed each time condenser was charging with the same polarity as the battery, the losses due to the ohmic resistance of the circuit would be made up and the circuit would oscillate indefinitely, this may be done by replacing the battery and switch with an alternator with a frequency the same as the resonance frequency of the oscillatory circuit. The alternator would have to be a special one and is seldom used in practice.

We will presume that the oscillatory circuit shown in Fig. 29 is connected to a suitable alternator, but in its present condition the radiation will be very small indeed.

If we replace the capacity by a type as shown in Fig. 39, which can now be seen to consist of one end of the inductance, is connected to earth, one plate of the condenser, and the other end is a length of wire slung up in the air, the other plate of the condenser, the air will be the dielectric. When the condenser is fully charged there will be electrostatic lines of flux between the aerial and earth as shown in Fig. 40. When the condenser discharges back into the inductance, not all the flux returns before the reverse field is created which will repel the flux and force it into space at the speed of 186,000 miles per second. These lines of force have a property that gives rise to magnetic lines which travel along with them, but at right angles to them, and is illustrated in Fig. 41, although the radiation in the diagram appears as if it were travelling in a line or beam, this is not so, it flows out all around the aerial unless a special system is used.

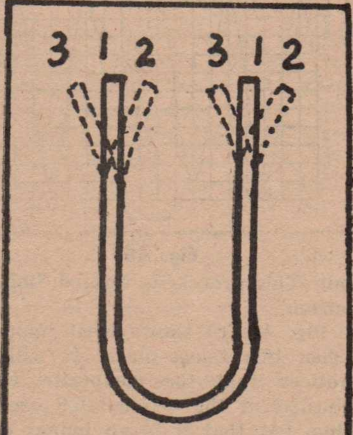



FIG. 43

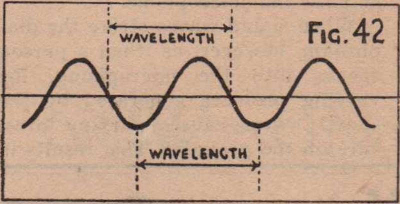



FIG. 42

The higher the frequency of the oscillatory circuit the fewer the number of electrostatic lines that have time to return to the inductance before the field is being built up in the opposite direction so more energy will be radiated. This is the reason high frequencies are utilised in wireless transmission as frequencies of a few thousand cycles per second would radiate only very small quantities of energy.

The wavelength of a transmitted signal is the distance between two points on the wave whose components are in the same phase as shown in Fig. 42: it may be calculated from this formula, $1885\sqrt{LC}$ metres; L is in microhenries and C is in microfarads.

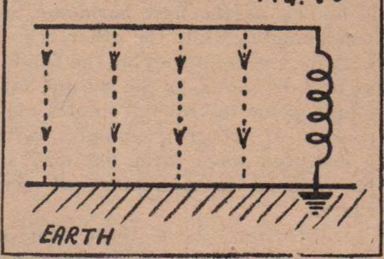
### Sound

It is now necessary to learn something about sound before we see how it is transmitted over wireless.

A tuning fork will produce a "pure" note, so will be used as a simple method of explaining how sounds are generated.

The two prongs of the fork are stationary, so no sound will be produced; as soon as the prongs are set vibrating they will travel backward and forward about the stationary position. We will now examine what effect the right prong has on the air surrounding it; at the instant it moves to position 2, Fig. 43, it will compress the air to the right of it and rarify the air to the left, and when it travels to position 3 it will continue while the fork continues to oscillate, which will travel through the air as pulses which are called sound waves, and travel at a speed of approximately 1,100 feet per second.

FIG. 40




### Audio Frequencies

If a person's ear is in the range of the sound waves the ear drum will vibrate in time with the pulses, which will be transmitted to the brain and recorded as sound.

No human ear is capable of receiving sounds from about 50 to 10,000 cycles per second.

If we were to plot the pulses of a tuning fork a sine curve would result so that the tone is said to be pure, which is more the exception than the rule with musical instruments.

### Harmonics

We are all well aware that although two different musical instruments are tuned to the same note they have their own characteristic sound, this is caused by the different wave form of the two instruments as shown in Fig. 44.

It is obvious that the "loudness" of the note is dependant on the amplitude of the vibration.

The heavy line in Fig. 44 represents the waveform of a note which can be analysed into sine curves, as shown by the two dash lines; these are known as harmonics, the one that consists of a single sine wave

**(Continued on next page)**

## FUNDAMENTALS

**(Continued)**

is known as the first harmonic, or fundamental, while the other, which is twice the frequency of the fundamental, is known as the second harmonic, some instrument's notes may consist of many harmonics with a distorted wave form, but may all be reduced to a number of sine curves.

"Distortion" is a term that is often met with in radio receivers and amplifiers, and means that the wave form is altered by the addition of harmonics that were not present in the original wave form.

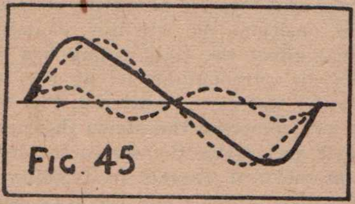


Fig. 45

If an amplifier were fed with a pure note and it introduced third harmonic distortion, the note from its output would consists of the note with its third harmonic.

**Modulation**

The radiated wave is known as the "carrier", Fig. 46, so named because in itself it does not give us the speech and music we hear, but merely serves to transport it from the transmitting station to our receivers. The transportation is accomplished by means of a process called modulation, and this will now be explained.

