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RADIO WORLD

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PUBLISHED BY THE PROPRIETOR—
A. G. HULL,
Balcombe St., Mornington, Vic.
'Phone: M'ton 344.

Short-wave Editor—
L. J. KEAST,
7 Fitzgerald Rd., Ermington, N.S.W.
'Phone: WL 1101.

ADVERTISING REPRESENTATIVE
Stephen H. Farrell, 74 Pitt St., Sydney. 'Phone BL2260.

REPRESENTATIVES
In Queensland: John Bristoe, Box 82, Maryborough, Q.

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CONTENTS

A Quality Amplifier . . . . Page 5
Practical "Q" Meter 11
Dodging the Transformer 15
Improved Noise Limiter 17
Alternating Current in Practice 19
Effective One-Valve Sets 27
Tuning Unit for Powerful Receiver 29
Short Wave Review 31
Bargain Corner 34

EDITORIAL

A MINOR depression is being felt in radio circles at the moment. There is considerable talk about the causes and cures. In the latest issue of "Radio and Hobbies," my one-time protege, John Moyle, makes no apology for saying that "there is a lack of drive and imagination among far too many radio firms."

Some advertisers are saying that there is a falling off of interest in technical radio. I can assure them that this reckoning is quite wrong. Our subscription list was never longer, our sales more than 300 per cent. greater than pre-war. The fact is that these readers are thirsting for something interesting, something new. Technical journalists are doing their best to quench this thirst, but it is a hopeless task when component manufacturers won't produce any new lines, or even good ones. What inducement is there for anyone to build new receivers when the finished article will have little or no advantage over the many sets already littering the workshop?

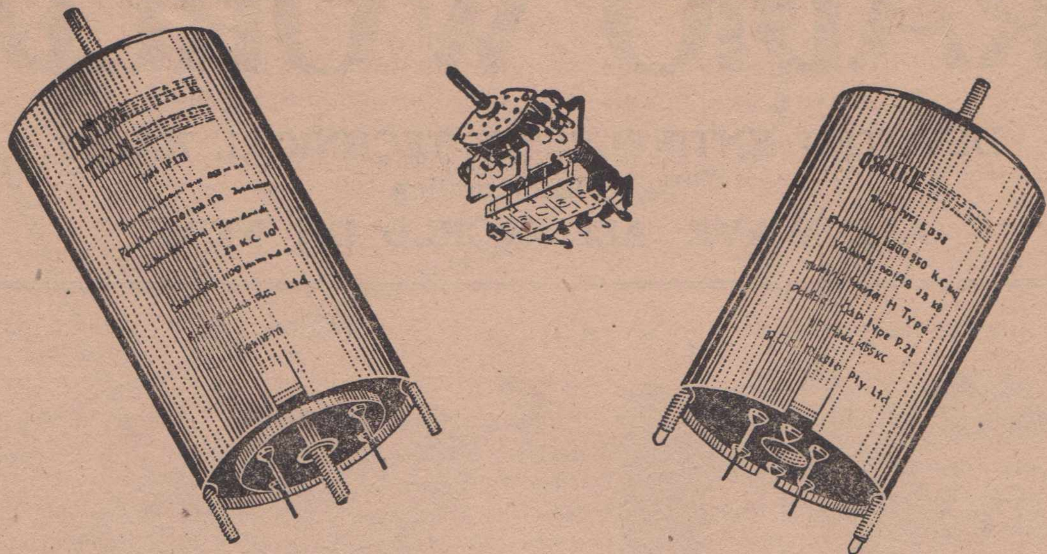
Fortunately, there are one or two firms still active. For example, see details of the new Aegis tuning unit in this issue.

In last month's issue we started to deal with the subject of what is wrong with the radio set business, and we have had many letters of congratulation on this effort. We hope to follow up in next month's issue. It has been thoroughly confirmed that a great many set designers are impractical in their outlook, and out of touch with their public.

Many of them would learn a lot if they put in a few months on the bench in a radio repair department.

—A. G. HULL.

Behind good reception . . .



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A QUALITY AMPLIFIER

In response to numerous requests, here are the full constructional details of an amplifier, embodying the novel direct-coupling arrangement which has been mentioned in recent issues.

By
A. G. HULL

IN the April and June issues we gave details of some experiments being done with direct-coupled amplifiers using twin power supplies. The idea was quite a novel one, nothing of similar design having been attempted before with these amplifiers, so far as we know.

It has been pointed out, however, that there were direct-coupled amplifiers with twin power supplies from batteries, long before even the original Loftin-White circuits of the 1929 era. Fundamentally these battery-operated direct-coupled amplifiers, which were built for the amplification of heart beats and that type of special work, operated on exactly the same principle as this latest direct-coupler which has created such a stir.

Our articles on the subject, so far, have been of a rather sketchy nature, and intended more to convey the idea to technically-minded readers than to give enough data for amateur builders to build their own amplifiers.

Dozens upon dozens of amplifiers have been built to our original circuits, but there have been a great many more requests from those who do not have a full knowledge of the subject, yet want the brilliant reproduction which is possible with this type of amplifier. So here is an article which should make the construction quite a simple job.

In order to smooth out the procurement problems associated with special equipment we enlisted the aid of the A and R transformer people and they have brought out a complete range of the special components. including a special power transformer with twin secondary windings.

