THE AUSTRALASIAN

Radio World

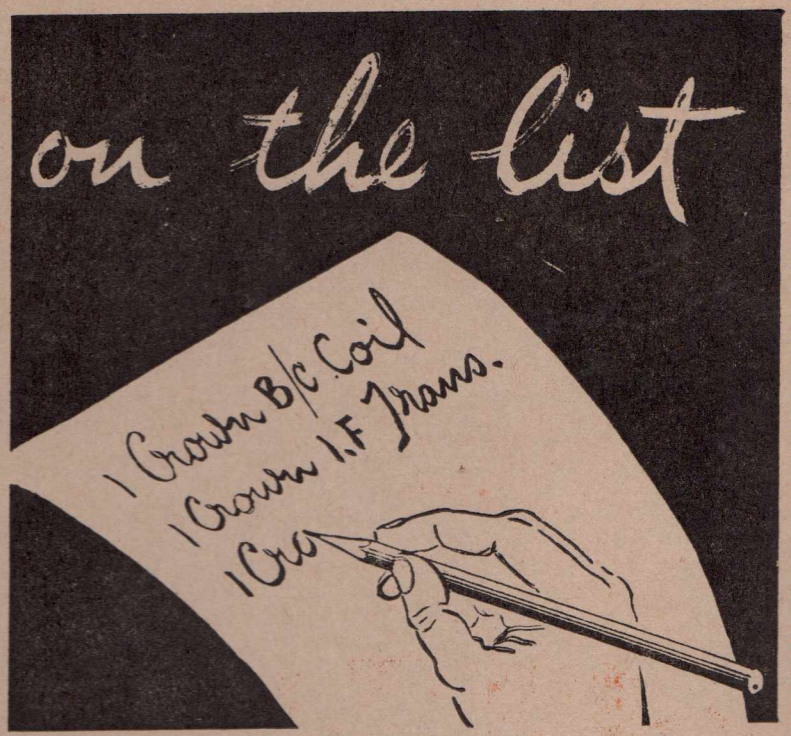
Registered at the G.P.O. Sydney, for transmission by post as a periodical.

1/-

VOL. 10 ..... NO. 8 JAN.-FEB. 1946

First on the list

FOR SET BUILDERS



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RADIO WORLD

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EDITORIAL

I laughed at a comic drawing in the local paper recently. In the first picture a man was struggling on to the step of an overcrowded bus, muttering to himself, "There's lots of room if the people on board would just move up a bit." In the second picture the bus has reached the next stop and this time our hero is muttering, "Surely these silly fools don't think they can get on this bus; they ought to be able to see that it is overcrowded already."

The radio trade is like that, too.

You find that many people with a handy knowledge of the radio game change over from amateur to professional status, set themselves up in business and, when firmly established, they take on a high and mighty air of superiority and mutter, "The Government ought to stop people starting up in the radio business unless they are fully qualified."

Few people in the radio trade are able to boast that they can pass examinations in every phase of radio theory, but this does not mean that they need be unable to give the public service or make profits.

On the contrary, they may be endowed with more common sense, business acumen and general knowledge than those who have spent the best years of their lives in the cloistered halls of a University.

A reasonable amount of healthy competition is likely to be a far better safeguard to the public than any government regulations or examinations.

A. G. HULL.

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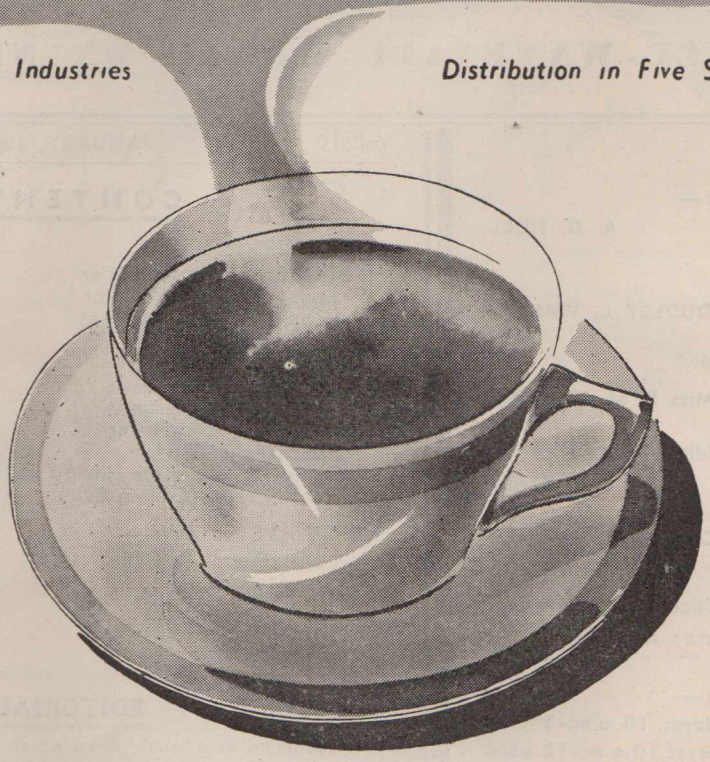

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THE CHAMPION AMPLIFIER

ELSEWHERE in this issue is an article by Charlie Mutton, Victorian Amplifier Champion, in which he tells of the design of his winning amplifier and the experimenting which he carried out prior to the contest. Now, as everybody should know, Charlie won the contest in fine style and the article has added interest.

Minor Changes

Actually a couple of minor changes were made at the last minute. The main change was in regard to the driver valves, which were changed from the 6V6G shown in the circuit diagram, to 6J7G's as triodes. The reason for the change was the abandonment of the cathode follower principle. The drive requirements as used originally had to be reduced somewhat for normal plate loaded arrangement. This change involved changing the plate loads of the drivers from 10,000 ohms to 100,000 ohms, using a 2,000-ohm bias resistance for the drivers in place of 125-ohm and re-arranging the voltage distribution due to the fact that the 6J7's were only drawing about 3 mA each instead of 18 mA, for each 6V6GT. This involves a reduction of 30 mA in driver plate current. The output switching was still retained as in the original amplifier, however, just in case anyone interested should want to hear the difference in the two modes of operation of the output stage. Strange to say that even changing to 6J7 triode drivers, there was still ample drive available to make the cathode follower sound much too loud for comfort.

In view of the fact that in the past the writer has made a special feature of articles on direct-coupling and has in reply had a gratifying response from readers all over the Commonwealth who have built direct-coupled amplifiers, it is felt that there was adequate justification in featuring such articles. Further justification is evidenced when it is seen that out of thirteen finalists of a total of sixty-seven entries, Mr. Hutchinson won Grade 4 with a direct-coupled job and succeeded in getting into Grade 1 and Grade 2; Mr. Stevens, who unfortunately had pick-up trouble, reached Grade 1 and Grade 2 with a direct-coupled job, and finally Mr. Alexander was placed second in Grade 3 for single-ended jobs, with a 6J7 direct-coupled to a single 6L6.

Out of curiosity the writer asked the judges after the contest was over just what the results of the Decca Frequency Record Test revealed or, in other words, was the winning amplifier much different in

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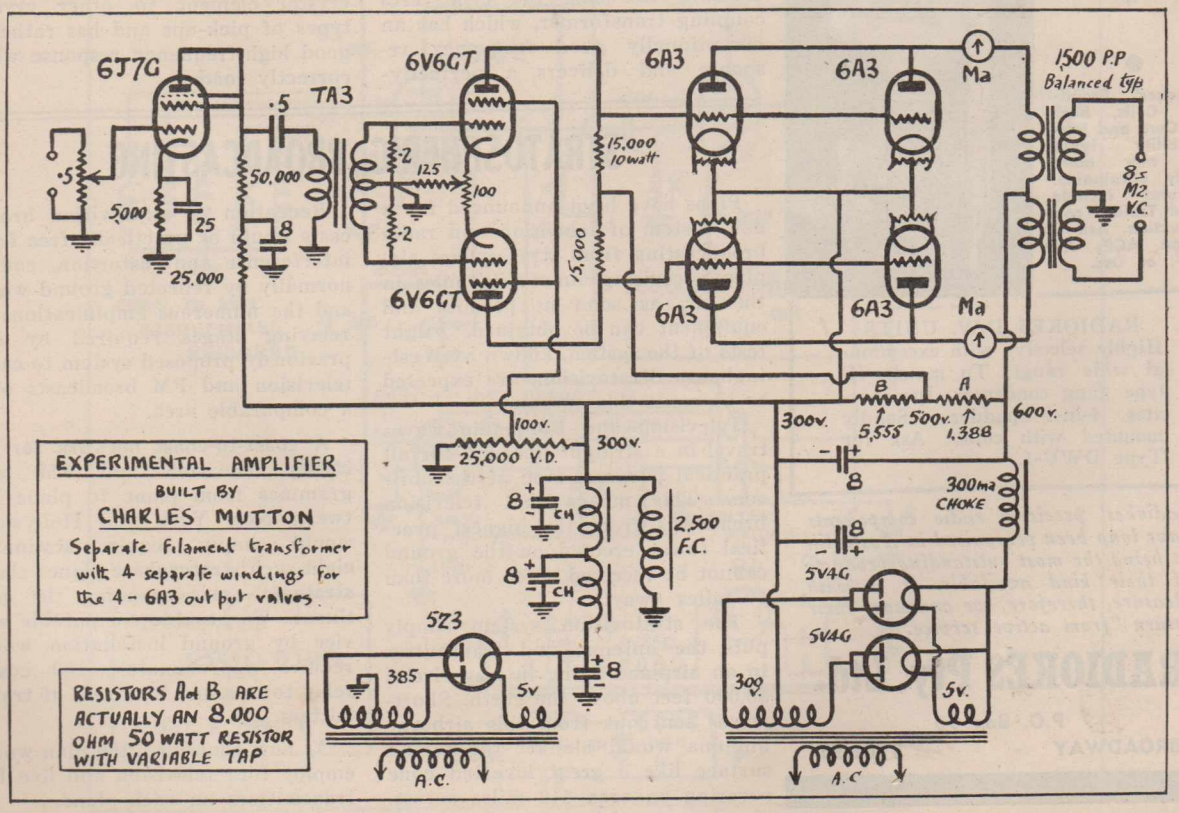

CHAMPION

(Continued)

response to the other entries. It therefore becomes interesting to note that all amplifiers were within three to four DB of one another on bass and middle frequencies but at 5 KC the winning amplifier was +10 DB up on any of the other entries. Examination of the figures seemed to place Mr. J. Hutchinson next to the winning amplifier in the matter of high-note response. One particular point which seems to have been neglected by most competitors was the very necessary expedient of pick-up equalisation due, no doubt, to the popular misconception that crystal pick-ups possess a good high-frequency characteristic. The writer hopes at an early date to feature a short article on the matter of pick-up equalisation and its practical application.

The other point which was most evident was again, as in last year's contest, the prevalent use of both coupling and output transformers designed and produced by Trimax Transformers. The success of the writer's amplifier was due in a large measure to using the type TA3 coupling transformer, which has an exceptionally good frequency response and delivers a perfectly-balanced push-pull signal to the driver stages without any trace of distortion. The output transformer, equally important, was also of Trimax design and was quite a hefty 30-watt job with both primary and secondary windings sectionalised and perfectly balanced electrically. This transformer closely approaches a standard 150 mA power transformer as regards physical dimensions, thus giving adequate inductance in the primary, a point most necessary for the production of true bass response at all levels.

Class AB1 operation of the four 6A3's in the output, with fixed bias, required the use of a speaker of exceptional power handling capabilities with plenty of field watts for adequate energisation. The imported Jensen M20 with appsox. 35 watts in the field did the job admirably, and with a measured 22 watts of audio in the voice coil, showed not the slightest signs of cracking up, which more than proves the old saying that an amplifier is only as good as the speaker on the end of it.

The pick-up used was a Tru-Tan model B10 with the off-set head. This particular model has a different crystal element to other crystal types of pick-ups and has rather a good high-frequency response when correctly loaded.

STRATOSPHERIC BROADCASTING

Plans have been announced for a new system of television and radio broadcasting from stratosphere airplanes, cruising almost six miles in the air, as soon as permits and equipment can be obtained. Flight tests of the system, known as Westinghouse Stratovision, are expected to be made this autumn.

Television and FM radio waves travel in a straight line and for all practical purposes stop at the horizon. This means that television broadcasts from the highest practical tower erected on the ground cannot be received much more than 50 miles away.

The stratovision system simply puts the antenna and transmitter in an airplane flying in lazy circles 30,000 feet above the earth. Shortwaves sent out from this airborne antenna would blanket the earth's surface like a great inverted cone covering an area 442 miles across.

Reception of stratovision broadcasts would be practically free from interference and distortion, caused normally by reflected ground waves and the numerous amplifications or relaying stages required by any previously proposed system to carry television and FM broadcasts over a comparable area.

A coast-to-coast network for relaying television and FM programmes from plane to plane between New York and Hollywood would simply require stationing eight such stratosphere planes above strategic areas spanning the continent. To provide comparable service by ground installation would require approximately 100 costly relay towers and hundreds of transmitters.

As now conceived, the plan would employ four television and five FM transmitters on each plane.

SIMPLE SERVICE OSCILLATOR

MOST radio men, whether on the servicing side or just for their own use in their experiments, possess a multimeter. Fewer of them own their own modulated oscillator, and really find the need for one almost as

By

G. L. F. SMITH

pressing as that of a multimeter.

It is the intention, therefore, to describe an instrument which has been constructed by the writer, after many trials of various circuits.

As with all instruments there are a large number of ways in which one can be constructed, and rather than lay down any particular layout, that will be left to the individual constructor.

Before going any further it would be advantageous to discuss the requirements of such an instrument.

Frequency Range

Being primarily a source of Radio Frequency, the first thing to be considered is just what frequencies are likely to be required and if possible to incorporate coils to cover them all. As I.F. alignment is one of the main uses for the oscillator, all these frequencies must be available, and considering the fact that there are still many sets in use with 175 kc/s. If's, then we could start with this as our lowest frequency. As 100 kc/s. is extremely useful for checking of calibration it would be as well to include this in our range.

All broadcast frequencies would be essential and higher frequencies up to 30 mc/s. also. These latter could be only those most commonly used bands, but with the advent of all wave receivers a complete coverage from 100 kc/s. to 30 mc/s. or higher would be far more satisfactory.

Frequency Stability

For any alignment to be accurate it is essential that the frequency remain constant irrespective of any exterior variations. To overcome this a buffer circuit between the oscillator tube and the output is really essential.

Modulation

In using oscillators on receiver work the resulting output after passing through the detector must be audible in the speaker, or else a signal which can be measured on an output meter. Modulating the RF with an AF signal provides us with the answer to this problem.