The first, and one of the most important units in the radio chain is the microphone. There are many different types, but the basic principle common to them all is that of the microphone used in the ordinary telephone — to transform sound into corresponding electrical impulses.

In the carbon type microphone this is accomplished by making the sound impinge on this diaphragm, behind which is a cavity housing carbon granules. A battery is connected so that a current is passing through these granules all the time, even when no sound is present to actuate the microphone.

When sound waves strike the diaphragm, however, as when a person speaks into the microphone, the varying pressure generated by the sound waves causes varying pressure on the granules. This results in

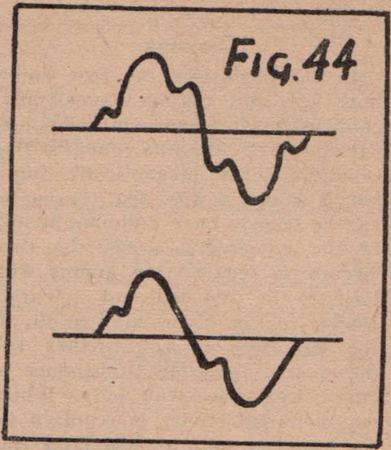


Fig. 44

corresponding variation in the electrical resistance of the granules to the current flowing through them so that the current must also vary. Hence in this varying current we have an exact electrical replica of the sounds impinging on the diaphragm of the microphone.

To simplify matters we will assume that, instead of a complex sound a single pure 1,000 cycle note is played in front of the microphone. This can be represented by the sine curve shown in Fig. 47 (b), Fig. 47 (a) can be taken to represent the radio frequency current, though to represent it faithfully there should be many more "ups and downs" than are shown.

Now we have the musical note, and the constant radio frequency oscillation. The next step is to mix the two so that when the carrier is radiated it will bear the impress of the audio signal we want to trans-

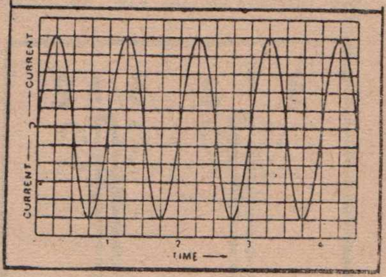



Fig. 46

mit. This process is termed "modulation."

Fig. 47 (c) shows what happens when this takes place. It will be noticed that the composite wave consists of the original RF oscillation, but that it is no longer constant in amplitude. (This means that whereas a horizontal straight line can be drawn along the peaks of the waves shown in Fig. 47 (a), in Fig. 47 (c) this is no longer possible). Nevertheless the important point to note is that the frequency of the oscillation remains unaltered. The variations of its amplitude are such that the tips of the modulated wave outline an exact replica of the low or audio frequency modulating current. Its envelope, as it is called, is outlined in Fig. 47 (c) by a dotted line.

After the receiving set has picked up the carrier and it has been passed on to the detector (second detector in the case of superhets), it is no longer needed, and so it is dispensed with and the audio frequency signal made audible by the process of detection or demodulation. This will be explained later.

### Receiving Aerial

The vital link between the transmitter and the receiving set is the aerial, which intercepts the signals and hands them on to the set. As the transmitted signal, travelling at the speed of light, crosses the aerial,

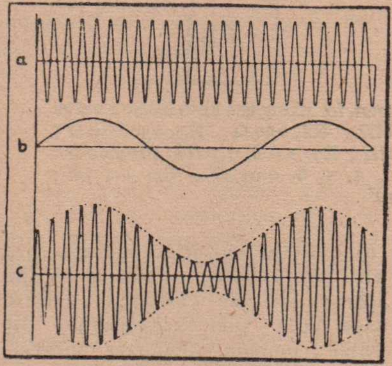



Fig. 47

it induces in the latter an alternating current having a frequency corresponding to that of the transmitter. For example, if the latter operates on 500 metres, which equals 600 kc/s (metres × kilocycles = 300,000) the frequency of the current induced equals 600 × 1,000 = 600,000 cycles per sec.

Just like the simple oscillatory circuit every aerial has a natural period of vibration, or a natural resonant frequency. This can be found very approximately by multiplying the total length of wire comprising the aerial and lead in by 4.5. This gives the natural wavelength of the aerial in feet. To convert this to metres, divide by 3.28, and to obtain the resonant frequency in k.c. divide the result into 300,000.

Thus, with an aerial 100 feet long, the natural wavelength = 100 × 4.5 ÷ 3.28 equals approximately 137 metres. Thus the resonant frequency equals 300,000 ÷ 137 = 2,183 kilocycles per second.

From the above, it can be seen that the longer an aerial is, the higher is its natural wavelength, or the lower its natural frequency. Thus we could actually tune a simple receiver just by altering the length of the aerial for each station required. In practice, though, this would be hopelessly inconvenient, and so another method of tuning is used. The main point to remember is that an aerial, although it is usually strung up in one single length of wire, actually possesses an appreciable amount of inductance and capacity in the form of a coil and condenser, as shown in Fig. 48. The amount of inductance, or in other words, the number of turns of wire required on a given diameter former, and the amount of capacity, can be caluclated when the limits of the waveband it is required to cover are known.