Performance.

This amplifier is capable of delivering about 15 watts of undistorted power output ample for normal household use. It gives an uncanny brilliance to the reproduction, irrespective of the frequency range covered. The amplifier itself is capable of handling the whole of the audio range without the slightest difficulty, but it is not this frequency range alone which makes direct-coupling what it is. The difference between direct-coupled and ordinary amplifiers has to be heard to be understood. You can't just dismiss it as a better transient response, less phase displacement, or in any general terms. Just to satisfy ourselves we have been operating two amplifiers along side

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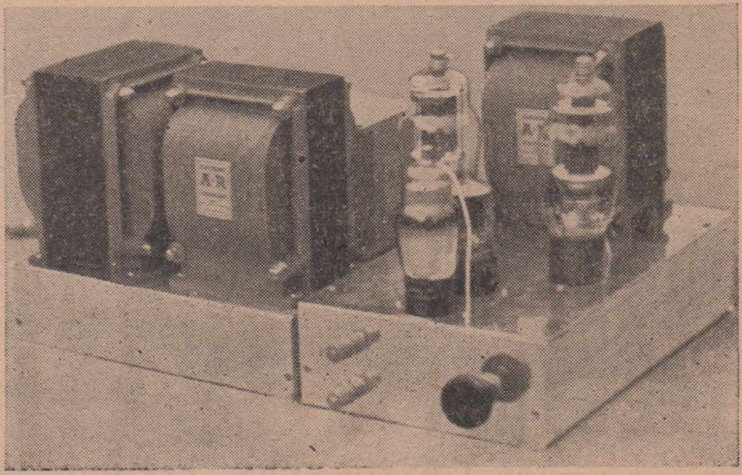


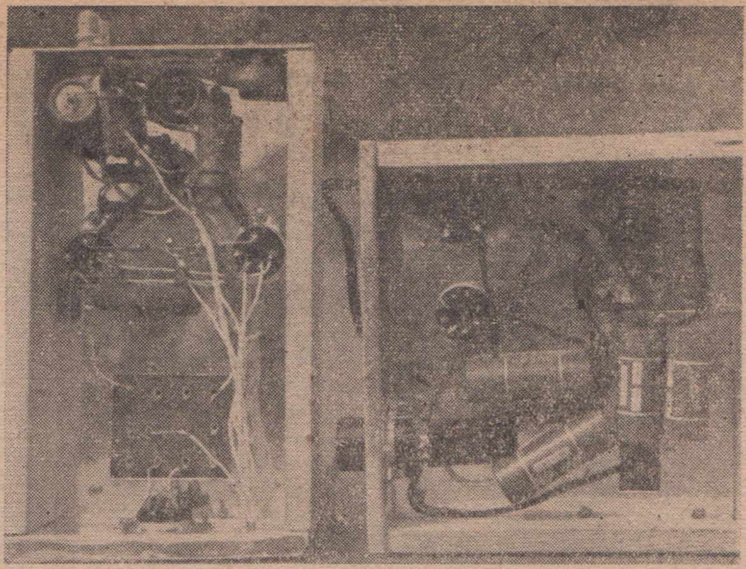
QUALITY AMPLIFIER

(Continued)

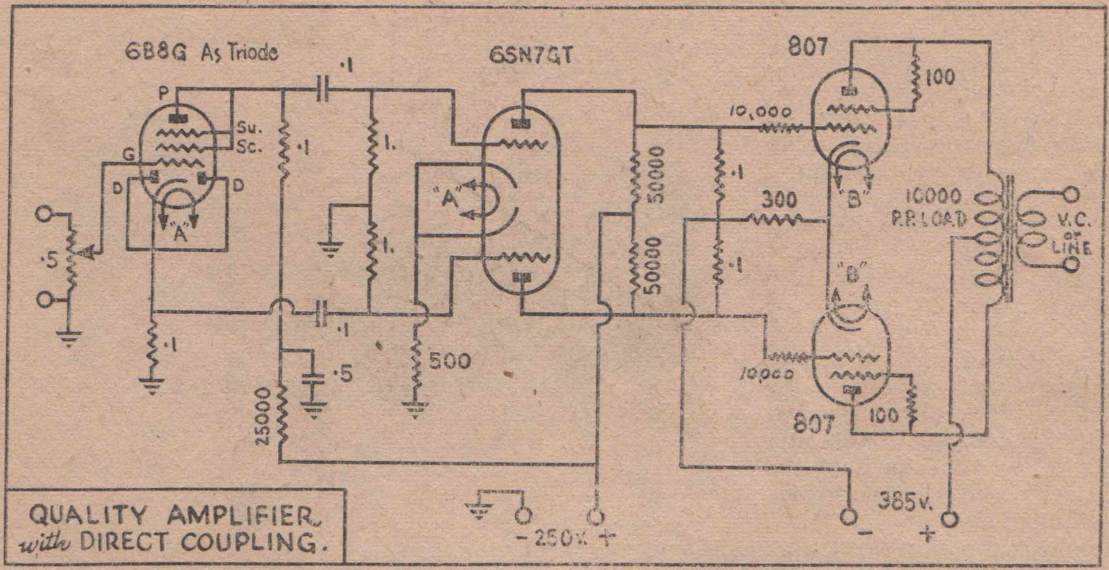
each other, one the resistance-capacity coupled job also described in this issue, the other the direct-coupled job. Switching quickly from one to the other has proved the point quite clearly, yet we can't find the right terms to describe the difference.