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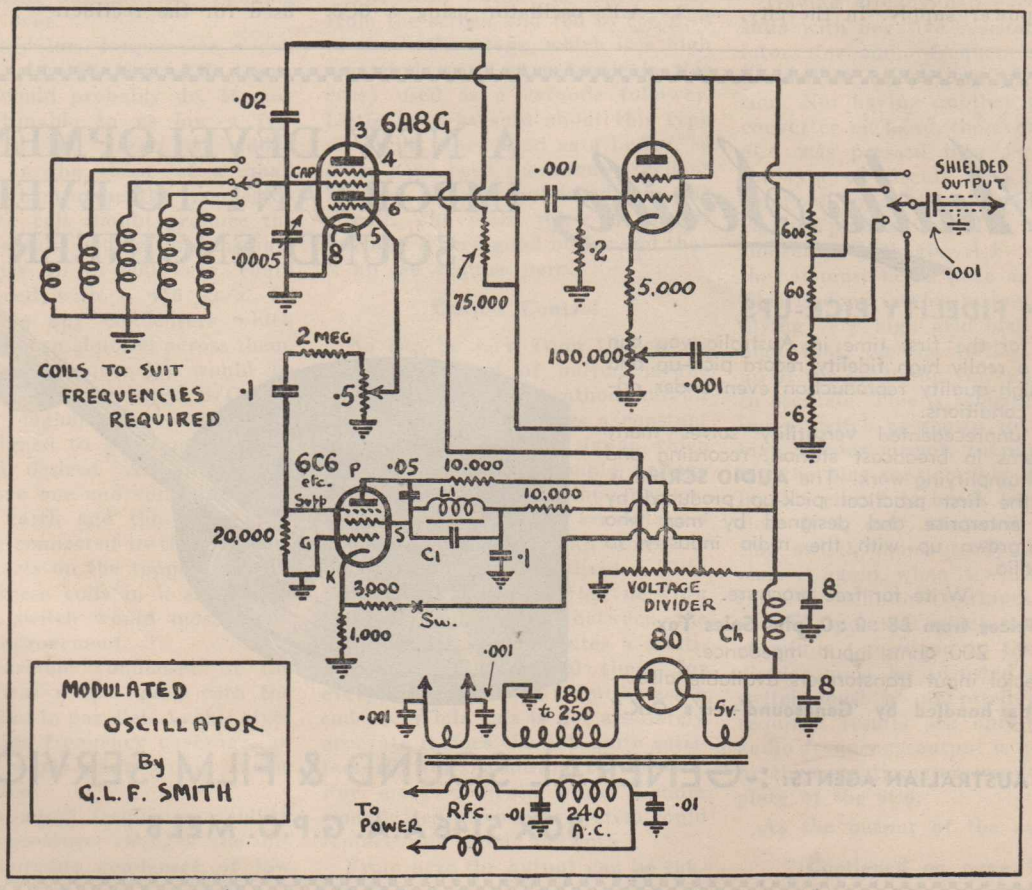


OSCILLATOR

(Continued)

The audio frequency usually used is 400 c/s., although any frequency which suits the user may be used. The RF is normally modulated to 30 per cent by this AF.

Output Control

As the output signal may be applied to any stage in a receiver, some means must be provided to vary its amplitude in order to prevent overload of the set when applied to early stages and against that to provide sufficient amplitude for the later stages.

This variation is usually carried out in two stages. One is by means of a switch which taps off the signal in approximate multiples of the previous tapping out. The other control is an ordinary potentiometer for varying the output over the range provided by the coarse control.

Power Supply

The conditions under which the builder operates really governs the type of power supply. In the city, of course, the usual thing is to use a standard AC power supply, but where no AC is available, either vibrator or dry battery supply would be used. Possibly the most useful system would be a combination AC-Vibrator supply as used in some portable and communication receivers.

Dry batteries would only be considered as a last resource on account of their unfortunate habit of being exhausted just at the time they are required.

The Complete Unit

The outfit now to be described endeavours to comply with most of these previously mentioned requirements.

It contains four tubes, which are used in the following jobs:—

1.—R.F. oscillator. 6A8G pentagrid converter. Can be any pentagrid battery or AC the user cares to substitute.

2.—Cathode follower buffer stage using a 6D6 triode connected, but open to very wide variation of tube types.

3.—A.F. oscillator using a 6C6. Any sharp cut off RF tetrode will be O.K. here.

4.—Rectifier (Power Supply) AZ3. ½-wave circuit. Any supply desired may be used.

H. T. Supply

A standard 40MA standard power transformer may be used, but in case it may be of assistance to the builder who possessses an odd size transformer, the one used was originally from a telefunker 3 tube receiver and was about the same size as a bell transformer. The input was 115V. or 230V. and the H.T. output about 200V. half-wave. Only one separate filament winding of 4 volts was provided, as the rectifier was intended to have its filament provided from a 4V. tap on the H.T. secondary. As a 6.3V. winding was required the transformer was pulled apart and the 4-volt winding's turns counted and found to 12 turns per volt.

Winding 76 turns of approx. 20 SWG enamel wire over the 4V. winding gave the 6.3 volts as required, and the 4V. winding was used for the rectifier.

The AZ3 being a full wave rectifier had its plates tied together more from force of habit rather than to provide more current, as one plate alone would provide several times the current required. The filter, as seen in the circuit, is normal and the resulting DC output is between 180-200 volts. If a 40 MA transformer is used its output may have to be reduced to 200V. Ripple in the output of the original job was so low that it presented no difficulties in any way.

The R.F. filter circuit in the line side of the transformer is not really essential, although it does prevent any possibility of RF signal feeding through the mains.

R.F. Oscillator

This section uses the pentagrid converter tube in a negative resistance oscillator circuit, as can be seen from the circuit, only a single untapped coil is needed for any particular range of frequencies and feedback coupling or taps are dispensed with, which results in a simple single pole multi position switch being suitable for changing the coils over.

For very low frequencies a coil from an old 175 kc/s. I.F. transformer would probably do. It may not be tunable to as low a frequency as 100 kc/s. but added capacity in the shape of a small condenser permanently connected across the coil should produce the desired result. Other intermediate frequencies up to 500 kc/s. could be obtained with a 455 kc/s. IF coil, minus any condensers which may have been shunted across them.

Broadcast frequencies would be obtained with a midget B/C coil and the higher frequencies with coils designed to give any particular band desired. All these coils would have one end connected to a common earth and the other ends would be connected to their respective contacts on the tapping switch. Placing these coils in a shield can with the switch would most likely be an improvement.

The variable condenser in the original was a two gang with the two sections in parallel. As this gives a very wide frequency coverage, an ordinary single gang would suffice in its place.

For improved frequency stability with temperature changes the fitting of ceramic condenser of low value (about 10 uuf) across the main gang would be an advantage. This type has a negative temperature co-efficient and would offset any changes in the capacity of the main gang.

The R.F. output is taken away from the screen and fed to the grid of the buffer stage, which is a high mu triode (6C6 as a triode in this case) used as a cathode follower. Little need be said about this type of circuit when used as a buffer, as there have been numerous excellent articles already published on this circuit. The main thing is that it provides a very good buffer and that is all we require here.

Output Control

As can be seen from the circuit the fine control of output is the potentiometer in the cathode circuit of the buffer. This gives a constant variation of the output signal, which is then fed to the simple voltage divider network. Various proportions of the full output are obtained by using a switch to tap along the different points on the divider. With the values shown in this network there is relationship between the points which approximates a multiplication factor of 10 times for every switch position from the earth end up. While this is not absolutely accurate it does the job quite satisfactorily for the normal serviceman. For more accurate work a more complicated attenuator system could replace this simple network.

From here the output can be taken away by means of a shielded lead, preferably one which has the additional protection of rubber over the shield (microphone cable).

A.F. Oscillator

Having already had excellent results with negative resistance oscillators for audio frequencies it was decided to utilise one on this section. Not having another pentagrid converter on hand, the ever popular 6C6 was pressed into service and the type of circuit used is usually referred to as the "Dynatron" in English publications. The main consideration with the A.F. output is that it must be as pure as possible. This is done in this instance by applying very high grid bias. It is so high that, on the initial warming up of the oscillator, the tube refuses to oscillate. This is remedied by using a switch as shown to open the bias bleeder circuit, thereby reducing the bias considerably and causing the circuit to break into oscillation. It is only necessary to open this switch momentarily and then close it again, when it will be found that the oscillator continues to operate. The point at which this bleeder circuit is tapped on to the voltage divider must be adjusted until the switch must be operated until the required results are obtained. The audio frequency output is controlled by the potentiometer coupled to the plate of the 6C6.

As the output of the audio sec-

(Continued on page 11)

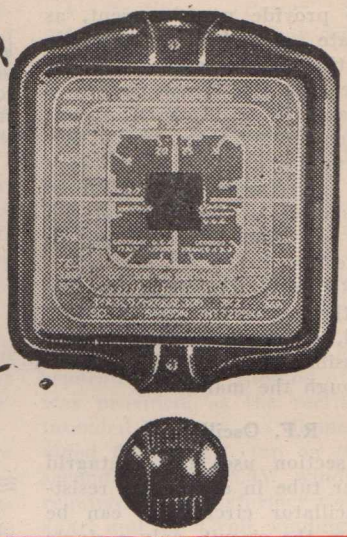
Colour Code for "LITTLE COMPANION"

From the hundreds who were lucky enough to get "Little Companion" kits before the strike and power restrictions upset the supply of components, we have had many congratulations on the job. Only one doubtful point seems to have been encountered, and this was in regard to the color-coding of the resistors supplied with the kit. However, better late than never, so here is the colour code for the sizes of resistors actually used in "Little Companion":

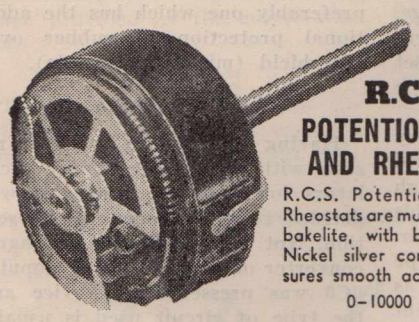
250—Red body, brown dot, green end.
400—Yellow body, brown dot, black end.
2,500—Red body, red dot, green end.
20,000—Red body, orange dot, black end.
40,000—Yellow body, orange dot, black end.
50,000—Green body, orange dot, black end.
100,000—Brown body, yellow dot, black end.
250,000—Red body, yellow dot, green end.
500,000—Green body, yellow dot, black end.
1 megohm—Brown body, green dot, black end.

Back Again!

THE POPULAR R.C.S. DA7 RADIO DIAL



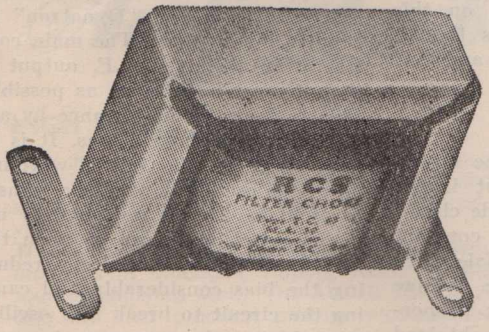
TROLITUL — a semi-transparent, lightweight moulded insulating plastic — is used exclusively by R.C.S. in the manufacture of R.C.S. quality radio components.



R.C.S. POTENTIOMETERS AND RHEOSTATS

R.C.S. Potentiometers and Rheostats are mude of moulded bakelite, with brass spindles. Nickel silver contact ring ensures smooth action.

0–10000 Ohms.



R.C.S. FILTER CHOKES AND AUDIO TRANSFORMERS

These R.C.S. quality components incorporate heavy copper wire wound on Trolitul bobbins. The use of Trolitul eliminates electrolysis, ensuring much longer effective life.

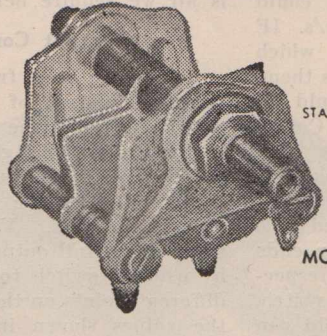
TB4. A Class. Single.
TB5. A Class PP.
TB6. B Class PP.
TC65. 50 M/A 30. H.
TC60. 100 M/A 30 H.
TA4. Audio Chokes.
TC58. L.T. Vibrator Chokes.
TC70. H.T. Vibrator Chokes.

R.C.S. TRIMMERS

R.C.S. Trimmers—Two-plate coil trimmers mounted on Trolitul base.

R.C.S. STAR AND M/C CONDENSERS

R.C.S. Midget condensers feature Trolitul end plates and are available in single and double bearing types.



		Max. Cap. MMFD.	Min. Cap. MMFD.	Plates
STAR	CV34	10	3	2
	CV35	15	3	3
	CV36	25	3.5	4
	CV37	35	4	5
	CV38	50	4	7
	CV39	70	5	9
	CV40	100	6	14
MC	CV41	10	3	2
	CV42	15	3	3
	CV43	25	3.5	4
	CV44	35	4	5
	CV45	50	4	7
	CV46	70	5	9
	CV47	100	6	14

R.C.S. RADIO PTY. LTD.

174 CANTERBURY ROAD, CANTERBURY

OSCILLATOR

(Continued)

tion is far in excess of that required for correct modulation the resistance in series with this potentiometer is used to reduce it to controllable proportions. Unless this is used it will be found that the potentiometer is unable to give sufficient control.

To check satisfactorily the correct position for approximately 30 per cent a C.R.O. is really essential, but should the constructor not have access to such an instrument, he would have to judge by ear. Overmodulation would be indicated by bad distortion. The setting of the potentiometer may be left at this point, or else the shaft can be brought out through the panel for manual operation.

To prevent feedback of the AF through the HT leads decoupling must be employed.

The entire AF oscillator must be placed within its own shield also to prevent stray AF from getting places when it shouldn't.

The audio frequency is governed by the combination of coil and condenser, which are varied until the required frequency is obtained. The coil in this case was the primary of a midget speaker transformer and the condenser would have to be of such a value to produce the desired results.

The switch shown in the screen H1 lead to this tube is to enable the modulation to be switched off entirely on occasions when a source of pure RF signal is required.

Should AF only be required, switching can be used to allow AF to be sent to the output terminals with the RF section switched off. This would prove extremely useful for AF measurements in amplifier and general signal tracing.

The complete unit must be enclosed in a shielded container which, in the original, consisted of a black iron box with the back brazed in, while the panel was aluminium. Self tapping screws were used in this job wherever possible, as they are very convenient, and do away with the need for nuts or tapping of holes.

A leather handle and rubber feet finished the cabinet, except for a coat of enamel or some such treatment.

Wiring of the original was carried out wherever practicable with square tinned copper bus bar which happened to be available, and the small components are rigidly mounted, with the result that the whole construction is very stable, and unless this is so, it is hopeless to expect the calibration points to remain accurate.

Calibration

When satisfied that all is functioning satisfactorily and that none of the parts are likely to move, then the most important part of the job can be done, and that is calibration of the dial for the different frequencies and bands.

The dial itself could be plain with the frequencies marked as they are checked, or else an ordinary 0-180 or 0-100 dial could be used, and the calibration done using graph paper and completing a curve for each bank.

Should an accurate frequency meter be available, then it is a comparatively simple matter to carry out this work.

Without such an instrument the job is a little more difficult, but an ordinary receiver can be pressed into service here. The unmodulated RF output of the oscillator can be beaten with the signals from broadcast stations, to check broadcast band frequencies. For intermediate frequencies a rough check can be made to ensure that the oscillator is near right by feeding into a known frequency IF stage, then for accurate checks the harmonic of this IF signal can be beaten with broadcast stations as before. An example would be for 455 kc/s. If there is a station on 910 kc/s. zero beat the two by varying the oscillator, making sure that the right harmonic is being tuned in. One way of checking this is to swing the receiver dial until the signal from the oscillator is heard again. The difference in frequency between these two points is the output frequency of the oscillator.

Even though a transmitter may not be operating on a particular frequency, sufficient accuracy can be obtained by checking on both sides of the required frequency a taking an average point.

Higher frequencies than broadcast bands may be checked against known frequencies, particularly in 5, 10 and 20 mc/s., at which points are to be found marker signals of a very high order of accuracy.

Having built such an instrument any mechanic would soon find that the care put into its construction amply returned in performance, and although not held up to be the best of modulated oscillators, it does a very good job indeed.

RADIO PROXIMITY FUSE

The discovery and development of "radio proximity fuse" which in its success in war rated second only to the atomic bomb has been announced by the United States Navy Department.

The fuse, no larger than a pint milk-bottle, packs its power in a glass tube five-eighths of an inch long and three-eights of an inch in diameter, which explodes a projectile when it is close enough to a target to inflict damage.