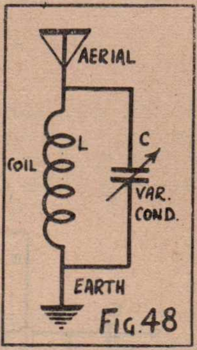



Fig. 48

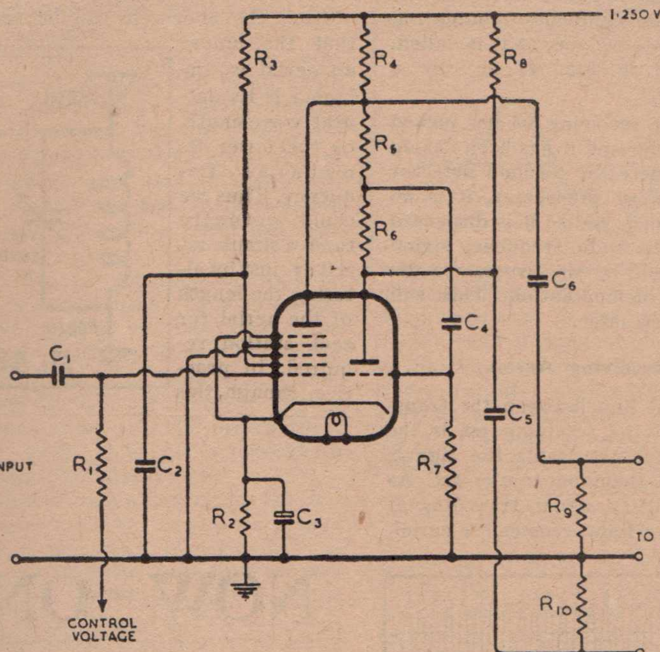
The formula is our old friend for calculating resonant frequency

$$f = \frac{1,000,000}{2\pi\sqrt{LC}}$$

where "f" is the frequency in kc/s; "L" the inductance in microhenries; "C" the capacity in microfarads.

# NEW DUTCH VALVES

## Three Types Only for All Receiving Purposes




**Circuit recommended by Philips, Eindhoven, for using the new ECH21 valve as a phase-splitter. Values: R1, 1.5 MΩ; R2, 650 Ω; R3, 250,000 Ω; R4, 200,000 Ω; R5, 1.0 MΩ; R6, 1.1 MΩ; R7, 1.0 MΩ; R8, 100,000 Ω; R9, 700,000 Ω; R10, 700,000 Ω. C1, 4, 5, 6, 0.01 µF; C2, 0.1 µF; C3, 50 µF.**

IT is learned in Eindhoven that new series of indirectly heated valves have been developed by the Philips company during the occupation, and that they are to be marketed after the war. In both a 6.3V A.C. and in a universal series there are only three receiving types: a triode-heptode, and RF pentode, and a duo-diode-pentode. The valves are of glass-and-metal construction, are of small dimensions, and embody a keyed metal spigot for easy location in the valve-holder. In some cases the spigot is used as a contact in addition to eight pins; top-caps are not employed; screening is provided by an internal woven wire cylinder. It is claimed that the three valves in each series suffice for normal designs of receiver, and the use of older types is deprecated.

The frequency-changer, the RF pentode, and the output pentode in the AC series consume respectively 0.44, 0.2 and 0.8 amp. at 6.3V; the last-named, when working into a 5,700 ohm load, provides 4.5 watts output at 7 per cent. total distortion for an input of 3.9V RMS. For feeding two such valves in push-pull, the triode-heptode can be used as a combined variable-gain AF amplifier and phase-inverter, as shown in the accompanying circuit recommended by the makers. Magnification varies in the ratio of 10 : 1 as the negative potential applied to the heptode control-grid is increased from zero to fifteen volts, and, for an output of 10V RMS, total distortion rises from 0.8 per cent, with 0.1V RMS input and maximum gain, to 6.2 per cent. with 1.0V input and —15V bias. The triode-heptode, having no internal connection from the triode-grid to the heptode third grid, can also be used for simultaneous IF and AF amplification.

The universal valves are of interest in that the heaters consume only 0.1 amp., the triode-heptode requiring 20 volts, the RF pentode 12.6, and the DD-pentode 55 volts; the half-wave rectifier in this series has a 50-volt heater. Into a load of 3,000 ohms the output valve provides, for 10 per cent. total distortion, 1.35 watts of audio power with 100 volts on anode and screen, and 4.8 watts with 180 volts. The RF pentode has a slope of 2.2 mA/V at minimum bias, falling to 0.02 mA/V when the control grid is 37 volts negative; over this range the anode AC resistance rises from 1,000,000 to over 10,000,000 ohms. The frequency-changer has a conversion-conductance of 0.75 mA/V with a grid-potential of —2V, the anode AC resistance of the heptode portion being then 1,000,000 ohms. In both the RF pentode and the triode-heptode the control-grid/-anode capacity is under 0.002 uuF.

Advantages claimed for the valves in these new series include the following: (a) that the inter-electrode capacities are, in the absence of a pinch and owing to widely-spaced pins, lower than usual; (b) that the capacities vary less from specimen to specimen; (c) that the variation of capacities with temperature is reduced by the absence of the customary plastic base, the dielectric-constant of which commonly changes appreciably with temperature. In the case of the triode-heptode, the reduced inter-electrode couplings minimise the tendency of AVC voltage fluctuations to produce frequency-drift.

"Wireless World."

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### COLOUR TELEVISION SETS!

According to Mr. J. L. Baird, a combined sound and television set for the home, with colour television and stereoscopic effect, is likely to be produced after the war for about fifty pounds. Mr. Baird was also of the opinion that with mass production the price of a black and white receiving set may well become much less—possibly in the neighbourhood of fifteen pounds.