An outstanding feature of the difference is that it is just as noticeable with a restricted frequency range as it is when wide-range reproduction is attempted.

There is considerable difference in individual taste as regards record reproduction. With ordinary commercial recordings of to-day, and badly-worn records of the past, there is considerable doubt as to the value of a brilliant high-note response. Many listeners prefer the style of reproduction which is obtained with crystal pick-ups of the type which give heavy lows and cut off fairly sharply at about 7,500 cycles. The Tecnico FL48 is a typical example of this type of pick-up and is recommended for use with this amplifier. For those who want the utmost in brilliance and who are prepared to tolerate a certain amount of surface noise, the Acos GP12 high-fidelity pick-up is suggested. Both these pick-ups are available readily at reasonable prices and have sufficient output to load up the amplifier to deliver 10 watts and more from ordinary recordings. There are plenty of other pick-ups also suitable, but, if in doubt, be sure to get out advice before building this amplifier for



A PHOTOGRAPH OF THE WIRING



use with a magnetic or low output type of pick-up.

The Speaker.

There are four major links in the chain of good quality reproduction, the record itself is probably the most important. The better the amplifier the worse the record will sound, if it is a poor one. Then there is the question of the pick-up, with which we have just dealt. There is no need to worry about the amplifier, so the next link is the loudspeaker and its baffling. We can only think of two likely speakers as being suitable, the Rola "O-12" at quite a modest price and the Goodman's imported speaker which costs much more. A single Rola "O-12" will handle the output, but not according to the makers' recommendation, which is only about 7 watts. In practice these speakers will take punishment and relish it, but if you want to be on the safe side, maybe two Rolas in parallel will ease your conscience.

When it comes to baffling, beware of box baffles and vented enclosures, for these are more often harmful than helpful. Theoretically a vented enclosure is a great help to quality reproduction, but it needs to be right. Otherwise it is worse than the flat baffle. Simplest for the amateur quality enthusiast is a solid baffle of five-ply timber about five-eighths thick and three or four feet square.

Fourth link in the chain is the matter of acoustics of the room. This is a big problem and one on which we can't offer to advise. Possibly the best plan is to carry out your

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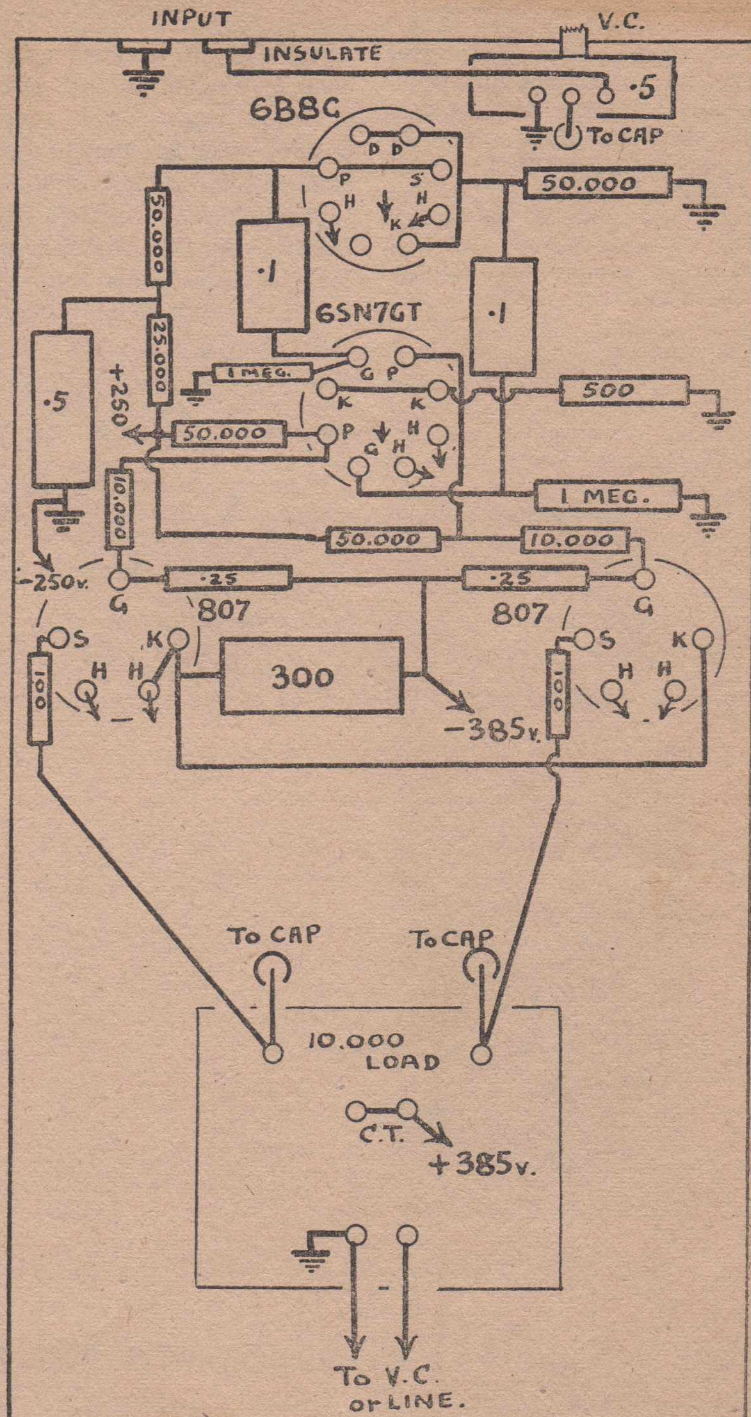