The VT-fuse, so named by the late Captain S. R. Shumaker, who as director of the research and development division of the Bureau of Ordnance began its production, is described as "an extremely rugged five-tube radio sending and receiving station which fits into the nose of the projectile."

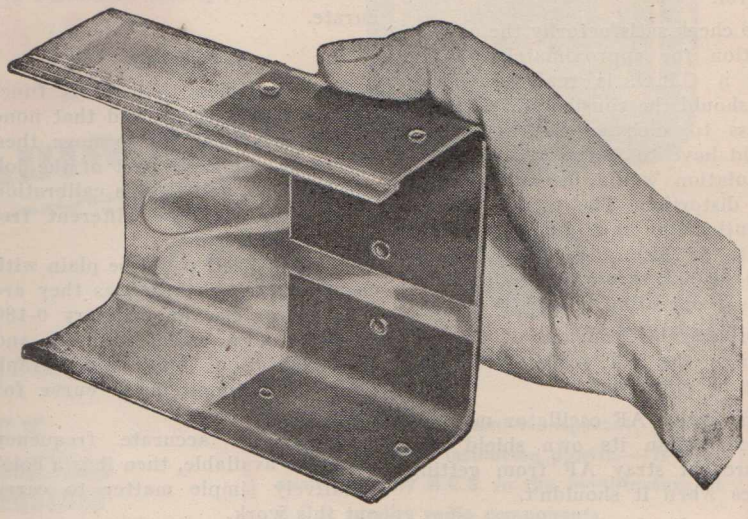
Within it is a vacuum tube which sends out electro-magnetic waves on impulses at the speed of light or at 186,000 miles a second. The impulses are reflected back by any target that gives radio reflection, such as metal objects, water or earth.

If a VT-fuse projectile passes within 70 feet of an airplane, reflected impulses trigger a switch which causes an electrical detonator to set off the main charge.

Use of the device eliminates fuse-setting, excludes errors inherent in time-fuse mechanisms and makes possible maximum results at the split-second speed demanded by modern anti-aircraft fire.

KINGSLEY DOES IT AGAIN!

"FERROTUNE" *by KINGSLEY*



● ANOTHER MAJOR TECHNICAL DEVELOPMENT

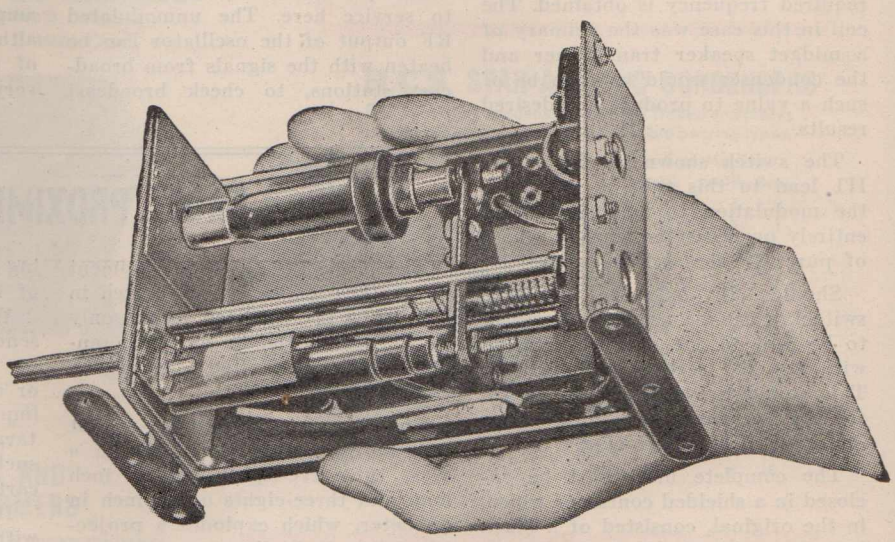
Announcing the first of a series of Gangless Tuning Units — "Ferratune" is a device which tunes a Radio Receiver without the use of a conventional gang condenser.

● FREQUENCY COVERAGE

540 KC to 1650 KC; each revolution of driving knob equals 100 KC.

● DIAL READING

Straight line tuning all over dial.



● MECHANICALLY SOUND

Robust construction, well engineered for long service under all conditions.

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CATHODE FOLLOWER TESTS

By
CHARLES MUTTON
1 Plow St., Thornbury
Vic.

BY the time this article reaches print and is published, the approaching Victorian Amplifier Championship, which is held annually will probably be over and done with. And all we who laboured and were burdened with the usual "pre-comp." worries will have relaxed with a sigh. The writer being in close touch with most of the enthusiasts who dabble with amplifiers has noticed a subtle swing towards using the cathode follower technique.

This fact, the writer believes, is due to previous articles published in this journal, and other overseas journals on the subject of the cathode follower output stage. All these articles to a large degree sing loud praises for this particular system, claiming improved bass response, greatly improved speaker damping, comparable results with cheaper quality transformers to those obtained with Hi-Fi transformers used in the normal manner. General improvement in high note and transient response. Such many and elaborate claims are really hard to ignore and sorely tempt even the most blase enthusiast to cast aside preconceived ideas on the normal plate loaded output stage and promptly adopt the cathode follower as a cure-all for all that ails our present systems.

Personally, the writer, having been associated with the game for close on sixteen years, is inclined to be a little sceptical of elaborate claims made for many recent developments. After seeing so many new innovations come and go and then to find that after witnessing half a dozen or more different amplifier contests in two different States, draw to a conclusion with the lowly old triode the 2A3 finish up unquestionably the victor often makes one wonder just what **is** the next step forward. However, let it not be assumed that the writer is conservative in his views, that is far from the case; on the contrary, the writer is only too pleased and interested to try anything which aims at improving existing audio equipment, but at least requires adequate proof that such an improvement exists and not merely the result of a long tussle with a slide rule and many pages of mathematical formula. How prone is the academic mind to conjuring up amazing performances on paper, only to be sadly disillusioned when it comes to the practical application of the problem in question.

The following article is a summary of results obtained while conducting experiments on the cathode follower output stage, admittedly they are not entirely conclusive results, but nevertheless they give some food for thought and in these particular set of circumstances rather tend to disprove some of these aforementioned claims.

Making Certain

In the first place this particular amplifier was designed with a view to entering it in the forthcoming Amplifier Contest, and in view of the many claims of cathode follower enthusiasts, it was thought desirable to use the cathode follower output stage, merely to determine just how good the system was. Being a direct coupled fan it was also thought desirable to use direct coupled drivers to the output stage. Now, in previous articles the matter of drive came into prominent discussion, in view of the fact that the output stage operates with an approximate gain of .9, in other words a loss, the drive required is terrific, due to the fact that one has to put more grid drive in, than the AC signal voltage at the plates which produces the normal watts output. To do this, previous articles have told us, it becomes necessary to make use of a step-up ration transformer; in one particular case the ratio stated was 5 : 1. This fact the writer disagrees with entirely, because where is the transformer which has a step up ratio of 1 : 5 which does not seriously attenuate the high frequencies after reaching 5,000 cycles. However, this problem is not serious because it is not necessary to use a 1 : 5 ratio transformer. Push pull drivers followed by a Trimax TA3 type transformer which has a step up of only 1 : 2 overall will give sufficient drive for a cathode follower output stage, this particular transformer is beyond reproach in the matter of frequency response, the maker's guarantee a flat response from 30 to 10,000 cycles, while with balanced input, i.e., push pull drivers, as mentioned above, the high frequency response is greatly extended further still.

Direct Coupling

But neglecting transformer coupling to obtain the requisite drive, let us turn our attention to the direct coupled drivers as proposed earlier. At the outset let it be said that ordinary voltage amplifiers with reasonably high plate loads such as .25 megohms, present a serious difficulty in getting the required drive unless the impractical method of using about 8 or 900 volt supply is used. After many hours of poring over likely driver tubes it was decided that the most economical and most efficient would be a 6V6GT used as a power tube driver, penthode connection, but with a modification to the screen supply voltage to reduce the total current to an economical value. A set of conditions which seemed to have possibilities was as follows: A single 6V6GT with a plate load of 14000 ohms, 250 volts on the plate, 100 volts on the screen, only draws a total cathode current of approximately 18.5 milliamps and will deliver a power of 1.5 watts to the load at a total of 5 per cent second and third harmonic distortion. Under these conditions it requires only 5 volts drive for full output and the tube has an amplification factor of 325. It was decided then to use drivers using 15,000 resistive loads. two 6V6GT's in push pull under these conditions as direct coupled

(Continued on page 14)

CATHODE FOLLOWER

(Continued)

Using such low plate loads actually was a big advantage, as it provided the desired expedient of having a low resistance in the output grid circuit, which were being worked under fixed bias conditions. This reduced the possibility of running into the grid current region. As the writer stated in an earlier article last year, lack of power output with the previous direct coupled amplifier was a serious drawback in last year's competition, so it was decided to use push pull parallel 6A3's in the output stage, along with fixed bias from a separate well regulated supply. On paper this arrangement should deliver close to 30 watts peak power to the load, theoretically that is, but actually those figures are given for ideal conditions. Due, however, to the large plate swing of triodes and power supply problems, it is doubtful whether these actual output figures are ever obtained. However, allowing for insertion loss in the output transformer it was thought that a healthy 22 watts should be near the mark, which interms of undistorted power output is a lot of sound.

Phase Inverter

So now the design was taking shape the only thing left was the phase inverter. Anything in the form of resistance capacity coupling in the phase inverter stage is, to the writer, a horrible thought, so in went the TA3, which should be called "Old Faithful." The final set up, as revealed by the circuit, when we get to it, was as follows. A 6J7 triode connected shunt fed TA3 into PP 6V6GT's as direct coupled pentode drivers into 4 P.P. parallel 6A3's, fixed bias with 300 volts on the plates, with the output load in the centre-taps of the 6A3 filaments or cathodes as you wish.

At this stage the circuit had assumed rather large proportions and aroused certain misgivings as to its practicibility; however, it was perservered with and ultimately completed, much to the author's amazement, it worked with no hitches and worked exceedingly well. Plate current meters were fitted and a balancing circuit fitted in the cathode circuit of the drivers. The first impression from switching on was the entire absence of hum, which is not surprising, considering the amazing array of filter chokes, which, fortunately, are cheap. After playing several records, well tried favourites, while having to admit that the quality was good and distortion negligible, there appeared to be just that something lacking, the definition and transients were decidedly on the dull side, this proved a bitter pill to swallow, but it was realised that this was only the beginning.

Quick Switching

It was then decided to incorporate a quick method of comparison between normal plate coupling and cathode coupling; a logical scheme seemed to suggest a 6x2 wave change switch of the single bank variety, which would fit in a small space. Looking at the output circuit, the switching arrangement may appear complicated, but actually, taking it in sections will reveal its simplicity. Anyway it did what was required of it and that was to show up the complete farce of the cathode coupled output stage which has only one good feature to recommend it, and that is an extremely low damping factor at the voice coil, plus less hum and tube noise due to the large percentage of feedback used.

Upon switching from cathode coupling to plate coupling all doubts concerning the load in the plate vanished, the highs came up quite audibly; strange to say, the bass end lifted also. But the most marked difference was noticed in the vastly improved transient response. Not wishing to jump to conclusions immediately and condemn previous experimenters, it was thought that perhaps the author's ear was at fault; but no, four other people well versed in the game formed the same conclusion. The circuit, switching arrangement, etc., were all checked up carefully for slips, but everything was found to be in order, including a complete check with BFO, oscilloscope, and a reliable DB meter, both on inductive load and resistance load. Going one step further, a complete check from pick up to speaker was made and frequency runs versus output level, using a standard Decca frequency record were made. Again on inductive and resist load. All the answers checked up the same in every case, conditions, of course, being different on resistive load; but it all came back to the same indisputable fact, the highs from 5,000 cycles up were down 3DB using 1,000 cycles at zero reference level, and at 70 cycles the bass response was down 4DB, on switching to plate coupling, however, the response curve was back to normal. The complete set of figures are published from the frequency runs taken merely as a matter of interest for those who may wish to see them.

Going one step further, wishing to get complete satisfaction, a rough experimental amplifier was rigged up using 6L6G's in the output, using again the cathode coupled output arrangement and working the 6L6G's as pentodes the same results were obtained: still that brilliance and sparkle to the highs and transients entirely missing. Admittedly the amplifier was nice to listen to, but was dead, for all the world like listening to a speaker with a curtain flung over it.

NOTE —

The circuit referred to in this article will be found on page 5.

One thing different with the pentodes was noticed, however, and that was the bass response with the cathode coupled arrangement was exceptionally good as compared to the triodes hooked up the same way; but, of course, again the triodes under the normal hook up, i.e., loaded in the plate circuit, left the 6L6 job cold. However, it was decided that both amplifiers would be entered in the competition just to see if the forthcoming results also justifies the author's views. Provided either amplifier should be fortunate enough to reach the final, the results should be interesting. And thus ends a story on experiments with the cathode follower output stage. In conclusion, however, it must be pointed out that previous experimenters, while making elaborate statements regarding this new output stage, have not substantiated

their claims, with anything more than rather vague utterances that the bass response seemed good, the highs clean, and the transient response exceptional. To these I can only suggest putting in the switching arrangement as shown and really getting down to business and making a proper comparison. As far as the author is concerned, cathode coupling can stay where it rightly belongs: a matching device in video frequency amplifiers and coupling to low impedance lines. There are other uses to which it can be put, some of which are quite handy, but not in the output stage of an amplifier. As a parting shot, think of the inefficiency of the system, anyway.

Getting back to the circuit of the amplifier a few explanatory pointers may be helpful; it is extremely unlikely, however, that any amplifier enthusiast would be likely to go to all the trouble which the author has done in this particular case, but even so, one rather feels the trouble was justified after hearing the final job.

The Power Supply

In the first place it will be noticed that the power supply system is unorthodox. Perhaps the most simple way to regard the scheme would be to regard the two power supplies as two separate large batteries, connected in series with a potential divider across the whole supply, from which the various voltages for the amplifier are tapped off. One power supply delivers 300 volts DC at 325 MA solely for the 4 6A3 output tubes, this 300 volts being applied between the output plates and the centre taps of the filaments. Although the output stage only draws a total of 160 MA at no signal, this rises somewhat at maximum signal, certainly not to anything like the 325 MA rating of the power transformer but there are the driver currents to be considered, plus a generous allowance for bleed current and a certain amount to be allowed for regulation when the output stage is swinging on heavy bass passages. The HT negative of this big supply connects to the positive output of the second supply, which is performing the dual function of providing 300 volts fixed bias at the centre taps of the 6A3's and also the field energisation across the 2,500 ohm speaker field of the Jensen M20 speaker. In this way plenty of field watts are developed and the low resistance field across the bias supply ensures excellent stabilisation.

This possibly raises the question why are the filaments of the output stage 300 volts positive with respect to ground, which brings us back to our direct coupled scheme?

By having two power supplies in series we have got plenty of volts available, and in this matter the circuit shows that the actual plate supply for the drivers is tapped at a point 500 volts above the chassis, this means that the actual plate voltage right at the plates is somewhere in the region of 240v., allowing 260 volts drop in the 15,000 plate loads. This 240 volts positive is also applied to the output grids, under these circumstances we require that the filaments of the 6A3's float at 300 volts positive with respect to ground, which then provides the normal 60 volts negative bias required from class AB1 operation of the output stages. The voltage measured from the output plates to ground is therefore somewhere in the region of 600 volts. Two 5V4 rectifiers in parallel supplies the output stage, and a 5Z3 supplies the bias and field supply; this arrangement ensures that the bias is applied to the output stage before voltage is applied to the output plates, due to the bias rectifier being directly heated. As an added precaution a switch was incorporated in the HT centre tap of the 300 volt 325 mA power transformer.