# Shortwave Review

CONDUCTED BY L. J. KEAST

NOTES FROM MY DIARY

Would not be surprised to hear our old friend KZRM, Manila, any day or night now. Remember when we used to hear them so well on 9.57 m.c., 31.35 met.? What a great news session they had at 10.50 p.m. Their schedule was 7 p.m. to midnight, but on Saturdays they ran on till 1 o'clock. Always a great signal, but their morning session from 7.30 till 9 not so strong. Expect any day they will show up or rather "hear-up" again.

---

## SAYS WHO?

HCJB, Quito, will soon operate a 49-metre band transmitter on 6240 kilocycles.—Cushen.

•

This should be welcome news to Verie-hunters. According to "Victory News," the BBC have verified, by cards, reception reports on GSP and GSI submitted by Art Hankins, until recently Shortwave Editor of "Victory News." It appears, however, that reports must be sent on the BBC special forms and must be full and, above all things, accurate.

•

Received QSL card from TAP, Ankara, for report of last November, also photograph of Radio House, Ankara, together with quite a lot of information on station activities.—L.J.K.

•

Prior to commencing Post Bag series No. 25 on Monday, April 16th, Nuzetmunyas (this is my phonetic spelling of announcer's name) paid a nice tribute to the late President Roosevelt.

•

ABSIE very fine with news in Enblish: GRB, 6.01 m.c., 49.92 met., and GSW, 7.23 m.c., 41.49 met., at 5.30 a.m.; also on GWH, 11.80 m.c., 25.42 met., but poor.—Cushen.

•

The Blue Network has or is changing its name to American Broadcasting Company.

•

KRHO, Honolulu, 17.80 m.c., 16.85 met., carries AFRS programmes from 1.45-2.30 p.m.—L.J.K.

•

"Have received two veries from KRHO, one for the 16-metre band and the other for the 49.—Gaden.

•

Rex Gillett says he heard KRHO on 31.28 metres from 5.15 p.m. at very good volume but signal spoilt at times by VUD. Hugh Perkins says he heard them on 22nd April at 8 p.m. with extremely powerful signal. Rex goes on to say he has also logged KRHO on the same wavelength with news at 3 a.m.

•

I cannot find KRHO on 31.28 met. at either 5.15 or 8 p.m., but it is still on 6.12 m.c. at those times with its usual strong signal. I can only think on the night those gentlemen heard KRHO they were either on a test or linked up with another station and KRHO's announcement came over on that station. A similar thing happnes frequently in the afternoon with KROJ, 9.89 m.c., and KWIX, 9.85 m.c.—L.J.K.

•

"What's the Deal?" is the title of a new session in the AFRS programmes heard on Mondays and Thursdays over KROJ, 17.76 m.c., 16.89 met., at 11.15 a.m. and over KWIX, KGEI and KROJ at 7.45 p.m. Members of the Armed Forces are invited to send in any queries they have and the young lady who "knows all the answers" is Sgt. Anne Schuler. Very good session and most informative.—L.J.K.

•

Dr. Gaden, referring to the BBC, says, "Some station is usually audible at any hour of the day, the 6 and 7 m.c. bands the best in early a.m.; the 9 and 11 during forenoon, and 9 during afternoon. Late afternoon and at night very fine reception from 16 m.c. onwards. Despite the somewhat winter-like conditions of daylight reception, the high frequencies are still top hole at night."

•

Wally Young has dug up an old-timer in OIX-3, Lahti, 11.775 m.c., 25.48 met. This Finnish station is being heard at fair strength around 4.15 p.m.

•

WWV, Bureau of Standards, Washington, can be heard well at 9.45 a.m. on 10 m.c.

•

CBFX, Montreal, 9.63 m.c. 31.15 met., is very good at 9.50 p.m., and a 15-minute news session is given at 10 p.m. Signal fades a little by 11 o'clock. CHTA on 19.71 metres, carries news at slow speed at 10.25 p.m.—L.J.K.

# NEW STATIONS

**KNBC, 'Frisco, 17.78mc, 16.87m:** Heard from noon till closing at 2.45 p.m. Excellent signal. Is in parallel with KNBA, 15.15mc, 19.81m. Do not know exact opening time but think it is well before noon.—L.J.K.

**KROU, 'Frisco, 17.78mc, 16.87m:** Another outlet for AFRS programmes and a welcome addition to the morning Californian stations. Is heard at very good strength from opening at 6 till closing at 8. Opens in parallel with KROJ, staying with them till KROJ closes at 7.45. KGEX, 15.21mc, joined them at 7.15, and KROU and KGEX remain together till KROU signs at 8 a.m.

**KROU, 'Frisco, 7.56mc, 39.66m:** Still a further outlet for AFRS and OWI and has apparently replaced KWY opening as it does at 6 p.m. in parallel with KGEX, 7.25mc. Would be a great signal only for the morse and noise that is always prevalent in that quarter. Has since been replaced by KNBI (in parallel with KNBX, 9.49mc).

**—, Delhi, 9.68mc, 30.99m:** To add to their already large number of transmitters, ALL INDIA RADIO have been heard for several nights on this part of the dial. At times, particularly near 10 p.m., overshadows VLW-6, but the general effect is a very bad heterodyne, making both signals unpleasant.

**WVLC, Manila, 9.295mc, 32.28m:** This is the station now used for the Philippine hour from 7-8 p.m., when most nights are very good except for occasional splashes of interference from morse. When closing, state, "Tune in again at 12.30 p.m. Manila time (2.30 p.m. Sydney) for 'Voice of Freedom' over this same station, WVLC, on 9.295mc."