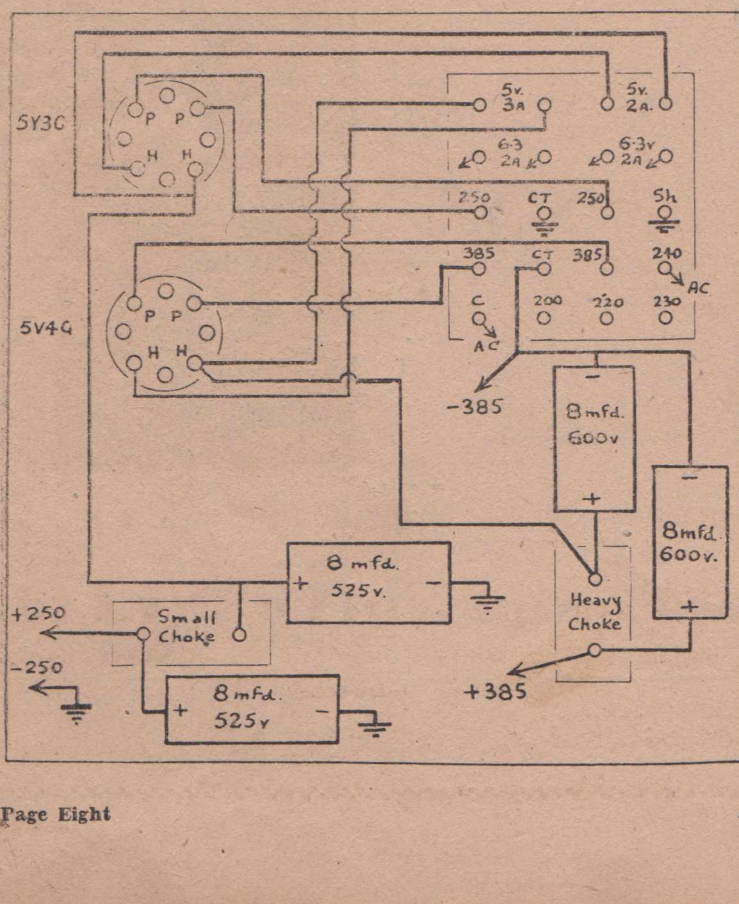
own experiments, trying your speaker in various mounting positions. For the utmost brilliance we suggest mounting it in the bathroom!

There is a terrific difference, according to the size of the room, nature of the floor coverings, walls, curtains, cushions, etc.

Construction

To get on with the job of building the amplifier, we suggest separate bases for the amplifier and power supply. These can be folded up out of sheet aluminium quite easily, with wooden ends for strengthening. Folding aluminium sheet is easy if you scratch a line across both sides where the fold is required, then hold the sheet between two pieces of hardwood in a vyce and bend by holding another piece of wood against the sheet, pushing steadily. Punches are available for a few shillings to make light work of the socket holes. The square holes for the transformer cut-outs are done with a hacksaw blade, after three or four small holes are drilled at the corners and then broken into each other by the points of your angle-cutters.

Building on separate bases makes the job much simpler, and avoids hum trouble which may be met if you build the amplifier and power all in one base without due care to lay-out. Only tricky point about the twin-base idea is the wiring up of the connecting plug, lead and socket. This calls for a certain amount of care, but is not really difficult.



The Amplifier Chassis.

There are a number of points about the amplifier wiring to be watched.

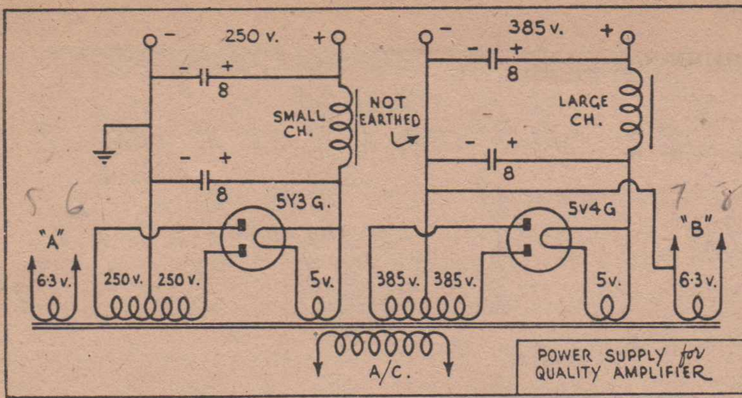
The whole performance of the amplifier depends on its stability. If there are parasitic oscillations, motor-boating or unwanted feedback the final results will be disappointing. Such troubles are often hard to detect without equipment. All that is noticed is that the amplifier does not have its proper power output or tonal quality.