The wattage in the field of the Jensen M20 amounts to about 36 watts. Across the field coil is also an additional 25,000 voltage divider which provides the 100 volts for the 6V6GT driver screens, this tapping is variable and forms a very convenient method of adjusting the output stage plate currents to the required 80 miliamperes per paralleled section. This is not hard to understand when it is realised that any change, even a small one, to the screens of the drivers will cause a fairly large change in plate current, which in turn causes a corresponding change in the drop across the 15,000 plate loads, which in turn will control the bias on the output stage and thus forms a very easy method of setting the output plate currents to the correct value. The output tubes were matched in pairs beforehand, and although under operating conditions two on one side were drawing 38 milliamps per tube, and the other pair 40 mills per tube, true balance was obtained by putting in the 100 ohm potentiometer in the driver cathode circuit as shown in the circuit. In this manner the hum voltage due to unbalance in the output circuit can be completely eliminated.

Only one other point comes up with this circuit, and that is the thermal noise, while not troublesome, is higher with this set up than normal; this is in no way detrimental to the performance, but is due simply to the fact that the tubes are operating at a higher plate voltage than is usual and the gain is fairly high. The thermal noise ceases when the first 6J7 is pulled out, which proves that it is being generated in this first stage and being subsequently amplified. In conclusion the author would be pleased to hear from any other enthusiasts who can throw any further light on the fors and againsts of the cathode follower output stage.

CATHODE FOLLOWER IN THE U.S.

Cathode follower circuits are still big news in the United States, and the latest (December, 1944) issue of QST contains a fine article on the subject, dealing especially with the use of cathode coupling for amplifiers operating in Class B. An interesting practical circuit is given to use a pair of 6V6G beam power valves in the output stage, with which it is claimed a flat frequency response (within a couple of decibels) from 30 to 15,000 cycles, although the outfit uses comparatively cheap audio transformers.

The author, Elliott A. Henry, of the Electronic Division of Maguire Industries Incorporated, Connecticut, U.S.A., gives due acknowledgment to "Australasian Radio World" as the source of some of the design data he has used in perfecting this amplifier.

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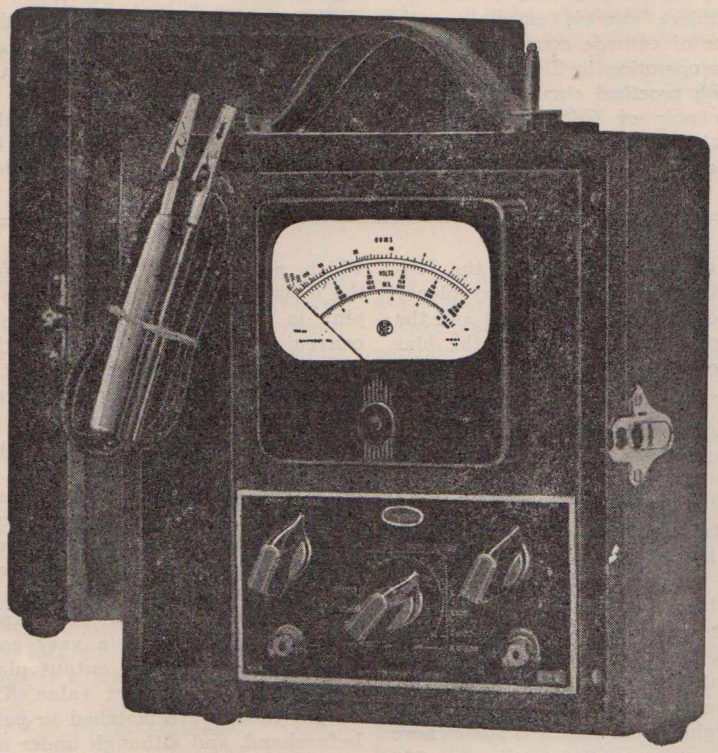

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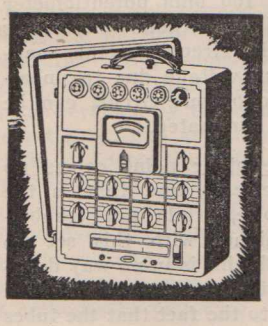

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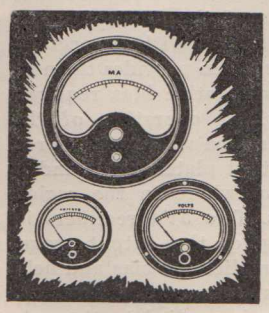

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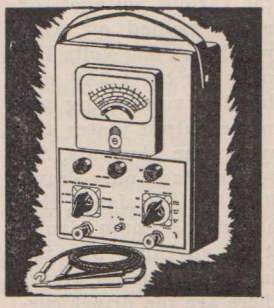

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HOME MADE FILTER CHOKES

By
J. G. DUFAUR,
B.E., A.M.I.E. (Aust.) A.M.I.R.E. (Aust)

SINCE publication of the article on transformers in the January issue of this paper, enquiries have been received requesting details for making iron cored filter chokes at home.

Before proceeding further, it must be emphasised that it is virtually impossible for any home experimenter with limited facilities, to make a filter choke of a specified inductance with accuracy by any other means than the trial and error method. In other words, make a choke which looks about the right size first and measure its inductance later. If the inductance attained proves insufficient, it is necessary to procure a larger core and/or increase the number of turns, thus increasing the inductance. The best way to test the choke is to fit it in the power supply for which it is required and see whether the resulting hum level is satisfactory. The inductance cannot be measured properly with a common bridge or multimeter since it varies according to the D.C. current it carries and, therefore, provision must be made to pass current through it under specified conditions before the inductance under any particular circumstances can be determined. It is hoped at a later date to describe special test equipment in these columns for making such measurements.

Theoretical Inductance

The theoretical formula for the inductance of a choke is as follows:

$$L = \frac{3.2\ N^2 u.A}{l} \times 10^{-8}$$

where L=inductance in Henries.
N=number of turns on choke.
u=incremental permeability.
A=cross sectional area of core in square inches.
l=length of magnetic path in inches.

This formula assumes, however, that the choke laminations are interleaved, i.e., no air gap exists in the magnetic path. In practice the formulae is of little use on its own, since the value of "u" not only depends upon the rated permeability of the core material but also upon the amount of A.C. and D.C. current which will flow through the choke.

If it is desired to obtain a complete understanding of the design of chokes, reference should be made to Chapter 26 in the "Radiotron Designer's Handbook," which can be obtained from any technical bookstall for the small cost of 5s. 6d. (Incidentally, this is an excellent investment, and every radio enthusiast should have a copy). In this book, complete details for the design of chokes carrying D.C. by Hanna's method, are given. Hanna's method is by far the most satisfactory procedure to adopt, but is generally of not much use to the home constructor because firstly he is using old laminations, with an unknown chemical composition, and thus does not know their permeability, etc. Secondly, the amateur finds difficulty in obtaining a uniform air-gap of a specified length, particularly because the correct gap value becomes less than the actual measured value where large gaps are used. In practice, choke manufacturers use Hanna's method to determine the general design of a new choke, following which they build a prototype and measure its actual inductance.

Practical Specification

From the average set constructor's point of view, he is mainly concerned with building a choke to the following specification:—

(1) The choke must have as high an inductance as possible (in most instances, any value between 15 and 30 henries will suffice. The actual inductance of the choke is not at all critical in the average case.)

(2) The choke must carry a specified current without overheating.

(3) The insulation must be cap-

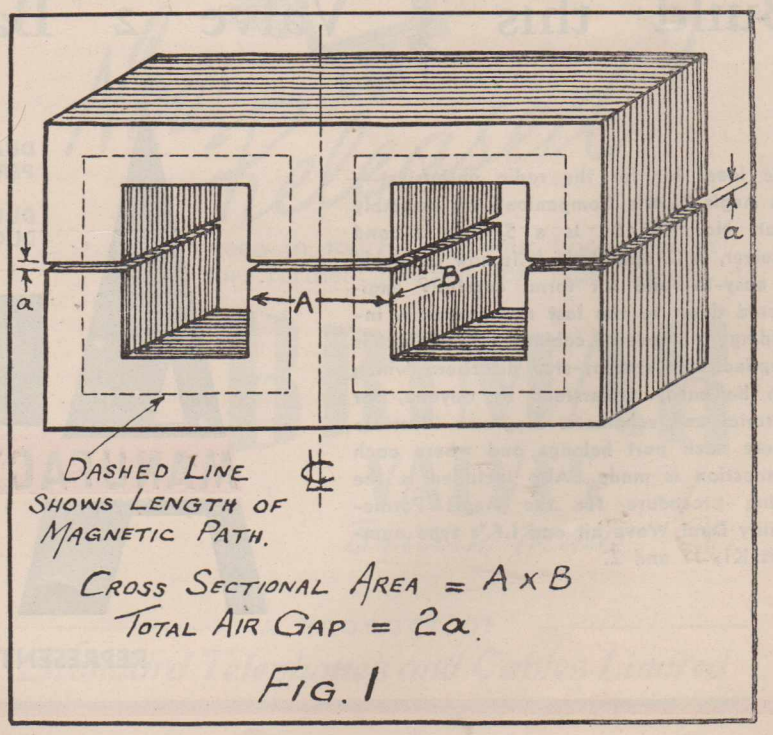

FIG. 1

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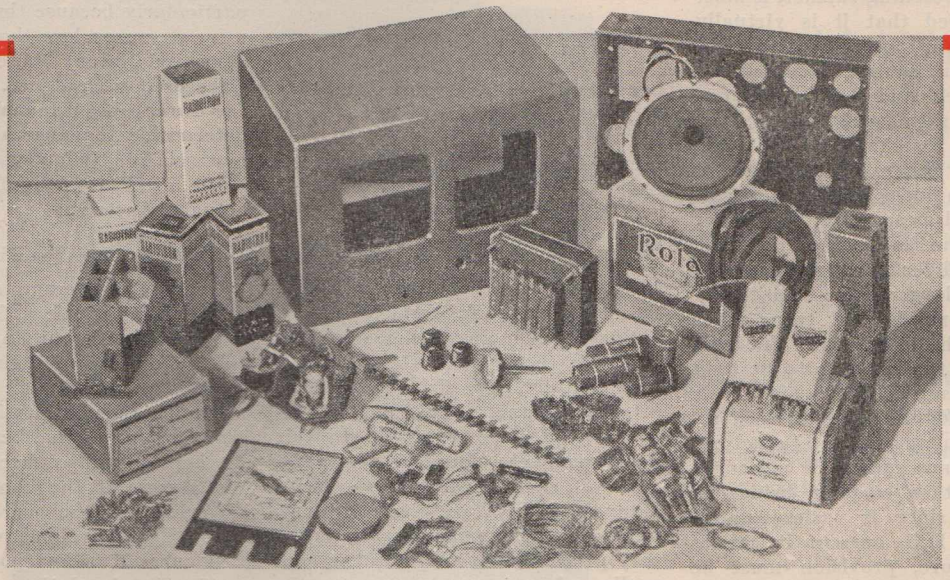

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CHOKES

(Continued)

able of withstanding the power supply voltage.

(4) The winding should have a reasonably low D.C. resistance.

With the above points in mind, the making of a satisfactory choke simply becomes the problem of obtaining a suitable core from an old unit and then winding as many turns of suitable insulated wire on it as it will hold and, at the same time, ensuring that the insulation between layers of turns and between the core and the winding is adequate.

Points of Interest

To expand on the above, the following points are of interest:—

(1) The most suitable gauge of wire to use can be calculated from standard copper wire tables, allowing 1,200 circular mils of cross sectional wire area per ampere. (A circular mil is the area of a circle with a diameter of 1 mil, i.e., 1/1000 inch. The cross sectional area of a wire in circular mils is numerically equal to the square of its diameter in mils). The table in the text, based on this figure, will indicate the most satisfactory gauge of wire for any specified current. The actual wire gauge used is not critical, but the larger the wire used, the smaller will be the D.C. resistance of the choke and the better the regulation of the power supply; alternatively, the larger the wire, the smaller will be the number of turns which can be applied. As the inductance of the choke is proportional to the square of the number of turns, the wire diameter must be minimised to enable sufficient turns to be applied.

(2) If a suitable choke core cannot be procured from the junk box, second-hand radio dealers will supply one with delight. The core chosen should preferably be on the large size, and for general purposes the magnetic path should have a total cross sectional area of not less than one square inch, and the length of the magnetic path should not be less than six inches, unless a very small unit is required. (See Fig. 1.) Keep in mind that the inductance of a choke is proportional to the cross sectional area of the core, and inversely proportional to the length of the magnetic circuit.

(3) The winding is applied in the manner described in the article on transformers in the January issue of this paper. A layer of insulation must be inserted between each layer of turns to prevent possibility of voltage breakdown and adequate insulation should be provided between the winding and the core. Wind the turns uniformly and tightly, as otherwise the space factor will become large and it will be difficult to add sufficient turns.

No simple formula can be given here for determining the number of turns required to obtain a specific inductance value. The turns on a 30 henry choke may vary between 700 and 2,000, depending among other things, upon the length of the air gap and the permeability of the core, which varies according to the magnitude of the A.C. and D.C. flux densities, these being proportional to the A.C. and D.C. currents respectively which pass through the winding, all of which are difficult to determine without special equipment.

The Air Gap

The air gap may be defined as

(Continued on next page)

CHOKES

(Continued)

twice the distance between the mating ends of adjacent laminations in the core assembly, since two gaps generally exist in each core. (See Fig. 1.) In cases where the laminations on each side of the core are interleaved, no air gap, of course, exists. When direct current flows through the winding, the permeability of the steel core is decreased, resulting in a reduction of inductance. By introducing an air gap in the magnetic circuit, the permeability may be increased if the D.C. flux density in the core is high. The optimum width of air gap depends upon the magnitude of the flux density and in small commercial filter chokes, may vary from .001 to .05 inches, depending upon the design.

As a general rule for home constructors, the laminations should be butted together when assembled, and not interleaved unless the D.C. flux density in the core is extremely low.

It is of interest to note that the greater the A.C. flux in a core, the greater will be the inductance of the choke.

S.W.G. Wire Gauge	Nearest equiv. B. & S. Wire Gauge	Max. R.M.S. or D.C. Current permissible in winding (Milliamps.)
22	21	650
23	22	480
24	23	400
25	24	330
26	25	270
27	26	225
28	27	180
29	27	154
30	28	128
31	29	112
32	29	97
33	30	83
34	31	71
35	32	59
36	32	48
37	33	38
38	34	30

Table showing current carrying capacity of wires for choke winding, based on the figure of 1 amp per 1,200 circular mils of cross sectional wire area.

The Choke in Practice

If you are unable to purchase a choke in good working order, buy a burnt-out one, or a core, and rewind it, keeping the above hints in mind. You will be unlucky if it does not provide adequate filtering in the power supply in which it is to be used, provided that the design of the power supply is satisfactory. Keep in mind that if the choke only happens to have half the inductance of the one it is replacing, the original amount of filtering can be attained by doubling the size of the associated filter condensers. As large capacity filter condensers in the form of pigtail semi-dry electrolytics are now readily available in a very small and convenient size, difficulty is seldom experienced in finding room to fit them in parallel with the existing filter condensers.

TRENDS IN SET DESIGN

By
A. G. HULL

IT is always difficult to forecast the future trends in radio set design, and we must admit that some of the present developments are not at all as we had expected.

During the war years we contemplated the post-war sets in terms of improved performance, high-power high-fidelity sets and big communications jobs covering from 5 metres to 2,000 and fitted with a dozen knobs.

Now that the post-war period is actually here, we find that interest in communications-type sets seems to be zero, and the bigger factories, even those of some repute, are hard at work trying to produce small midget sets which can only be classified as "cheap and nasty."