**RADIO NATIONAL de ESPANIA, Madrid, 9.42mc, 31.85m.:** Mr. Arthur Cushen sends particulars of this new Spanish station. After a musical programme, were heard closing at 5.30 a.m. when a lady announcer in English said, "This is Radio National de Espania—we broadcast a daily English transmission for the English-speaking world—we wonld appreciate hearing from shortwave listeners and have verification cards; so please write to us—the address is 'Radio National de Espania, Madrid'—that will get us." (Gong). Male announcer then said, "That concludes our daily transmission. We broadcast again tomorrow from 7 p.m., G.M.T., so be listening then." March, and sign off.

Mr. Cushen says they are now on approximately 9.47mc, where he was hearing them for several days before getting announcement on 9.42mc. Signal on 9.47mc is, although clear of TAP, not so good.

I am told they were heard for several mornings around 10 o'clock on 15.61 mc, 19.21m.

A letter from Rex Gillett also shows them trying a still further frequency, this time on 9.57mc, 31.35m. He heard them at 3.15 a.m. with news in Spanish, for Europe was given till they closed at followed by a programme in Hindustani till 4 o'clock. Then a concert in English 4.30 a.m. with announcements in English, French, German and Spanish.

Mr. Gillett also heard them one morning during the same hours with similar programme on 9.47mc, 31.68m.

And now Mrr. Edel reports them on still another frequency, this time 9.545 mc, 31.43m. At 2.15 a.m. in English a trical industry in Spain was given. Just very fine talk on the radio and electbefore 3 o'clock, said that first half of programme is now finished. Then in Portuguese they called Portugal.

Well, maybe by the time these notes reach you they will have settled down on one or two of the tests.

**RADIO BELGRADO, Belgrade, 9.507mc, 31.56m:** Mr. Edel reports hearing Yugoslavia around 1.30 a.m. An announcement was that they would broadcast in Russian on Saturdays and Sundays at 9.30 p.m. Moscow time on 49.18m (Sundays and Mondays, 4.30 a.m., Sydney).

Hardly had I typed the above and in comes an air-mail from Rex Gillett. He says he has heard them several times from 1.30 till after 3.30 on the 31.56m with a male and female announcer.

**XGOY, Chungking, 9.703mc, 30.91m:** Rex Gillett put me on to this one, saying he heard them just before 9.55 p.m. I find our Chinese friends open at 9.35 with gong and call-sign by Chinese girl. Signal is strong and would be quite good except for intermittent morse right on top. Musical programme followed with English announcements and at 10 o'clock, Chinese girl in English: "This is The Voice of China, XGOY, Chungking, broadcasting on 9,700 kilocycles and 7,153 kilocycles. Here are the news headlines from Chungking." They were of only 1½ minutes' duration and we were then requested to "tune in every night at 9 o'clock, Chungking time, for headline news from Chungking China." This was followed by announcement in Chinese by girl and on with Chinese music, followed by man in Chinese. Call-sign and frequencies were given again at 10.58½, followed by headline news with previous request. Then they went into French.

## STATION CHANGES

**WNRE, New York, 15.28mc, 19.63m:** This is a still further transmitter beamed to Europe and carrying U.S. O.W.I. programmes from 12.30 a.m.-9.15 a.m.

**WNRE, New York, 6.19mc, 48.47m:** Also beamed to Europe for same reason as above from 9.30 a.m.-4 p.m.

**VLC-6, Shepparton, 9.615mc, 31.2m:** Has now dropped Philippine hour and puts over programme from 7-8 directed to Asia. (Philippine hour is on WVLC—see "New Stations.")

**VLC-4, Shepparton, 15.315mc, 19.59m:** Is now heard from 8.30-9 a.m. in Japanese, directed to Tokyo.

**VLG-5, Melbourne, 11.88mc, 25.25m:** Is heard in parallel with VLC-2, 9.68mc, 30.99m, from 2.15-2.45 a.m., directed to Britain.

**KROJ, 'Frisco, 9.89mc, 30.31m:** This is the frequency now used in the transmission to Alaska from 2-4.45 p.m.—L.J.K.

**KWIX, 'Frisco, 9.85mc, 30.44m:** Until May 2nd, heard in parallel with KROJ, KNBA and KNBC from 5.30 till 6.30 p.m. and, when free from morse, puts in a great signal. Re-open as usual on the same freruency at 7 o'clock' and runs with KROJ (6.105mc) and KGEI (now on 9.55mc).

**Changes by KNBA, KNBC and KROJ:**
**KNBA, 13.05mc, 22.97m:** 3-5.45 p.m.; 5-6.45 p.m.
**KNBC, 15.15mc, 19.81m:** 3-4.45 p.m.
**KNBC, 9.70mc, 30.93m:** 5-6.45 p.m.
**KROJ, 11.74mc, 25.25m:** 5-6.45 p.m.

# The Month's LOGGINGS

**ALL TIMES ARE EASTERN AUSTRALIAN STANDARD TIME**

**Pressure on space only permits of unusual Loggings or alterations in schedules or frequencies.**

**Readers will show a grateful consideration for others if they will notify me of any alterations. Please send reports to Carlingford. Urgent reports, 'phone Epping L. J. Keast, 23 Honiton Avenue W., 2511.**

### OCEANIA

**Guam:**

**KU5Q** .... .... .... .... .... .... 17.83mc, 16.83m
Heard at about 10.30 a.m.

**KUIG** .... .... .... .... .... 10.51mc, 28.55m
Good at 8.30 p.m. (Young).

**KU5Q** .... .... .... .... .... 9.67mc, 31.02m
Audible at 10.15 p.m.

**KU5Q** .... .... .... .... .... 9.287mc, 32.30m
Good signal at 10.45 p.m. (Young).

**KU5Q** .... .... .... .... .... .... 7.40mc, 40.52m
Heard at 9.45 p.m. (Young).

**Philippines**

**WVLC,** Manila .... .... .... 15.92mc, 18.84m
Heard around 9.15 a.m. (Young).

### THE EAST

**China**

**XGOY,** Chungking .... 9.645mc, 31.10m
Heard at 12.45 a.m. (Young, Gillett).

**India**

**ZOJ,** Colombo .... .... 15.275mc, 19.64m
Opens at 1 p.m. with headline news, then programme summary—news at 2.30 Fair signal (Cushen).