To safeguard against these troubles we have specified grid stoppers and screen stoppers for the 807 type output valves. These stoppers should be wired directly to the socket connections with short leads. The pigtails at one end of the 100 and 10,000 ohms resistors should be cut off to a length of not greater than a quarter of an inch, then soldered closely to the socket terminals.

The output transformer should be mounted on the amplifier chassis, not on the speaker. It should be in such a position that the plate leads are short, direct and in the clear.

The Power Supply.

Wiring up the power supply calls for special care, as the arrangement is quite unconventional. Normally the negative side of the high tension is earthed, but in this power supply one of the high tension circuits is "floating" above earth, so don't earth the negative side of its filter condensers,



or the centre-tap of the power transformer secondary.

Note that the filter condensers on the 250 volt power supply can be 360 or 525 volt rating. For safety's sake, those across the 385 volt power supply should have a 525 or 600 volt rating.

The electrostatic shield of the power transformer is earthed.

The power supply leads will be connected to the in-put terminals according to the power supply voltage. The usual thing is 240 volts, but on account of various reasons, the actual power supply is often well below this voltage. If you have a meter to read a.c. you can check it, otherwise you can only go by the glow of the valve heaters.

Quite a number of suburban power supplies will be found to be nearer 200 volts than the rated 240.

The Input Arrangements.

The earlier articles on this new style of direct-coupled amplifier dealt with the job as we were using it, with the pick-up "floating," instead of with one side earthed, as is normal. By this means it is possible to feed straight into the grids of the 6SN7GT and drive the two output valves from it. This scheme works out fine, and we can strongly recommend it. Hum trouble may be encountered if you have long leads from the pick-up, but the remedy is obvious; shorten up the leads and keep them clear of wires carrying a.c.

However, in response to numerous requests, we show here

(Continued on page 30)

PRACTICAL "Q" METER

In recent issues we have detailed several handy pieces of test equipment of a fairly simple type. Here is something a bit more difficult, but still within the ability of the enthusiast.

THE Q-meter measures the figure merit or Q of coils, condensers and other components as well as inductance, capacity and resistance.

The instrument consists of an R.F. Oscillator, in this case an electron coupled Oscillator, fro mwhich a small amount of voltage is fed to the Q-meter circuit through a small non-inductive resistance which is in series with the tuned circuit. The voltage developed across the tuned circuit is then measured by the vacuum-tube voltmeter. The increase in potential caused by the oscillator across this small non-inductive resistor is magnified by the tuned circuit which includes the component under test for Q. This magnification is proportioned to the Q factor and so enables the V.T.V.M. to be calibrated directly in Q.

The oscillator condenser is calibrated in frequency having a separate scale for each frequency range. These calibrations are obtained by zero beating the signal from the oscillator with that from a receiver or modulatod oscillator.

Plug-in coils are used to prevent absorption effects as the oscillator output is fairly high. These coils should be wound to cover whatever frequency ranges are required.

A single gang condenser of about 450 mmfds. is shunted by a midget of about 35mmfds., the combination serving to tune all but the high-frequency ranges, in which case the larger condenser is switched out by the oscillator range switch.

As the number of twins required on the coils will vary according to the diameter of

By
H. M. WATSON,
89 Botting Street,
Albert Park (S. Aust.)

the coil former used, the capacity of the tuning condensers, and the frequency ranges at which it is desired to operate, no winding table is given, but winding data may be obtained from various text books or calculated by the formula

$$N = \sqrt{\frac{(3A + 9B)\ L}{.2A^2}}$$

Say, for instance, that our tuning condensers in parallel have a maximum capacity of 450 mmfds. and we wish to tune our oscillator to a frèquency of 1667 k/cs. Consulting an L/C table we find that an inductance of 20 mh. is required for this frequency. The next step is to find the number

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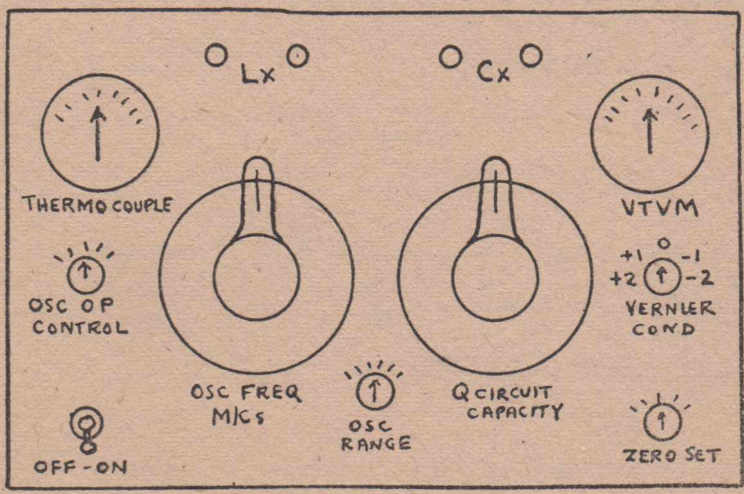


of twins required to give this inductance. Say that the available former has a diameter of 1.25 inches, then for best results its winding length should also be 1.25 inches. We now have