Features of the new-style midgets include a maximum power output of less than half a watt, with a 3½-inch permagnetic speaker, a high-tension voltage of about 100 to 150 volts and using the new single-ended glass valves. Cheapness is possible with the small power transformer, cheap speaker, and a general loss of efficiency in such matters as coils and intermediate transformers. Coils are wound with single enamelled wire, instead of the more efficient litz stranded wire, and coil cans are missing, the interaction between coils being avoided solely by careful positioning of the coils above and below the base. The low voltages throughout the set allow the use of condensers with a working rating of 200 volts, these being cheaper and smaller than the 400-volt types. The resistors are also smaller, as none of them are called upon to dissipate any great amount of power. The matter of reducing hum to a reasonable level is greatly helped by the lack of low-note response in the speaker, especially when inadequately baffled in a small cabinet.

Neither sensitivity nor selectivity is of a high order, as might be expected, but is sufficient to bring in all the local stations at the majority of suburban locations. This should be sufficient to serve the normal buyers, as doubtless they won't expect much for the price they pay.

Some people cannot understand why the big radio factories should want to turn their attention to the low-price market. One of the reasons, as told to me by the sales manager of a Sydney firm, is that the public is not responding to the present advertising of mantel models at about £18. He seems to think that the existing sets have proved their reliability so well during the war years that there is little inducement for people to scrap their present receivers. He thinks that the only way to keep his factory production at full pressure is to appeal to the public to buy additional sets, rather than replacements. Others hold the opinion that the lack of buying interest at the moment is not unreasonable and does not indicate any definite trend in the public's reactions to advertised sets and prices. They feel that the lack of buyers is simply due to a lack of co-operative advertising by the trade. How can you expect the public to rush and buy when many radio advertisements are telling them to "wait and see"? Looking over the past history of the radio trade it is easy to recall that buying waves of the past have always come about after exhibitions and associated advertising drives by several firms at the one time. These "drives" had made it appear fashionable to own a new set. Jack Smith hears that his neighbour has bought a new set. It seems to him the right thing to do. He notices that the papers are full of advertisements for radio sets. Everybody seems to be buying radio sets, and so he joins the crowd and buys one himself. That was how it was in the "good old days," but you can't expect a repetition of this state of things just at this particular moment. The disastrous rumours coming from the inquiry about frequency modulation are also playing havoc with the market.

Stampede?

It seems to us a great pity that the trade should be stampeded into the low-price racket by the present circumstances. We feel sure that they will not last, and good selling periods will come again. But if it once becomes accepted that a radio set is a thing worth about £8, then it is going to be a hard job to ever get the public to pay a good price for a good instrument.

The lack of interest in big communications-type sets is also deplorable. Many factories have gained invaluable experience with this type of receiver through the work done on munitions contracts. All the rough ground work has been covered and it would be a simple matter for them to produce receivers with performance equal to anything obtained by the best overseas sets of the type which have found a ready market in the highest price range, listing at from £100 to £500. There is a considerable market for these sets in Australia, too. It is a market which can be tapped without interfering with the ordinary run of set sales. Yet to date, we have not found anyone who is going about the marketing of a communications receiver in a business-like way. To sell these sets at their high prices calls for an entirely different selling technique.

ELECTRONICS CLASSES AT MELBOURNE TECHNICAL COLLEGE

The Melbourne Technical College is the first in Australia to provide special professional courses in Electronics and Electro-acoustics.

These courses are conducted by Mr. J. E. Straede.

So far, these courses have been for students actually attending the college, but, in future, it is expected that correspondence courses will be available for others who are interested. Both the Electronics and Electro-acoustics are now recognised as being of Diploma Standard and will in future be incorporated in the Diploma of Applied Science.

OUR U.S. RADIO NEWSLETTER

NEW YORK.—Achievement of a radio "miracle," the transmission of pictures in full colour over the towering roofs of New York City, was disclosed on October 11 before the Federal Communications Commission, when leaders in the broadcast field met to discuss rules and regulations proposed October 3 for commercial television.

Paul W. Kesten, executive vice-president of the Columbia Broadcasting System, said that three weeks ago he saw the pictures in "magnificent colour" in a laboratory over a closed circuit.

"Although nominally 525-line pictures, each completed picture contained 1575 imperceptible lines of beautifully-detailed colour—and the circuit was complete from the scanning device to the actual receiver," he said, "later that day I saw the same pictures actually broadcast, still in the laboratory, but with a transmitter at one end of the room and a receiver at the other. They were just as perfect as the closed circuit images.

"Only yesterday, October 10, I saw these television pictures successfully broadcast across the crowded New York skyline and received many blocks away with superb clarity, demonstrating the actual use of the ultra high frequencies and the modulation of a ten-megacycle video band—two of the things so many were so sure could not be done."

* * *

Automatic Radar Recording Camera

Expected to have both military and commercial applications, an automatic radar recording camera developed by the Fairchild Camera and Instrument Corporation of New York permits an operator to observe the luminous picture on the radar oscilloscope while the camera is recording the image on 35 millimeter motion picture film.

Wired directly into the radar circuit and mounted above the oscilloscope, the camera, containing a beamsplitter in the viewing hood, passes yellow light to the eye, reflects only the more actinic blue light upward to the lens, with little danger of fogging the film.

The camera is of the interchangeable magazine type, holding 100 feet of film. Its action is fully automatic, the shutter opening at the beginning of the radar impulse, closing as the film is moved for the next exposure. A selector switch controls the range of exposures.

Operating at extremes of temperature and altitudes up to 35,000 feet, the camera, through the radar scope, is said to have a range of 100 miles on a single frame, compared to the standard aerial camera's usual range of five miles.

Although developed primarily for use with radar, other applications may be made, including laboratory experiment recording, and like uses requiring an automatic permanent record.

PRINCIPLES OF RADAR

By
SIR EDWARD APPLETON, F.R.S.
Secretary of Britain's Department of Scientific and Industrial Research

RADIO-LOCATION (or Radar as it is now known) is widely recognised as one of the outstanding technical developments of World War II. Its later manifold derivatives are still closely guarded secrets, but it is now possible, without conveying anything of value to the remaining enemy of the Allies, to reveal anything of its origin and to disclose the basic technique which it involves.

Radar may be defined as the process of locating the position of an object in space by radio waves without any active co-operation on the part of that object. In other words, Radar enables us to find the position of a body, such as an aircraft, ship, iceberg, or ionised cloud, without going up to that body to find out for ourselves. The only co-operation required on the part of the body is of a passive character in that it is required to reflect radio waves.

Fortunately, all solid and liquid bodies, as has long been known, do this. Since, moreover, radio waves are, in general, uninfluenced by darkness, clouds or fog, Radar can play the war-time role of an infallible sentinel for the detection of enemy airborne or seaborne units.

The fundamental technique of Radar is not difficult to grasp. To detect any reflecting object it is necessary first to flood that object with radio waves, in much the same manner as a motor car headlamp floods a road sign at night. An aircraft, for example, reflects radio waves when it traverses the radio beam, and if ground detectors are used to pick up the reflected beam from the aircraft, it is possible to determine the **direction** of arrival of the reflected waves and thus the direction of the radio-located object with respect to the ground station. The determination of the direction of a radio source is, of course, a very old technique but, alone, it cannot give the true position of that source. In Radar, however, there is added, most essentially, the determination of the actual **distance** away along that direction. Briefly, then, Radar enables us to specify the position of a radio-illuminated target because it tells us, first, in which direction the target lies, and second, how far away along that direction it is situated.

Scientific Radar

The method of determining the distance of a radio-located object is one of the most interesting features of Radar, for it is a product of pure science, and involves the use of a technique developed 20 years ago with no thought of its present widespread practical application. The basis of the method is that the distance away of the located object is found by timing the journey of the radio waves to the reflecting object and back, just as seamen sometimes time an echo of a ship's whistle to determine roughly their distance from the face of a cliff. But the time scales of the two examples are vastly different. Radio waves travel with a speed of 186,000 miles per second, which is about a million times the speed of sound. Such waves, therefore, travel to and from an object 100 miles away in about one thousandth of a second, and it is the accurate and speedy measurement of time-intervals of this order which is the basic feature of radio measurement of distance.

First Experiments

The first experiments on the measurement of distance by radio reflections were carried out in 1924 by two Cambridge physicists, E. V. Appleton and M. A. F. Barnett in their experimental proof of the existence of the Heaviside Layer and the measurement of its distance above ground. In these experiments which were carried out under the auspices of the Radio Research Board of Britain's Department of Scientific and Industrial Research, the timing of the radio waves to the reflecting Heaviside Layer and back was achieved by changing the frequency of the waves by a known amount. Nowadays we should call their method that of frequency-modulation. It is no exaggeration, therefore, to say that the first object to be radio-located was the Heaviside Layer.

In these early experiments it is noteworthy that stations of the British Broadcasting Corporation were used. Shortly after Appleton and Barnett had finished their work, two United States scientists, G. Breit and M. A. Tuve, working in Washington, succeeded in measuring the height of the Heaviside Layer, using amplitude modulation of the radio waves. For this purpose they devised a radio transmitter which sent out very short pulses, or jabs, of radio energy and recorded the time interval between the emission of a pulse and the reception of its echo on a high-speed galvanometer. The pulse method, because of its simplicity, has been widely used later in the measurement of the distance of artificial targets such as aircraft and ships.

In the earlier scientific experiments rather elaborate photographic technique was used for the measurement of echo-delay times. What has later turned out to be a particularly useful simplification in the technique of the pulse-method was introduced in 1931 by E. V. Appleton and G. Builder in the use of the cathode-ray oscillograph, with an associated uniform time-scale, by which the presence of a reflecting object and the indication of its distance away could be continuously portrayed to the eye without the need of developing photographs. By 1932, therefore, the technique of

(Continued on next page)

RADIO v. CANCER

According to "The Petroleum Times," radio-frequency energy is being used by Soviet scientists in preparing mineral oil in a finely emulsified state for the treatment of cancer. The emulsion, of which the oil particles must be small enough to pass through very fine capillary vessels, has been successfully used for intravenous injections.

RADAR

(Continued)

measuring the distance of atmospheric reflecting surfaces, such as ionised layers and ionised clouds, by means of radio pulses and cathode-ray oscillograph display was becoming standard research practice in Britain.

Practical Radar

But the application of these methods to the radio-detection of such relatively small objects as distant aircraft and ships by no means followed automatically. In 1932, however, the engineers of the British Post Office reported what is considered to be the first recorded instance of the detection of the presence of aircraft by reflected short radio waves. In the following year, engineers of the American Bell Telephone Laboratories published an account of experiments in which it was shown that aircraft reflected sufficiently appreciable quantities of radio energy to make it possible to detect their presence even when they were otherwise invisible. By 1933, therefore, the principles of scientific radio-location were well known as applied to the radio-location of natural occurring reflecting surfaces, and it was also known that aircraft were capable of detection at short distances by the amount of radio energy reflected by them. It remained to develop the military application of the position-finding of artificial objects by fusing both branches of knowledge and, in particular, by using higher-powered transmitters to extend the range of detection. This brilliant application of scientific principles to forge weapons of the highest operational utility was begun in 1935 by a small group of British scientists, Messrs. L. H. Banbridge-Bell, E. G. Bowen and A. F. Wilkins, led by Sir Robert Watson Watt at an Air Ministry Station on the east coast of England. This effort, begun by this small nucleus, gradually expanded, and, as a result, Britain was already provided with radio-location sentinels for the detection of aircraft when war broke out in 1939.

Further Possible Developments

The use of methods of radio distance-finding by reflection have already provided us with a vast fund of knowledge concerning the electrical reflecting layers in the upper atmosphere from which it is now possible to predict the most suitable wave-lengths for use in communicating over various distances at different times in different parts of the world. Further work is now in progress in England on the location of meteor trails by means of radio reflections. Another problem being considered is the possible radio-location of the moon. Calculations show that with a very powerful sending station, and sharp focussing at the sending and receiving stations it should be possible to get back detectable radio echoes after the radio waves have made their 2½ second journey to the moon and back.

DUPLEX SPEAKERS FOR FIDELITY

Experiences with the latest American system

IN setting out to describe the phenomenal performance achieved by the engineers of the Altec-Lansing Corporation, it is felt that herein lies the answer to the many problems which have confronted discriminating music-lovers and technicians alike over the past ten years. To enumerate each of these problems and treat each individually would be time-consuming, so let us firstly discuss those of outstanding importance.

By

CHARLES MUTTON

In view of the overseas trend towards the increased demand for Frequency Modulation, which ultimately must also become the case here, it is desirable that the reproducer be capable of handling frequencies up to 15,000 c.p.s. In this respect the present system under discussion meets the most stringent requirements in that it will faithfully reproduce all frequencies from 40 cycles to 16,000. In the upper range it almost, and in most cases, exceeds the limit of the human ear. This fact alone precludes any danger of obsolescence, which one must admit is highly desirable and a very necessary feature.

Secondly, the bugbear of all single diaphragm systems, intermodulation distortion, is completely eliminated, due to the unique construction employed, which will be described later.

Thirdly, comes to mind perhaps the most neglected of all these problems, namely, the matter high-frequency distribution and its subsequent effect on what we term "beam effect," which becomes troublesome even at frequencies as low as 2,000 c.p.s.

Fourthly, and by no means of least importance, is the question of physical size. This feature has largely been a prime deterrent in high fidelity systems, not being universally accepted in such places as recording studios, broadcast station monitoring booths and finally in the home of the discriminating music lover. A general description of the Altec-Lansing Duplex Speaker should convince even the most sceptical that the above problems have been eliminated completely.

The high frequency section utilises a metal diaphragm instead of the usual paper or fibrous cones. This diaphragm is made of alumium alloy, being selected because of its high mass stiffness and high velocity of transmission. It is here worthwhile to note tht the transmission speed is at least five times greater than through paper cone material, generally used for high-frequency radiation.

Beyond Audibility

Designed to operate as a piston above the limits of audibility, this lightweight diaphragm is stiff enough to avoid break-up effects which would introduce intermodulation distortion so common to both fibrous and paper cones. It becomes apparent that if the diaphragm was to radiate directly, and was made small enough to avoid sharp beam effects at the high frequencies, it would be too small to handle enough power near the cross-over region for practical purposes. As a result an extremely efficient multi-cellular high-frequency horn is used as the radiating medium.

This multi-cellular horn consists of a 2x 3 configuration of six cells, which are nested within the large cone of the low frequency speaker and has a cut-off frequency of 900 c.p.s. This horn unit is mounted on the end of the low frequency unit pole piece, which is bored out to permit the passage of sound from the high-frequency unit. A fine mesh bronze screen at the junction of the pole pieces prevents the entrance of foreign particles into the high-frequency sound chamber. Positive alignment of the bores of the two pole pieces and of the horn mounting flanges avoids discontinuties which would cause destructive interference along the high-frequency sound transmission path. The high-frequency horn is covered with a sound-deadening material, but is not finished with a smooth surface which would set up a regular reflection pattern for sounds being generated by the surrounding low-frequency cone. The voice coil of the high-frequency unit is wound with aluminium wire in order to reduce the moving mass to a minimum.

Mounted in a cabinet of approximately 6 cubic feet of the bass-reflex type, the low-frequency cut-off is 60 cycles, while the high-frequency cut-off is above audibility. Each unit is fed with a different range of frequencies by using a dividing network of the constant impedance type, the crossover frequency being fixed at 2,000 c.p.s. The inductances used in the dividing network are of the high Q type and are capable of operation over wide range of voltage, with negligible inductance changes.

Eye Appeal

Finally, the vented enclosure cabinet is of a size not much in excess of the usual better class of radio console, is beautifully made and has an exceptional appeal for the discerning eye. The signal-handling capacity of the whole unit is rated at 25 watts.