**VUD-8,** Delhi .... .... .... 11.87mc, 25.27m
Heard "United Nations in Delhi, India" from 9.40-10 p.m. (Bayley).

——, Delhi .... .... .... .... 9.68mc, 30.99m
Heard from opening at 9 p.m. (Gillett).

### GREAT BRITAIN

**BBC, London**

**GRU** .... .... .... .... .... .... 9.915mc, 30.26m
Excellent to Latin-America in Portuguese at 11 a.m.—L.J.K.

**GRY** .... .... .... .... .... .... 9.10mc, 31.25m
Delightful signal in programme to the Forces from 2-6 p.m.—L.J.K.

**GRJ** .... .... .... .... .... .... 7.32mc, 40.98m
Terrific with A.E.S. programme at 6 a.m. (Cushen).

### AFRICA

**Algeria**

**AFHQ,** Algiers .... .... .... 6.04mc, 49.67m
Carries the U.S. programme "Cross Section" at 6 a.m. (Cushen).

**Belgian Congo**

**RNB,** Leopoldville .... .... 9.78mc, 30.66m
Heard with news for North America at 8.15, 9.15 and 10.15 a.m. with good signals (Gillett).

### CENTRAL AMERICA

**Guatemala**

**TGWA,** Guatemala City .. 15.17mc, 19.78m
Weaker than previously in mornings (Gaden).

**TGWA,** Guatemala City .. 9.76mc, 30.74m
Very fine till 4 p.m. with CBS programme (Cushen, Gaden).

### SOUTH AMERICA

**Brazil**

**PRL-7,** Rio de Janiero .. 9.72mc, 30.86m
Fair strength at 8 a.m. (Gillett).

**Chile**

**CE-970,** Valparaiso .... 9.73mc, 30.82m
Heard occasionally but very faintly at 8 a.m. (Gillett).

**Ecuador**

**HCJB,** Quito .... .... 11.115mc, 19.85m
Heard at 6.30 a.m. (Cushen). (Their present sked is 4.30-9 a.m.; 8-11 p.m.)

**HCJB,** Quito .... .... .... 12.445mc, 24.08m
Heard at 6 a.m. (Young).

**U.S.A. (San Francisco unless otherwise mentioned)**

**KNBI** .... .... .... .... 15.34mc, 19.56m
Weakest of the 'Frisco's in morning (Gaden).

**KGEX** .... .... .... .... .... 15.21mc, 19.72m
Probably the best 19-metre Friscan in morning (Gaden).

**KNBC** .... .... .... .... 15.15mc, 19.81m
Splendid signal before lunch (Gaden). (Sked is: 11.20 a.m.-1.15 p.m.—L.J.K.)

**KNBA, 13.05mc, 22.97m:** 3-4.45 p.m.; Heard in parallel with KNBC from 11.20 a.m.-1.15 p.m. at gradually increasing volume. See "Says Who" for other skeds. —L.J.K.

**KCBF** .... .... .... .... .... 11.77mc, 25.49m
The best San Friscan on this band in a.m. (Gaden).

**KCBA** .... .... .... .... .... .... 6.17mc, 48.62m
Heard well at 8 p.m. (Bayley).

**U.S.A. (Other than 'Frisco)**

**WOOW,** New York .... 11.87mc, 25.27m
Opens at 7.30 a.m. in parallel with WOOC, 7.82mc—terrific signal—heard till after 9 a.m. (Cushen).

**WLWS,** Cincinnati .... 11.71mc, 25.62m
Good at 9.15 a.m. (Young).

**WBOS,** Boston .... .... 9.897.5mc, 30.31m
Heard closing at 9 a.m. (Gaden).

**WNRA,** New York .... .... 9.855mc, 30.44m
Fair at 9.15 a.m. (Gaden). Fair at 9.45 p.m. (Young).

**WLWR,** Cincinnati .... .... 9.75mc, 30.75m
Very good at 9.15 a.m. (Gaden).

**WNBI,** New York .... .... 9.67mc, 31.02m
Audible at 10.15 p.m. (Young).

**WLWO,** Cincinnati .... .... 9.59mc, 31.28m
In parallel with but only half as good as WGEO at 9.15 a.m. (Gaden).

**WGEO,** New York .... .... 9.53mc, 31.48m
100 per cent in Spanish at 9.15 a.m. (Gaden).

**WOOC,** New York .... .... 7.82mc, 38.36m
Heard opening at 7.30 a.m.—Fair signal (Cushen).

**WLWS,** Cincinnati .... .... 6.37mc, 47.10m
Heard 8.45-10.15 p.m. daily in Spanish, also on 7.82mc, 38.36m (Cushen).

### MISCELLANEOUS

**Arabia**

**ZNR,** Aden .... .... .... 12.11mc, 24.77m
Fair at 2 a.m. (Young).

**ZNR,** Aden .... .... .... .... 6.75mc, 44.38m
Fair at 2 a.m. (Young). Heard poorly at 3 a.m. (Cushen).

**France**

**Paris** .... .... .... .... .... 9.52mc, 31.51m
Very fine at 6 a.m. (Cushen). Heard at 7.15 a.m. (Gillett).

**Paris** .... .... .... .... .... 9.49mc, 31.61m
Suffers from much interference at 6 a.m. (Cushen). Closes at 7.30 a.m. (Gillett).