$$\sqrt{\frac{(3 \times 1.25) + (9 \times 1.25) \times 20}{.2 \times 1.25^2}}$$

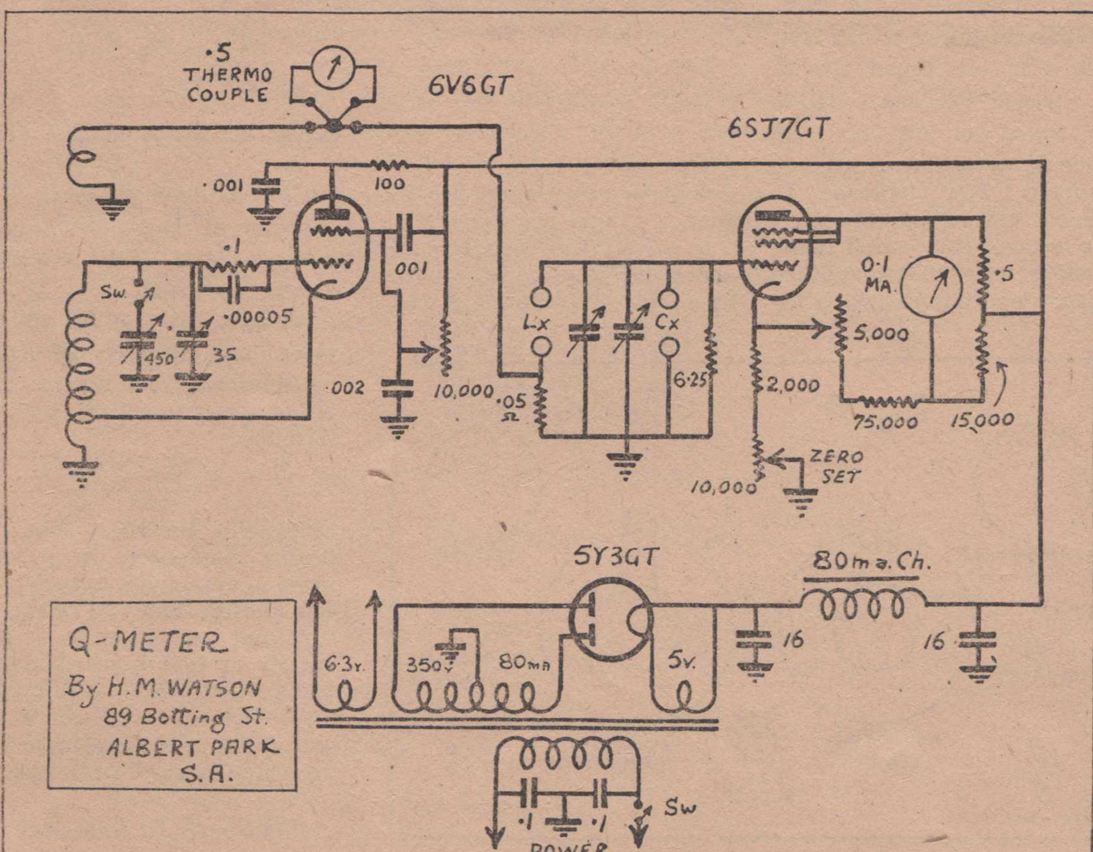
$$= \sqrt{730} = 27 \text{ turns}$$

The wire gauge is then consulted to find the gauge that will occupy a length of 1.25in. with this number of turns, viz., 27, and found to be 17 gauge B and S enamelled.

Two turns will suffice in all cases for the winding that supplies the voltage to the Q measuring circuit. The cathode tap position is best found by experiment, an average position being at about one third of the total turns from the earth end. The optimum proportion, however, will vary, the higher frequency coils requiring a larger percentage of feedback turns. As a guide a coil of about 50 turns would be tapped about ten turns from the earth end, whereas a coil of 10 turns would require to be tapped at about 3 turns from the earth end.

Only a small proportion of the oscillator power output is consumed by the Q measuring circuit so that there is no reaction of the Q measuring circuit on the oscillator. This small portion of output is fed to the Q measuring circuit through a .05 ohm non-inductive resistor consisting of a straight length of wire. As a guide just over one inch of No. 24 S.W.G. Eureka wire or just under 1 inch of No. 21 S.W.G. nickel chrome wire will give this resistance.

The current through this resistance is shown by the thermo-couple ammeter which is marked at two settings corresponding to the 2 scales of the Q meter, i.e., .4 and .2 amperes, giving Q ranges of



0—350 and 0—700 respectively. The oscillator output voltage is regulated by varying the oscillator plate voltage.

The main tuning condenser of the Q measuring circuit has a small condenser of 4 mmfds. shunted across it. This small condenser is calibrated in mmfds. from × 2 to — 2, each mmfd. section being subdivided into 10 graduations so that each small division is equal to .1 mmfd. This small condenser gives a very fine adjustment of tuning, and also enables coils and condensers to be matched accurately. If the main condenser is set at 100 mmfds. the small condenser scale will read percentage, as 1 mmfd. change of capacity will then be equal to 1 per cent. This is convenient when matching coils.

As stated above the V.T.U.M. is calibrated directly in Q; with the current set at .4 on the thermo-couple there will be .02 volt across the .05 ohm resistor so that when 1 volt is present at the grid of the 6SJ7 the Q will be 50, and when 7 volts are present at the grid the Q will be 350. With the current set at half the above value the Q range will be doubled giving a Q range up to 700. The V.T.U.M. is designed to give a full scale deflection of 7 volts.