This distribution of the high frequencies covers a 60 degree angle in the horizontal direction and 40 degrees in the vertical direction. Comparing these figures as against 5 degrees coverage in the single diaphragm types of speakers gives some conception of the improved performance of this system.

The Altec-Lansing System on Trial

The writer was fortunate enough to attend a recent demonstration arranged by the executive and technical staff of Trimax Transformers, who are Australian agents for the

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SPEAKERS

(Continued)

Altec-Lansing Unit.

After listening to systems covering most well-known makes in scores of different baffle designs over the last ten years, it can be stated without being gullible that the engineers responsible have co-ordinated all the finer points in speaker design, improved on them and finally achieved perfection in this compact and amazingly efficient reproducer. The reproduction emanating from this fine set-up beggars description. This was one occasion when that old adage "Hearing is believing" is strictly correct.

The writer's first impressions were that no matter what listening position was adhered to, the reproduction retained its true perspective and depth of tonal quality. Either seated on the floor, elevated well above the normal axis of the speaker, extreme left or right, all these were tried in turn, but one could honestly say that the apparent effect was as if the speaker itself was rotating in the arc of a circle and the usual beam effect was conspicuous by its absence. Due to this wide angle of distribution, the spatial perception or "presence" on orchestral recordings was a revelation, each individual instrument taking on an entirely different conception of definition as compared to ordinary reproducing systems.

For purposes of comparison, another single diaphragm type of speaker was set up and listening tests conducted while comparing a similar recording on both systems. The following effect was most noticeable. While one would expect the surface noise from a given recording to be greater on the Lansing system, due to its greatly extended frequency range, such was not the case; in fact, the surface noise, all conditions being equal, was very definitely worse on the single diaphragm job. This is not difficult to comprehend when it must be pointed out that, due to various factors inherent in most single type diaphragm speakers, there exists several or more very pronounced peaks or resonances, one of these occurring in the region where needle scratch becomes troublesome. In this case the resonance spoken of only served to aggravate the trouble. On the other hand the smooth response of the Lansing system shows no prominent peaks, thus explaining the difference in performance between the two systems on this particular point.

Another point or fault which the Lansing system showed up was a very distinct pick-up resonance which evidenced itself in the form of a very rough, whiskery tone at about 6 Ks; by putting in a low-pass filter this was eliminated completely. This fault passed unnoticed on the single diaphragm speaker, indicating extremely poor efficiency at high frequencies.

Exceptional realism showed up on sounds such as castinettes, the triangle, piccolo and snare drums. On the lower register one was not conscious of hearing the bass, but rather felt the vibration and power of really true low-note reproduction, which is so rarely attained with ordinary systems.

The whole demonstration showed the writer that here at last is the answer to the bottleneck in high-fidelity sound systems, the speaker system. Rather does it point to the reverse; the engineers on the reproducing end have done the job to perfection. Now those people who manufacture amplifying systems, pick-up devices and recordings will have to redouble their efforts to make equipment to do justice to the Altec-Lansing Duplex Speaker Unit.

Unfortunately, due to the policy of our present Government, the dollar position will not yet permit mass importation of these units into Australia. Such a state of affairs is perhaps likely to continue until we have also won the peace. Information more specific may however, be obtained from the agents, Trimax Transformers, whom the writer feels sure, will only be too pleased to enlarge upon the general specifications contained herein, as well as other information desired.

In conclusion, let it be said that it is indeed refreshing to find a firm having sufficient vision and foresight to give to the discriminating music-lover and technician alike the opportunity to look forward to the ultimate in the realm of high-fidelity sound.

METER MAKERS TO CO-OPERATE

Additional force has been given to the manufacture of electrical and radio instruments by the formation of an association covering this specialised activity.

With its office in Sydney, the Electrical Instrument Manufacturers' Association of N.S.W. proposes to come to grips with conditions and problems that may arise and establish permanently and strongly in Australia this precision industry that has done so much in its sphere for the Australian war effort.

Already many important decisions have been made that will result in benefit to industry generally, and it is felt that this association will encourage instrument progress.

First Members

First members are General Instrument Co., Master Instrument Co., Paton Electrical Pty. Ltd., Radio Equipment Pty. Ltd., A. J. Simpson and Vane Electrical Instruments Pty. Ltd. Since formation additional applications have been received for membership. Manufacturers interested can contact the Secretary, Electrical Instrument Manufacturers' Association of N.S.W., 12 O'Connell Street, Sydney.

RADAR TO BE USED ON RAILROAD LINES

A radar-type radio-communication system, using ultra high frequencies of 2,660 megacycles, will be installed on the Rock Island railroad lines, the chief executive officer of the road announced recently.

He said it would be the first application of radar components to a railway system and that it will use the hitherto secret klystron tube. This tube is reported to make possible the use of a wave-band 20,000 times as wide as a home broadcast band.

Communications officers of the line said the new system makes possible for the first time "constant, clear, audible signals through tunnels and deep gorges."

CALLING CQ!

By Don Knock

Press news from G-land says that it was decided on 27th November to relax Defence Regulations to allow British subjects in England to purchase and hold radio transmitting equipment, and that the ban on amateur transmission would be lifted shortly. So by the time these words reach "A.R.W.'s" press, the G's may be on again.

As anybody may hear for themselves, U.S.A., Canada, South Americans and others are in full occupancy of 28-29.7 Mc/s.

* * *

4th December, 1945.—Most mornings just now the "10-metre band" is alive with W's and mixed up with these are a few of the W/J boys, Americans in the armies of occupation. Frankly, I don't blame these Hams for seeking such "occupational therapy," although the mode of operation is definitely piracy. I am intrigued to note that quite a bit of cross-band working is going on between W's (in U.S.A. on ten) and W's (in the Japanese area on 20). No doubt all will go merrily until F.C.C. takes a hand. The edict by WTA, warning "the gang" off 14 Mc/s, has not taken complete effect, for one or two irrepressibles are still to be heard on phone and C.W., wedged in between the irritating din from teleplex stations. Both 14 and 7 Mc/s are impossible to recognise as pre-war amateur channels—for strangers are there galore.

New Regulations Gazetted

On the 28th November, 1945, the new Australian amateur (experimental) radio regulations were gazetted on the lines already referred to in this section of "A.R.W. " There will be few objectors to the power ratings of 50 and 100 watts for the two grades of licences, but the raising of the minimum age to 18 years from the previous fixture of 16 years is likely to be the subject of much argument. There are points for, but more against the new limit, and it seems off-hand to imply that a youngster with brains enough to sit for and pass the A.O.C.P. is nevertheless irresponsible to a degree that he cannot operate experimental gear until he turns 18. He may pass his exams brilliantly perhaps; and then is expected to kick his heels until two years amble by. In that two years he may turn to other fields and a potentially good man may be lost to radio's future, or, as is more likely, he may be impelled to break the law and to operate equipment illicitly. Both possibilities are distasteful and not calculated to encourage the class of studious youth this country needs for her future manhood. Keen youth—amateur radio—and world peace—can be synonymous.

The New Frequencies

As this is written (Dec. 2nd, 1945), word is out about the frequency channels to be allotted to Australian amateurs. They are:—

28-29
50-54
166-170
1345-1525 Mc/s.

There will be satisfaction at least that **some** channels are made available by those who hold authority, but also a measure of perplexity as to the choice of two of them. It was expected in the first place that, following decisions by U.S.A.'s F.C.C., the pre-war 10-metre band would be slightly dehydrated—at the H.F. end—28-29 Mc/s as against the W's 29—29.7 Mc/s, is perhaps no serious bone of contention. Nevertheless, it is a definite **loss** to the Australian amateur. The new "five-metre" band from 50-54 Mc/s conforms to American decisions, and, although it is not harmonically related to 28-29 Mc/s, it is a band which may prove to be very useful indeed. There is a possibility of infrequent DX here. Nobody should get the idea that modulated oscillators and "squegger" receivers will be appropriate. This band calls for

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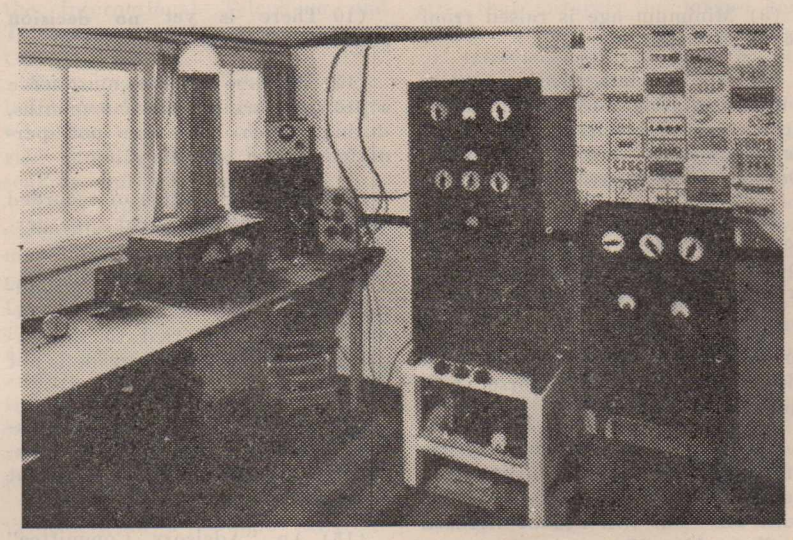


One of the neatest Ham stations we have seen is this — pre-war G8LP, operated by Geoff Hanley, of Wolverhampton, England. Power was 50 watts and his 20 m. phone reached Australia in fine style. G8LP survived the war and will be looking for VK's again soon.

HAM NOTES

(Continued)

full C.C. and superhet. C.W. technique as did 56-60 Mc/s—the pre-war band. Unless stable VFO with multiplication is used, crystals outside the usual run of things will be needed, from 6 to 6.6 Mc/s.

The band 166 to 170 Mc/s is a puzzle regarding choice of allocation, for the American arrangement gives the amateur 140 to 145 Mc/s in lieu of the pre-war "2½-metre band."

166-170 is included in a governmental block of frequencies. There may be a reason for the Australian choice, but certain it is that this new band will come in for plenty of use with local networks.

Technique calls for application of non-standard valves but fortunately "acorns" and valves of the 800 and 815 types will be available. Aerial dimensions are of compactly useful size—a mere 33 inches, giving a half-wave of 166 Mc/s. The last band, 1345 to 1425 Mc/s, was probably not intended as a joke or an insurmountable obstacle—but the average amateur can forget it—unless he has lived with Radar through the war year, and has acquired Radar technique (**and** gear). The story goes that 3.5 Mc/s (80m) **may** be restored about March, 1946. As for 7 and 14 Mc//s—there is no indication as to the future. Meanwhile, licences will be issued for operation on the new bands, and we know that three of them will come in for plenty of occupancy.

—D.B.K.

NEW AMATEUR REGULATIONS

Information released to the Wireless Institute by the Superintendent, Wireless (P.M.G.'s Dept.), N.S.W., outlines the following salient points:

(1) There will be two classes of licences—"A" and "B," with the latter equivalent to the pre-war licence.

(2) Fee for either is 20/- per year and does **not** include reception of broadcast programmes. Another licence is needed for the latter.

(3) Minimum age is raised from 16 to 18 years.

(4) All previous licence-holders will be eligible for a Class "B" licence—an application form is to be completed—also a "Statutory Declaration of Secrecy"!

(3) The present A.O.C.P. becomes the 2nd class grade and morse code speed requirement goes from 12 to 14 words per minute.

(6) The first-class A.O.C.P. calls for higher knowledge of radio and electrical theory and morse code speed is 18 W.P.M.

(7) Any person under 18 years of age who has already qualified for 2nd class A.O.C.P. will be issued with this—but **will not be licensed until reaching 18 years!**

(8) A.O.C.P. exams (from Januarv. 1946) will be held on the second Tuesday of January, April, July and October, but it is likely, owing to shortness of time in which to make arrangements that the first 1946 exam will be held on 5th February. Exam fees are: First-class, 10/-; second-class, 7/6.

(9) Power ratings:
Class "B" maximum **INPUT to final anone** is **50 watts.**

Class "A" maximum output to final anode is 100 watts.

(10 There is yet **no decision** about frequencies.

(11) All new licencees must serve a probationary period of 6 months, during which they are not permitted to use telephony.

(12) No transmission of recorded music or entertainment is permitted.

(13) Holder of a first or second-class commercial or aircraft operator's ticket is entitled to the experimental ticket (what grade is not stated).

(14) Holder of a broadcast station operator's ticket is not enentitled to the A.O.C.P. without examination.

(15) An "Advisory Committee" will operate in all States in the same manner as the Vigilance Committee functioned previously.

LOCAL V.H.F. TRIODE

Radiotron type 7193 is a triode valve in the standard T9 envelope as used for all "GT" valves, and fitted with a standard octal base, but it is capable of being used as an oscillator or amplifier at frequencies up to about 300 Mc/s. In point of size it is slightly smaller than type 1AT-GT, but it may be used on plate voltages of 300 volts (CCS) and 500 volts (ICAS), with a plate dissipation of 3.3 watts on both ratings. A useful output may be obtained up to about 250 Mc/s, while the resonant frequency of the input circuit is 335 Mc/s.

In order to obtain this performance, it was necessary to bring both grid and plate to caps on the top of the bulb, the angle between the axes of these caps being 28 degrees. The octal base is therefore only required to make connections to the heater and cathode. This arrangement makes possible very short leads to the tuned circuits for both conventional and special U.H.F. tuning arrangements.

One suggested application of type 7193 is an oscillator driving type 807 in amateur transmitters. Type 7193 is not recommended for use at audio frequencies, since conventional types (6J5-GT, 6SJ7-GT, etc.) have approximately equal performance and the two top caps make its use somewhat awkward. Its performance is only shown to advantage on high radio frequencies.

BASES ON SINGLE-ENDED GT VALVES

A few samples of 6SJ7-GT, 6SK7-GT and 6SQ7-GT valves have been made available fitted with intermediate shell octal bases. When production commences on these types, and also type 6SF7-GT, all four types will be fitted with small wafer octal bases with metal sleeves, in line with standard American practice. These bases have metal sleeves which are internally connected to pin No. 1 and thereby earthed. A slip-on shield may therefore be used to make contact with the metal sleeve without requiring either chassis clips or a connecting lug to No. 1 pin. It is anticipated that this will decrease the cost of a receiver owing to the

simpler type of screen-can required, while in addition it may be possible in certain cases for the screen-can to be omitted entirely without detrimental effects, owing to the combination of the internal screening and base sleeve. The question as to whether or not a shield-can should be used must, of course, be a matter for individual determination by the receiver designer.

MISCELLANEOUS VALVE TYPES

Radiotron type 9070 is a special long-life valve having characteristics somewhat similar to type 6C6, while type 9071 is a long-life version of type 6V6-G, although both have considerably reduced ratings compared with the popular near-equivalent types. Radiotron 7193 (a special type manufactured by this company during the war for use at very high frequencies) is now available from stock, and efforts will be made to popularise it, particularly among amateurs.

These three miscellaneous types will be sold through the Commercial Engineering Department of A.W.A., as in the case of other miscellaneous and transmitting types, and will not be available through ordinary trade channels. Technical data is available on request from the Amalgamated Wireless Valve Co. Pty. Ltd., 47 York Street, Sydney.

U.S. AMATEURS—LATEST RULINGS

On 21st August last, F.C.C. announced that, effective forthwith, amateur operators "in good standing" who have been off the air since Pearl Harbour, may operate, until 15th November, in the 112-115 Mc/s (2½ metre) band. This was on a shared basis with War Emergency Radio Service, and W.E.R.S. was to terminate on 15th November. F.C.C. was to announce further policy before the end of this provisional period, and it is likely that by the time this issue of "A.R.W." is in press, American Hams will be back on the "DX" air at one or other of the popular frequencies.