**Italy**

**"The Voice of Italy,"** Rome
6.02mc, 49.81m
Closes at 8 a.m. with fine signal after giving news in German (Gillett).

**Poland**

**Radio Lublin,** Lublin .... 6.115mc, 49.05m
Has been heard concluding an English language programme at 3.45 a.m., announcing as "This is the Polish Radio, Lublin calling" (Gillett).

**Sweden**

**SBU,** Stockholm .... .... 9.545mc, 31.46m
Not reported for a long time—has been fairly good strength in relay with SBU, 6.065mc, 49.46m At 7.15 a.m. customary 11 notes are heard.

**Switzerland**

**HEO-4,** Berne .... .... 10.345mc, 28.99m
Heard at great strength but does not seem to be on every day Has news at 5.45 a.m., then, "Swiss Spotlight" and "Swiss Observer." Signs at 6.15 a.m. with "Goodnight to our friends in America." Says next news in 5 hours (Cushen).

**Yugoslavia**

**Radio Belgrado,** Belgrade
9.507mc, 31.56m
See "New Stations."

## STATION CHANGES

**(Continued from page 24)**

**Change by KGEI:**

An announcement heard on Sunday, 29th April, stated that from 0900GMT, May 1st, a change in frequency to S.W. Pacific Philippine area would be made. KGEI will aperate on 9.55mc, 31.41m, from 7 p.m.-1.15 a.m.

**HER-5, Berne, 11.96mc, 25.08m:** Has replaced HEI-5 in Tuesday and Saturday broadcasts to Australia, New Zealand and Pacific area. Session now opens at 3 p.m. (three hours earlier than previously) and till closing at 4.30 is heard well but the earlier hour has not helped the transmitter on 12.965mc, 23.14m, so as from May 1st this will change to 14.535mc, 20.64m and result should be better.

**Further 'Frisco changes:**

**KRHO, 17.80mc, 16.85m,** carries AFRS programmes from 12.15-12.30 p.m. and 12.30-12.45 p.m.

**KNBI** has jumped from 6.02mc, 49.83m, to 9.49mc, 31.61m.

**Here are some to watch for:**

The following New Zealand transmitters may be testing any day—if they have not already done so: ZL1, 6080; ZL2, 9540; ZL3, 11,780; and ZL4, 15,280 kilocycles.

**KWV, San Francisco, 10.84mc, 27.68m:** Our old friend has returned but is out of luck for most of the time, at my listening post, owing to morse and noise. Opens at 6.15 p.m., and closes, I think, at 8.30 p.m. At any rate, by that time it has faded out owing to the noise generally associated with that part of the dial. Not a good spot for or intended for us, but may be reaching the Philippines O.K.

**KGEX, San Francisco, 7.25mc, 41.38m:** Now opens at 8 p.m.

# Speedy Query Service

**Conducted under the personal supervision of A. G. Hull**

**L.C. (Burwood) asks for the correct frequency for the intermediate transformers and oscillator coils of standard commercial brands, such as R.C.S., Radiokes, Crown, Kingsley and Aegis.**

**A.**—Most of these are nominally designed for a frequency of 455 kilocycles, but it is possible to adjust them to work on almost any frequency in the same region and still give satisfactory results. This is sometimes desirable in order to dodge a whistle on certain stations, for example, when a local station has a frequency equal to twice the intermediate frequency. When such trouble is encountered the i.f. frequency can be adjusted to 460 K.c.

* * *

**J.B. (Petersham) writes: "What is the voltage gain of a 6A6 twin triode used as a cathode follower driver? Is it necessary to use a separate filament winding for a cathode follower driver? What is the voltage gain of a 6J7G with 250 volts on the plate?"**

**A.**—You won't get any voltage gain in a cathode driver, but will get the ratio of the transformer used. It is not necessary to use a separate heater for the driver; only necessary with cathode-followers in push-pull with directly-heated valves such as 2A3. The voltage gain will depend on the plate load resistance used, the value of the grid leak following and other factors. Should be somewhere in the region of about 100 to 120.

* * *

**W.G.C. (Stawell, Vic.) wants to make up a power unit for a two-valve set and wants to know how to fit resistors to give 50, 100 and 150 volts.**

**A.**—The only easy way to get stabilised voltages is to put a voltage divider across the high tension and then take current off suitable tappings. If you take the current through resistances in series, then the actual voltage available will depend on the current drawn, as per Ohm's Law. With the voltage divider the bleeder current has a steadying effect on the voltage. We suggest using an ordinary 15,000 ohm wire-wound divider with adjustable clips. You can estimate the voltage roughly by the position of the clip. For example, a clip half-way up should give about half the full voltage at a low current drain. Incidentally, you should use another filter condenser across the output of the rectifier before the first choke, i.e., from rectifier heater to secondary centre-tap. Correctly a 4-volt rectifier valve should be used, but you might manage with an 80, which is designed for use with a 5-volt filament supply.