The oscillator coil is plugged in and the oscillator condenser switched and tuned to the desired frequency. The oscillator output voltage is set by varying the oscillator plate voltage until the meter reads either .2 or .4 amps for the Q ranges of 700 and 350 respectively, according to the Q of the component being measured.

Care should be taken to avoid overloading of the thermo-couple meter by backing off the plate voltage control when switching from one range to another, however, with good construction the output should remain fairly constant for all ranges.

The V.T.V.M. should be zeroed with its terminals shorted to provide a D.C. path as otherwise the meter will go up scale slightly due to grid current.

Care should also be taken to see that no stray fields are present. To check for voltage pick-up from stray fields the oscillator should be detuned from the circuit being measured whereupon the V.T.V.M. should read zero.

To Measure the Q of a Coil.

Connect the coil between the "L" terminals, set the oscillator to the desired frequency and tune the coil to resonance by the Q meter tuning condenser (maximum deflection). The reading at resonance is the Q of the coil.

To Measure Capacity.

A coil must be provided that with the 450 mmfd. or whatever condenser is used, will provide resonance at the desired frequency. Two readings are then taken , one with the component in the circuit and one with it out. For the reading with the component in the circuit, such component should be placed either in parallel with the Q circuit (across the "C" terminals) or in series with the Q circuit (between the coil and Q meter terminals). Provision should be made for a continuous D.C. path through the coil and series component by a leak not over 5 megohms if necessary. The Q, the capacitance and the frequency should be recorded for the two readings from which the necessary calculations may be made.

SPEEDY WAS RIGHT!

An example of the way in which modern communications are making the world smaller has come to our notice.

On 3rd September a subscriber in Kuala Lumpur, Malaya, found himself in difficulties with a set he was repairing. He wrote by air mail to our Speedy Query Service for advice.

The query was received and answered on the 6th. Our reply reached Malaya on the 10th. The advice contained in the letter proved helpful and the set was soon in operating condition.

Thousands of miles separate Mornington and Sentul, so we feel that a reply in a week is certainly good going. To the many hands of the P.M.G's. Department who must have handled the letter, and its reply, with such promptness, we offer our thanks and congratulations.

Many readers who live much closer at hand will be lucky if they get such speedy service from our Query Department!

VALVE TESTER

In the circuit of the valve tester, which was published in last month's issue, the voltage for the emission test was not shown. It should be 100 volts.

Dodging the Transformer

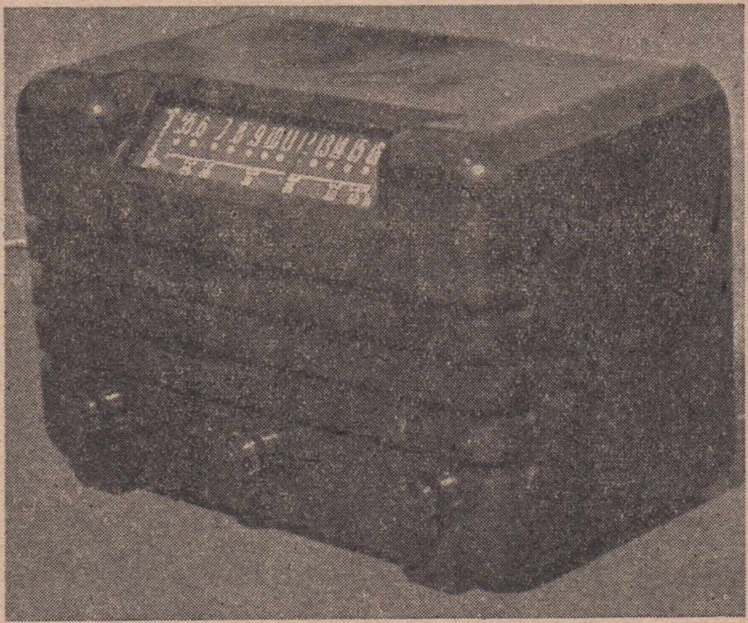
The radio trade is in sad need of new ideas for set designs. Dealers report that few modern sets are as good as pre-war ones, let alone better, as they should be.

THERE is considerable stagnation in receiver design these days, and it is seldom that anything new or interesting is encountered.

There were a few interesting tit-bits in the Radiolette circuit which we gave in the July-August issue, but otherwise the only different style of receiver we have encountered recently was one in which the old "bell-ringer" style of power supply had been resurrected.

Old-timers will recall this idea which was introduced shortly after a.c. operated were thought of.

The bell-ringer was a transformer which was originally intended for use to supply power for a door-bell. The primary was 240 volts and the secondary about five or six volts. By using the secondary to heat up the filament of a rectifier valve and feeding the raw a.c. straight on to the plate, it was possible, by half-wave rectification, to get a couple of hundred volts for high tension supply. The trap was that one side of the power mains became the negative high tension, and was connected to the chassis. If the particular main to which the chassis was connected happened to be at earth potential the set was safe enough, but it was a fifty-fifty chance that you would be electrocuted if you got between the chassis and any external earth. Many fatalities occurred and the whole scheme was discouraged, in favour of the transformer with a secondary high tension winding which could be completely isolated from the mains.