—VK2NO.

HAMS—IMPORTANT!

Have you received application forms for your licence yet? If not, drop a line to the Divisional Secretary of your State Division of the W.I.A.

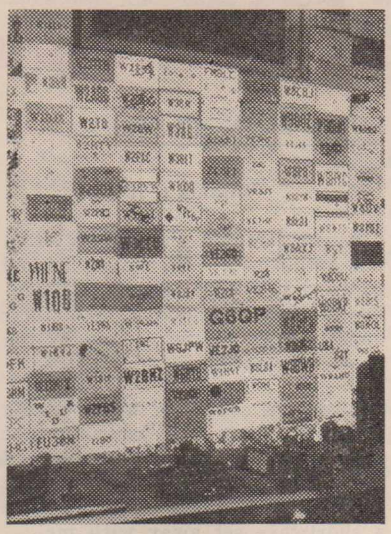
The P.M.G.'s Wireless Branch cannot possibly succeed in notifying **all** pre-war licencees owing to changes of address and other war-bred reasons.

Re-licensing is now in process of preparation.

—VK2NO.

N.S.W. DIV. RUNS A.O.C.P. CLASSES

Starting first Monday of December, N.S.W. Div. of W.I.A. will inaugurate twice weekly A.O.C.P. classes on Monday and Wednesday nights. Applications are called for positions of class manager, morse code and theory instructors from W.I.A. members. Duration of each class is expected to be 3 months, and entrance fee is one guinea with a 2/- fee for each lecture. If intending students are already members of W.I.A. it is only necessary to pay the difference. Full details of syllabus, etc., may be obtained from the acting class manager, Mr. E. Treharne, Box 1734, G.P.O., Sydney.



WALLPAPER!

The ham who gets a "kick" out of DX contacts accumulates an array of QSL cards, like these at pre-war G6QP.

"PULSE TIME" MODULATION SYSTEM

A new system of radio-telephony and broadcast transmission and reception, the secret of which has been under a wartime ban until now, was demonstrated for the first time by the International Telephone and Telegraph Company in New York City last month.

Known as the "pulse time" modulation system, it permits 24 or more telephone conversations to be carried simultaneously by a single sending and receiving outfit.

When applied to broadcasting, especially to circuits like frequency modulation, it is expected to make possible the routing of twelve different programmes from as many studios over a single sending station atop a single high building or tower and to receive all twelve over a single receiver in the home. A simple switch on the home set would select the programme or programmes desired.

It is made possible by the development of a cathode ray tube about one foot in length and two inches in diameter. One such tube known as "cyclodos", is a high-speed electronic switch that receives and combines the incoming programmes or telephone talks at the sending station. A hopeless jargon results. This is broadcast. At the receiver is another tube, similar in size, that unravels the jargon and routes each broadcast programme or telephone conversation to its proper destination.

The tubes are such marvels of construction that inside them it is possible to cause an electron beam to rotate 8,000 to 30,000 times a second for either telephone or broadcast use and scramble and unscramble programmes. It was demonstrated that this could be done without appreciable distortion.

Actually what takes place is the splitting up of each programme or talk into millions of parts a second. The electron beam accomplishes this. Each part is a sample of the whole programme entering the tube. Parts of each programme or conversation, thus split into segments, are carried through the tube and fed into a common terminal in order of time as simple "samples" or pulses of the whole. Hence the name pulse time modulation.

Shortwave Review

CONDUCTED BY
L. J. KEAST

NOTES FROM MY DIARY

Wouldn't It

I can imagine the moans from DX enthusiasts who, having looked forward to a real session of listening over the holidays, had their hopes dashed to the ground by the power restrictions.

I spent a couple of weeks in the Irrigation Area and, knowing that the restrictions were being observed there with the same commendable spirit as in Sydney, I did not take a shortwave set away with me.

At the time of writing this paragraph the December issue of "A.R.W." has not been published, due to the strike, and reports from listeners have been fewer than usual. However, it is hoped the magazine will be out by the 10th, and the January issue will follow very closely.

Washington, D.C.

Received a very nice letter from Roger Legge, Jr., who is stationed in Washington, D.C., doing propagation and frequency work in the IIS-OWI East and West Coast broadcasts.

Incidentally, he thanked me for the reception reports that I had sent to the O.W.I. (As most reporters know, I conducted the listening-post for the U.S. Office of War Information in Sydney for just on three years. It was most interesting work and, although often entailing 17 hours a day, I was very sorry when the O.W.I. offices were closed in Australia. It is gratifying to know from headquarters that they attribute the excellent signal strength received in Australia to the reports I sent which assisted them greatly in the seasonal determination of frequencies and transmissions) Mr. Roger Legge, Jr., is probably one of the most prolific contributors to overseas magazines dealing with shortwaves and has been a Dx-er for the past 13 years and has received verifications from voice stations in 150 countries.

Congratulations

I am sure all regular readers of these pages will be pleased to hear that Lindsay Walker, of Applecross, W.A., has gained his Diploma as Bachelor of Science in Engineering. Early this year he comes over to the Eastern States to take up his duties with the Commonwealth. When opportunity permits, I bet he will be doing some Dx-ing. Congrats, Lindsay.

Canada's New Voice

In the old days of "Wireless Weekly" and our good old friend R. N. Shaw, I used to be always moaning that we could not hear Canada at all well. But now they can pretty well hold their own with most overseas stations, and a few points taken from an article by Mr. J. A. Ouimet, Assistant Chief Engineer to the Canadian Broadcasting Corporation, will probably be of interest. Inaugurated early last year, the C.B.C. International Service gave Canada a new and powerful voice reflecting the strength of a young and powerful country. This was effected by the application of the latest developments of communications engineering. The choice of the best possible location was of paramount importance. The C.B.C. already had a standard station, CBA, near Sackville, N.B., on a site which met all requirements. It was therefore decided to build the new station at Sackville and to merge the shortwave installation with the existing facilities.

This region was entirely unsatisfactory for the programming and administrative quarters, so the shortwave service studios were established in Montreal and the porgrammes fed to the transmitter at Sackville via landlines over a distance of approximately 600 miles.

It was found possible to cover practically all parts of the world with relatively high concentration, using only three sets of directional antennae. The European beam is reversible to serve Mexico, Central America and New Zealand. The African beam is reversible to serve Australia and New Zealand. The South American beam is reversible to Asia and part of Australia.

The CBC use 12 frequencies: CKOB, 6.09; CHAC, 6.16; CHLS, 9.61; CKLO, 9.63; CHMD, 9.64; CKXA, 11.705; CKEX, 11.90; CHOL, 11.72; CKCX, 15.19; CHTA, 15.22; CKNC, 17.82; and CHLA, 21.70 mc.

Hong Kong

In a letter just to hand from Ern Suffolk, of Lobethal, South Australia, he tells me he has been appointed Official Observer for ZBW, Hong Kong, and would appreciate any remarks from Dx-ers concerning this station. He says, according to official sources ZBW is now on 9520kc from 9 p.m., but he also states he cannot hear them at all anywhere, and goes on to say that if 9.52mc is their spot, it is an unfortunate choice, because VLW-7, Perth, pounds in at his location on that frequency. He has suggested to the authorities at Hong Kong that they try 9.64, 9.65 or 9.66mc, as those channels are clear at night.

I have not heard Hong Kong for quite a while, but, according to my records, they were last on approximately 9.505mc, 31.57m.

SAYS WHO ?

CKCX, 15.19mc, has replaced CHTA in the transmission heard at fair strength around midnight, but by 4 a.m. is the best signal on the 19-metre band.

CHTA was moved to let PCJ use this frequency, then WOOC moved from 15.19 to 15.20mc to let the Canadians use 15.19mc. United Nations at last!—Cushen.

The Marconi Company has secured the first important civil contract placed since the end of the European war. The Portuguese Ministry of the Colonies has ordered 12 shortwave telegraph and telephone stations for the colony of Mozambique. The equipment will cost £120,000 stg.—"S.M.H."

Hugh Perkins, of Malanda, Queensland, apologises for not sending reports, as he has been busy making model aeroplanes for Christmas. However his interest in Dx-ing was rewarded by several verifications, amongst which was one from Singapore and another from Brazzaville.

Incidentally, he states that one of his favourite stations of a night is VLA-6, 15.2 mc.

And here are some interesting notes from Roger Legge, Jr., of Washington, D.C. The times mentioned are, of course, Eastern Australian Standard, so it is doubtful if we will hear them very well, but there is always the chance, so here goes:

YV7RB, Cumana , Venezuela, moved to 3.47mc from 3.45mc. Signs off at 12.30 p.m.

YNFT, Granada, Nicaragua, 7.50 mc, now announces this instead of YN2FT. Signs 1 p.m.

CXA19, Montevideo, Uruguay, moved to 11.835mc, from 11.705mc.

Mr. Leo Edel says he heard the battleship "Duke of York" on 10.02mc, 29.94m, at midnight one night in contact with A.W.A., Sydney.

Referring to paragraph under "Says Who?" in November issue relating to VU2ZZ, a most interesting letter has arrived from Ern Suffolk, Lobethal, South Australia. Mr. Suffolk says: "Relative to VU2ZZ, 14.88mc, 20.16m., I have an idea this station is located at Pondicherry, a French territory situated on the East Coast of India. There are several such slices of India belonging to the French. Pondicherry is situated about halfway between the city of Madras and the top portion of Ceylon. Lower down the coast is Karikal and halfway up the eastern coast is Garnam, whilst on the lower western shores of India is Mahé. All of these places are French possessions; therefore the VU callsign, together with the fact that only French language is used, suggests that the station location may be one of these. I have corresponded with the station director of VUT, 758kc, Trichinopoly, and in a recent letter from him he replied to my query re VU2ZZ's location. He suggests that it was an AFRS station, because there was one of this type—VU2ZV—on broadcast band. He may be right, but I do not agree. Two or three AFRS in India are heard on broadcast band, all with programmes for the forces in English only." (Well, with that excellent information, I am sure Dr. Gaden has something to go on and I would not be surprised if he does not soon definitely establish the exact location of VU2ZZ. Thank you, Mr. Suffolk, for your prompt and full report.—L.J.K.)

More Re VU2ZZ

Since writing the paragraph above, I find from "Radio Call" that John Clifton, of Kingswood, South Australia, has received a letter from the French Ministry of Information in Pondicherry, stating that it has no knowledge of the station VU2ZZ. The French authorities have forwarded the report on to Delhi in an endeavour to solve the mystery of VU2ZZ's location.—L.J.K.

Dr. Gaden writes: "Listening to Belgrade one a.m., was surprised to hear the call **Warsaw.** I could not then get Belgrade. Calibration seemed O.K. at night, so perhaps they have altered things over there. Feel sure I was on 6.10mc—no heterodyning, either." (This is interesting, as records at present are: Lublin 6.115 and Belgrade 6.09mc. —L.J.K.)

One verification that Arthur Cushen is looking forward to and expects to receive about the middle of March, I think, is from the parson, to say he is well and truly wedded. Arthur at the moment is more concerned about his little home, which is being built as fast as materials will allow, than whether his many aerials are sufficiently guyed. The handing over of the key by the builder determines the exact hour that Arthur tunes in to The Wedding March.—L.J.K.

Re AFRN, Tokyo: "My verie for 7.552mc outlet states that this S/W frequency is under control of the AFRS and that all the other S/W outlets are merely relays and not under AFRS control."—Ern Suffolk.

Miss Sanderson, of Malvern, Victoria, has received some belated verifications, apparently held up by the Censor, way back in 1942: WGEA , KRHO, KGEX and KWID. With restrictions greatly eased and the possibility of Miss Sanderson purchasing a six-valve set, we can expect some further fine reports from this young lady, who has found Dx-ing such a great

(Continued on next page)

hobby.

"Received a QSL card from Leopoldville, cream with brown printing, photos, folder type. It was in reply to a report I sent them, but they do not say which channel is verified. I favour the 30-metre band, the callsign of which is shown as OTC. They are anxious to learn whether or not their two English language programmes are received in Australia: 7.30 p.m., on 16.88m, and 10.15 a.m. on 30.66m."—Roy Hallett.

Arthur Cushen writes: "Radio SEAC verified by letter from Radio SEAC, Radio Unit, 191 Turret Road, Colombo. They were surprised at my reception of the 3.395mc transmitter, which is beamed to Southern India with "somewhat under 1000 watts." Stated that at the end of the year would put new transmitter, 100,000 watter, on the 11.765mc, making this the most powerful Forces station in the world. The 7,500-watt transmitter which is now on 11.765 is to move to 3.395mc. New studios are being built and a new 350-feet tower erected. Schedule given is: 15.12mc, 3-4.30 p.m.; 6-10.30 p.m. (seems to be extended now); 11.765 mc, 11 p.m.-2 a.m. All trans. also on 3.395mc."

Ern Suffolk writes: "Have been rather surprised that South Africans have not been more freely reported. Durban, on 6.17mc, is best of those heard from 2 a.m., with programmes in English and Afrikaans. Programmes are relayed by Pietermaritzburg, according to announcements. Have been hearing Durban for past three months and signals are now rather fair . . . best at 3 a.m.

"Johannesburg, on 6.09, or 6.095 may be nearer, is not as strong as Durban, but sufficiently strong to copy a report around 4 a.m. Programmes were also in English and Afrikaans.

"Another South African is on 9.61mc, 31.22m., closing at 2.45 a.m. At least, I take it to be from this country. Programme heard on several occasions has been in Afrikaans speech only."

SOME IMPORTANT CHANGES IN THE A.B.C. S/W TRANSMISSIONS

Operative as from Sunday, February 27

New Stations are in bold type.

Note: VLR-3 has been discontinued.

VLR-2, Melbourne, 6.15mc, 48.78 m.: Sundays, 6.45 a.m.—9.15 a.m.; 6.58 p.m.—11.30 p.m.

Weekdays: 6 a.m.—7.10 a.m.; 5.30 p.m.—11.30 p.m.

Saturdays: 6 a.m.—7.10 a.m.; 5.30 p.m.—12 midnight.

VLR, Melbourne, 9.54mc, 31.32m: Sundays, 9.30 a.m.—6.30 p.m.

Weekdays, 7.20 a.m.—10. a.m. 11.45 a.m.—5.20 p.m.

Saturdays, 7.20 a.m.—10 a.m. 11.45 a.m.—5.20 p.m.

VLH-4, 11.88mc, 25.25m.: Sundays, 6.45 a.m.—8.30 a.m.; 3.30 p.m.—6 p.m.

Weekdays, 6 a.m.—8.15 a.m.; 4.30 p.m.—6.30 p.m.

Saturdays, 6 a.m.—8.15 a.m.

VLH-5, 15.24mc, 19.69m.: Sundays, 8.45 a.m.—3 p.m.

Weekdays, 10 a.m.—4 p.m.

Saturdays, 10 a.m.—5.30 a.m.

VLH-3, 9.58mc, 31.32m.: Sundays, 6.15 p.m.—11.30 p.m.

Weekdays, 6.45 p.m.—11.30 p.m.

Saturdays, 5.45 p.m.—12 midnight.

VLG-7, Melbourne, 15.16mc, 19.79 m.: Daily, 6 a.m.—8 a.m.

Sundays, 6.45 a.m.—8.15 a.m.

All times given are Australian Eastern Standard Times.

ALTERATIONS TO DEPARTMENT OF INFORMATION S/W. OVERSEAS TRANSMISSIONS

As from January 14

VLA,6, Shepparton, 15.2mc, 19.74 m.: Now closes at 8.55 a.m. instead of 9.