**In the February issue, on this page we enquired for information about "Durium" recordings. From a reader in Huntly, New Zealand, who says he has handled hundreds of these, we have the following remarks:**

**"They were very light and flexible, could be bent and twisted, folded or doubled without any injury. A child of four years could comfortably carry 120 to 150 records. The instructions on the records were that they had to be played with very blunt needles. Most of the public soon forgot to change the needles, and the first time these records were played with a sharp needle the sound track was simply cut to shreds, thus they died a quick death. Reproduction from these recordings was equal to the best in that day, about 1927."**

**(From another reader we have a rather shaky report that the "Durium" records were made of celluloid, but this seems doubtful. Anyone who can throw light on how these records were made is invited to let us have details for publication.—Editor.)**

## AUDIO OSCILLATOR

(Continued from page 15)

method of calibration requires the use of an oscilloscope. With it, the 60-cycle power-line frequency may be used as a basic "standard", since this frequency is kept fairly constant. Voltages at harmonic frequencies of 60 cycles then may be mixed with the unknown audio oscillator signal and then identified through a knowledge of certain geometrical patterns which appear on the screen. These patterns are known commonly as Lissajous figures. Their interpretation is simple because, when they are brought to a standstill on the screen, they represent a simple ratio between the two frequencies which appear simultaneously on the vertical and horizontal plates.

### Conclusions

Sometimes an audio system which is designed for general use by the public need not have a frequency range anywhere near to that of the test oscillator here described. The average human ear can not respond above approximately 15,000 cycles. Broadcast modulation is limited to 5 kc. plus and minus the carrier frequency — a band width of only 10 kc. Just where a wide-band audio oscillator such as this one finds its usefulness may not at once be apparent. It has been pointed out in this article, however, that certain of the newer developments in radio circuits, more particularly in the field of f.m. and video, require wide-band circuits for special purposes, so that the width of the audio spectrum with relation to the human ear is beside the point. If such circuits are to be tested, a wide-range oscillator such as the one described in this article is required.

## HI-FI HINT

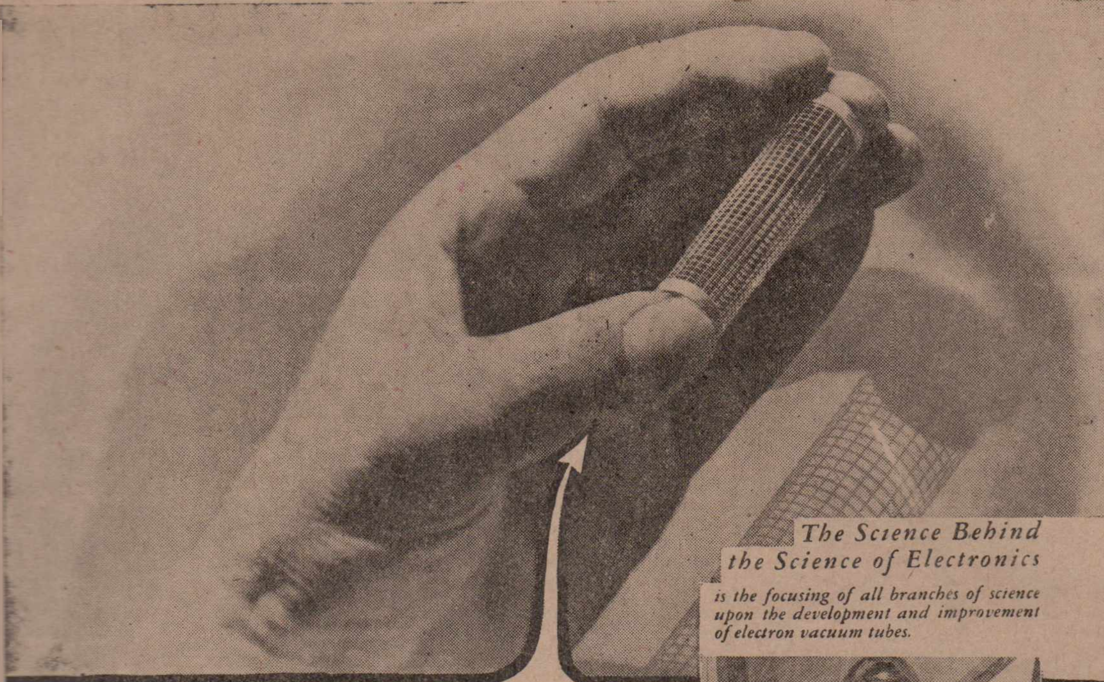
(Continued from page 11)

is going to step down the plate resistance in the same ratio, so only the ratio of the two resistances count. Using Type 50 tubes, the plate resistance would appear as a 4 ohm shunt resistance across a 10 ohm voice coil. 45 tubes give a slightly lower shunt resistance, but 2A3's, running Class A, give less than a third of an ohm. However, these same 2A3's, running Class AB1, have a resistance of 11½ ohms which is not so good.

By way of comparison, 6L6's give 78 ohms and 6F6's give 111 ohms when pentode connected.

There is an old rule that says that if you want 4 watts of high quality audio power, make an oversized amplifier of 10 or 20 watts. This rule was fine when everything was Class A. However, a 30 watt Class B or a 15 watt Class AB amplifier does **not** sound as well as a 4 watt Class A amplifier, provided 4 watts is all you want. Not to our ear anyway.

—William A. Ready.



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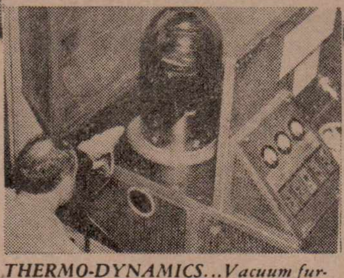

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