VLC-4, Shepparton, 15.315mc, 19.59 m.: To Asia in Japanese. 9 a.m.—9.20 a.m.

VLC-8, Shepparton, 7.28mc, 41.21 m.: Has replaced VLG-3 and VLC-4 to Britain and now on from 6.20 p.m.—6.55 p.m.

VLC-2 and VLA-6 to Northern Asia now closes at 6.15 p.m.

VLA-6 opens at 6.35 p.m.

VLC-6 closes at midnight in programme to Bangkok.

VLG, Melbourne, 9.58mc, 31.32m: Has replaced VLG-5 to Britain from 1.15 a.m. (as from January 18).

MISAPPLIED ELECTRONICS

Unfortunately electronics has been over-publicised . . . To market an electronic device which is no better and does no more than its mechanical or electrical competitor of olden days would also result in discredit to industry even if the use of vacuum tubes in the device gives it an enhanced sales appeal—Paul G. Weiller in "Electronics."

PALESTINE BROADCASTING

The administration of the Palestine Broadcasting Service has been separated from the General Post Office and a new department of broadcasting has been formed in Jerusalem. The new department has appointed an assistant controller of the English programmes and separate controllers of the Arabic and Hebrew transmissions.

TELEVISION RELAY

A system for transmitting television from Washington to Philadelphia has just been put into operation by Philco. The distance of 152 miles is covered with the help of four intermediate relay stations, each with 40 W power and 100 foot high aerials.

Here are a few jokes I heard over short-wave that made me smile:

Amos and Andy, referring to Jack Benny: "Yes, sir, he lives so close to his money that even his skin feels like an outsider."

"The zipper on his wallet has yet got to make its first zip."

The following was given by TAP during Post-bag session:

"Did you hear of the Scotsman who was standing at a busy crossing with a loaf of bread under his arm. He was waiting for the traffic-jam. And did you hear of the Scotsman who was standing outside the paper office with a pair of trousers over his arm? He was waiting for the Aberdeen Free Press."

NEW STATIONS

KCBA, San Francisco, 6.17mc, 48.62m: This is a new frequency for this outlet of the Columbia Broadmasting System and carries the U.S. Government International Information Service to Japan, Korea and South-east Asia from 7 p.m. till 1 a.m. It is in parallel with KCBF (9.75mc), KNBA (7.8mc) and KRHO (6.12 mc) and for the benefits of the broadcast-band chasers with KSAI, 1010kc, from 7.30-11 p.m. —L.J.K.

KGEI, San Francisco: Probably before this edition reaches readers, KGEI in transmission to Guam and the Philippines from 7 p.m.-1 a.m. will move from 9.55mc, 31.41m, to 9.53mc, 31.48m. This will only be 10kc from VLW-7, Perth, and may cause interference in some parts of Australia, but the move away from Singapore (9.55mc) would be welcome.—L.J.K.

JIE-3, Taihoku, 9.695mc, 30.94m: This station in Formosa, once a regular, has been heard again after a long spell. Not sure of schedule but it can be heard most nights if morse permits.

WLWS, Cincinnati, 15.13mc, 19.83 m: Arthur Cushen reports: "WLWS, on 15,130kc, is a new frequency with 'Voice of America' broadcasts. Heard till 6 a.m. Then signs re-opening at 6.15 at even better strength."

HCIVT, Ambato, Ecuador, 7.00mc, 42.86m: This one is reported by Mr. Roger Legge, Jr., and doubtless Arthur Cushen or Dr. Gaden will land it before long. It closes at 1 p.m.

HC5EH, Cuenca, Ecuador, 3.94mc, 75.88m: Here is another being heard regularly by Mr. Legge, but will be a "toughy" in this country, I think. Anyhow, it is on till 2 p.m. and sometimes later.

Radio BISSAU, Bissau, Portuguese Guinea, 7.095mc, 42.28m: Here is a good catch by Roger Legge and this West Coast African should be audible in Australia. Language used is Portuguese and schedule is 8-8.30 a.m. This is just a little late perhaps for that country and that frequency, but the time should suit Arthur Cushen.

RADIO MACEIO, Alagoas, Brazil, 9.30mc, 32.25m: Roger Legge, Jr., also reports this one. Heard in Portuguese from 9-10 a.m.

YNET, Masaya, 7.102mc, 42.24m: This Nicaraguan station with slogan, "Radio Masaya, Emissora del Pueblo," according to Roger Legge, operates from 10.30 a.m. till 1 p.m.

YNBH, Managua, 7.01mc, 42.80m: Another in Nicaragua reported by Roger Legge. "Radio Panamerica" is heard till 1 p.m.

RADIO MACASSAR, Macassar, 9.37mc, 32.02m: This chief town and port of Celebes, Netherlands Indies, is heard nightly from 7.30. Signal strength is fair but modulation is poor. The announcer states the broadcast is to Australia and that reports would be welcomed. From 9 p.m. native language is used. I am grateful to Ern Suffolk, of Lobethal, South Australia, for first advice of this station. I had heard them several nights but could not catch call. Mr. Suffolk himself says it took an hour of concentrated listening to identify it.

RADIO HANOI, Hanoi, 12.135mc, 24.72m: "La Voix de Vetnan," Hanoi, Indo-China, is reported by Mr. Leo Edel as being heard nightly at fair strength, but badly distorted. French at 10 o'clock and news in English at 11. Slogan, wavelength and frequency given at 11, preceding the news.

KNBX, San Francisco, 6.06mc, 49.50m: This frequency used for some time a little while ago by KNBI is now heard nightly from 8 o'clock as KNBX directed to the Philippines and China. Languages used are: English, Tagalog, Mandarin and Cantonese. Closes at midnight after a 10 minutes' Press Roundup in English.

RADIO KUALA LUMPUR, Malay Penin., 6.09mc, 49.21m: Mr. Leo Edel is the first to report this one. Heard nightly from around 8.30, but often spoilt by noise.

"THE VOICE OF FREE INDONESIA" (Location ?), 15.22mc, 19.71m: Another reported by Mr. Edel. Heard every night from 9 till 11.

VLC-10, Shepparton, 21.67mc, 13.84m: Ern Suffolk reports this new Australian transmitter as heard on 24th December in parallel with VLG-3 in programme to Britain. He says signals of VLC-10 were fair at closing at 5.25 p.m., but at 5 o'clock they were inclined to be weak and fluttery. Dr. Gaden has since reported this one at same time one afternoon.

CIVILIAN RADAR USES

What is probably the first practical civilian use of radar is found in the General Electric "Electronic navigator" that can detect, through darkness, fog and storm, the position of any above-water obstacles such as lighthouses, buoys, icebergs, derelicts, other ships and land at distances up to 30 miles, depending upon the size and shape of the object.

This device operates on the radar principle of radio waves which are reflected from objects and are measured to give the true bearing and distance of the object from the point of sending. It will revolutionise "thick weather" navigation by providing the mariner with an instrument to plot a safe course, even though his normal visibility is strongly limited by natural conditions.

Distances of objects from a ship are shown on the viewing screen of the electronic navigator in true proportions, being measured by a series of concentric "marker rings" electronically super-imposed on a picture screen. According to General Electric engineers, measurement of the distance so given is accurate to one percent.

Speedy Query Service

(Conducted under the personal supervision of A. G. Hull)

V.W. (North Brighton, Vic.) enquires for a circuit for a single 1D8GT valve to give two audio and two r.f. stages and a diode detector, with back-biassing.

A.—Sorry, but we can't recall having published any such circuit, although there have been some which have used the 1D8GT to give several stages of gain, although we doubt if as many as you list. We can supply a stroboscope for 78 revolutions, but we do not have one for 33.

* * *

T.P.K. (Bairnsdale) is a bit scared about tackling the job of rewinding a power transformer to alter the filament voltage.

A.—A lot depends on where the filament windings are situated. Make a close inspection of the transformer and note where the wires run to. If the primary is next to the core, then the secondary, and the filaments are all on the top, you needn't worry too much, as the job is well within the scope of the average handyman. But if the secondary is wound on the outside, it will be too big a job to unwind and rewind it, unless you are a super-optimist. A layer of insulation tape between each filament winding should be ample insulation for your purpose. Find the number of turns per volt by counting the number of turns of a known filament winding while you are unwinding it. The figure is likely to be about 5 turns per volt, which means that you will need 20 turns on for the four-volt winding. As there is no disadvantage in using heavy wire, we suggest the larger gauge. Only point to watch will be to leave enough room so that the corepieces can be re-assembled without scraping the insulation off the windings.

* * *

J.G. (Kensington) enquires about subscriptions.

A.—There are no restrictions on our subscription lists and we are always pleased to have new subs. The fee is 10/6 for 12 issues, post free to any address in the world. Subscribers' copies are posted in Sydney on the same day that they leave the printer's hands. In the past many difficulties have arisen from time to time, making the actual posting date a little erratic, but our aim is to post the issues on the 7th day of the month.

W.H.H. (Brighton) is worried about the subject of gain in amplifiers.

A.—There is a terrific difference in the actual signal voltage output of various types of pick-ups. Some crystal types will deliver 5 volts of signal on a loud passage, whilst some pick-ups deliver less than one-hundredth part of a volt. Needless to add, under these circumstances, you cannot design an amplifier with gain to suit all types of inputs. By using a volume control or two you can cut down the gain of a high-gain amplifier, but in practice it is neither economical nor good practice. Other things being equal, it is easier to keep down distortion in a low-gain amplifier.

* * *

R.A.P. (Bondi) brings up the argument of vibrator versus rotary converter.

A.—Our view on this subject, expressed as concisely as possible, is that the vibrator unit is more efficient from the point of view of watts in to watts out, but is less reliable under normal service conditions. This effect becomes increasingly evident as the voltage goes up, to such an extent that we don't hesitate to say that the rotary converter is the only thing worth considering when you want 350 volts at 80 milliamps.

* * *

W.S.T. (Parramatta) enquires about the Audio Scribe pick-ups.

A.—These pick-ups are intended for professional use, and can give the most excellent performance if handled properly, but are not to be confused with ordinary commercial pick-ups, like the crystal and magnetic types. The Audio Scribe has a low-impedance output, making it essential to use a pre amplifier stage, which is necessary to give added lift. It would be no use to think of plugging an Audio Scribe into the pick-up terminals of an amplifier like the A513 Radiotron circuit. The Audio Scribe is mainly used for broadcasting station work, re-recording sound and so on. One model is specifically designed to be used on acetate recordings without wearing them out quickly. However, to answer your query more specifically; you can use the Audio Scribe with your amplifier if you go to the extra trouble and expense of fitting an input transformer and a pre-amplifier stage. If this is done properly, it should be quite a step in the direction of giving you better reproduction and less record wear. Cost of the pick-up, transformer and the pre-amplifier stage, if you made it up yourself, would cost about £20 the lot.

NOTICE TO READERS

Owing to circumstances beyond our control (strikes, power restrictions, etc.), our December issue was delayed almost a month. This January issue will also be late, but we are struggling ahead as quickly as possible and, in the near future, we hope to be able to regain our original publishing date, the 15th day of each month.

3 OUTSTANDING FEATURES OF THE NEW EIMAC 4-125A TETRODE

1 LOW DRIVING POWER

With but 2.5 watts driving power, the 4-125A will deliver 375 watts output at frequencies as high as 120 Mc. The low driving power requirement has been achieved without the use of excessive secondary emission. The control grid is specially processed to reduce both primary and secondary emission.

2 HIGH FREQUENCY PERFORMANCE

The Eimac 4-125A will deliver 200 watts output at 250 Mc. The performance curves below show the relationship between driving power and power output at frequencies up to 250 Mc.

3 LOW GRID-PLATE CAPACITANCE

The grid-plate capacitance of the 4-125A is only *0.03 uufd.* This low value allows operation up to 100 Mc. without neutralization. Stability is further assured by the special grid processing which reduces secondary emission.

A technical bulletin on Eimac 4-125A Power Tetrode contains full specifications and detailed discussion of the valve's characteristics, circuit diagrams and constant current curves. Write for your copy today.

The Eimac 4-125A is the first of many new Eimac valves that are on the way. Watch for future announcements.

GENERAL ELECTRICAL CHARACTERISTICS

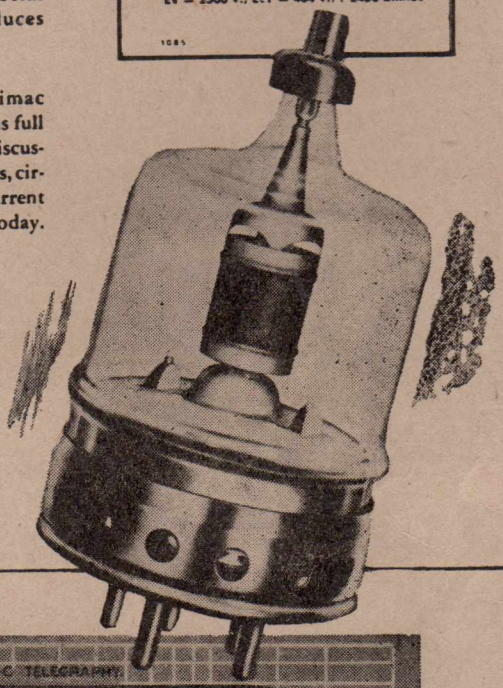
Filament: Thoriated Tungsten
- Voltage . . . . . 5.0 volts
- Current . . . . . 6.2 amperes

Plate Dissipation (Maximum) 125 watts

Direct Interelectrode Capacitances (Average)
- Grid-Plate (Without shielding, base grounded) . . . . 0.03 uufd.
- Input . . . . . 10.3 uufd.
- Output . . . . . 3.0 uufd.

Transconductance (Ib = 50 ma., Eb = 2500 v., Ec1 = 400 v.) . 2450 umhos

1085



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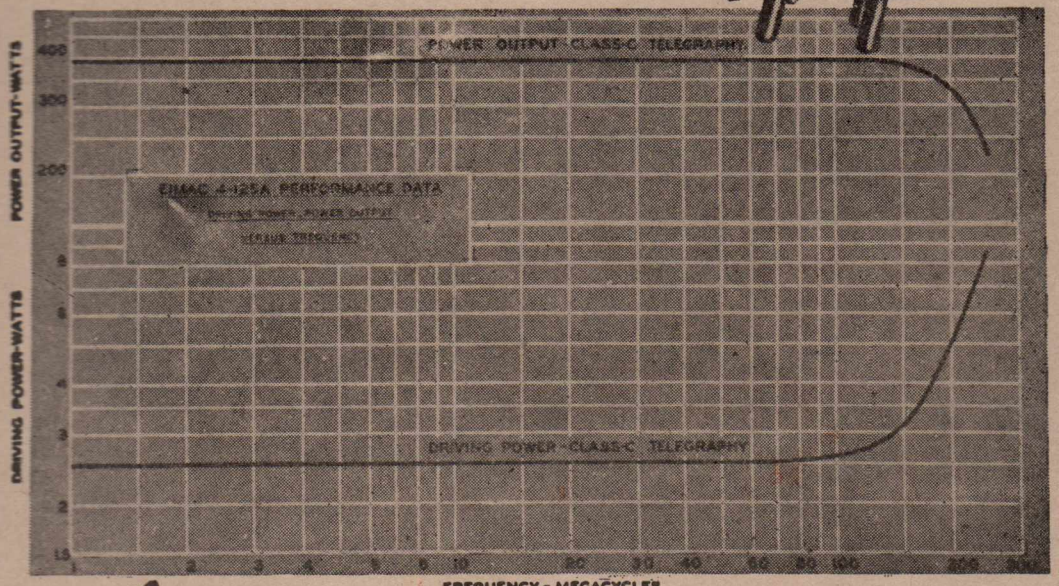

Eimac VALVES

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