AN INTERESTING ENGLISH SET, BUILT BY MASTERADIO. THIS SET WAS IMPORTED RECENTLY, AND WAS DOWN IN OUR LABORATORY FOR INSPECTION

No such method is possible with sets designed for a.c. and d.c. mains but precautions are taken with such sets to ensure that the chassis and negative high tension circuits are not accessible to the hands.

Such sets are fitted with back covers over the cabinet, with suitable warning notices. Earth terminals are insulated from the chassis by the use of fixed condensers, or by keeping the aerial primary completely insulated from the chassis.

Apparently someone has noted these precautions and worked out that, by applying them to a straight a.c. operated set, it would become possible to use a small filament transformer instead of the usual type. By using a transformer with a 6.3 volt secondary with sufficient current

(Continued on next page)

DODGING (Continued)

rating, it becomes possible to use it to supply all heaters, including the heater of a 6X5 type rectifier. Then by running one side of the a.c. mains to the plate of the 6X5 you can get half-way rectification to supply a suitable high tension voltage.

The advantages of the scheme are several. Tht transformer costs less, the transformer weighs less and can be smaller, making it possible to have a more compact and lighter set.

These points appear important at first glance, but when you get down to tin tacks it is most doubtful whether they are worthwhile. The saving in cost of the transformer is only three or four shillings, according to my price list of small transformers. The saving in weight is only a few ounces and the matter of size is only a matter of fractions of an inch. Offset the cost factor by the cost of the necessary back cover for the cabinet, with three or four screws for it, and the shillings will have been eaten up again.

Sets with direct connection to the mains also suffer from the lack of the electrostatic shield which is built into the power transformer. This shield is earthed and stops quite a bit of noise which comes in on the mains. In practice this means that the set which is directly connected to the mains suffers with noisy operation and modulation hum on some stations. This type of hum, which tunes in and out as you tune the set over the station, may be filtered out with chokes and by-pass condensers, but if these are fitted the advantages of the whole idea shrink into oblivion.

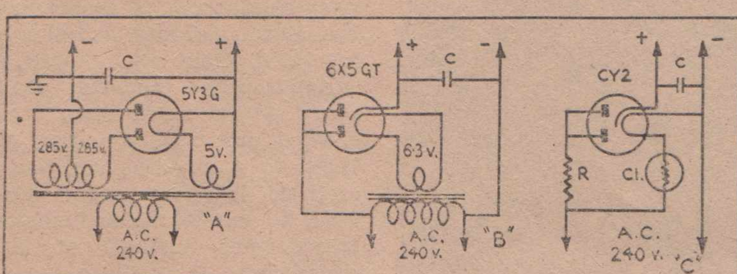
However, testing out this little set with its small transformer brought to mind other methods of dodging the cost and weight of the power transformer. Exploring along these lines brought back to memory the popular type of American set which might be a success in Australia, too. This set uses the power cord as a resistance to drop the mains voltage to enable the heaters to be fed directly from the mains through this resistance. One side of the mains is also applied to the rectifier plate for high tension. With this sort of set no power transformer is used at all, so it really does save space, weight and cost. The special power cord has the usual two wires for the mains, plus the third wire which is in the form of a spiral of resistance wire. The wattage to be dissipated when breaking down 240 volts to apply to the heaters, even when they are of low current types and connected in series, is too high for a small resistor if mounted in the set, but a lot of heat can be dissipated in the length of a power cord. Of course, the set must be operated with the correct power cord which must not be cut or extended.

One of the latest Philco portables from America was tested here recently and its design noted. It was fitted with 1.4 volt valves of the 1R5, 3S4 range, and could be operated from its internal battery unit for portable use. By throwing over the switch and pulling out a cord and plug it could be operated from 240 volts a.c. or d.c. No transformer being used, the set was of particularly light weight and small dimensions.

Instead of the resistance type of power cord it is possible to use the special barretter valves which are listed for the purpose, such as the type C1. This barretter is a sort of resistance, mounted inside a glass envelope, with valve base. It regulates the current through it to the figure required for the other valve heaters, 200 milliamps in the case of the C1.

Barretters of this type are used in sets designed for a.c. and/or d.c. operation, but most of these are bulky sets. There does not seem to have been any effort in Australia to make small, lightweight sets by dispensing with the power transformer.

Maybe it is all for the best, for these sets are dangerous to service, for the alignment of the set and its adjustment must be done with the safety cover off the back of the cabinet.



POWER SUPPLY ARRANGEMENTS. A, THE CONVENTIONAL; B, USING A SMALL FILAMENT TRANSFORMER; C, USING THE BARETTER.

Improved Noise Limiter

By VK2AXB

SINCE the earliest days of radio communication, one of the greatest problems encountered by professional engineers and amateurs alike has been that of eliminating superfluous noises in the reception of radio signals. The problem has, if anything, become even more aggravated of latter years by the introduction of modern devices such as domestic machinery, neon signs, fluorescent lights, ignition noise from the ever-increasing volume of cars, and so no.

The writer has been for some time engaged in experiments with mobile communications, both with A.M. and F.M. telephony, and, whilst it is undoubtedly true to say that the best answer to both natural and man-made interference is the use of frequency modulation (with the very important proviso that a **true** F.M. receiver is used, and not an A.M. receiver tuned on the slope of its selectivity curve) it will be a very long time before such transmissions become accepted as standard, if, indeed, they ever do.

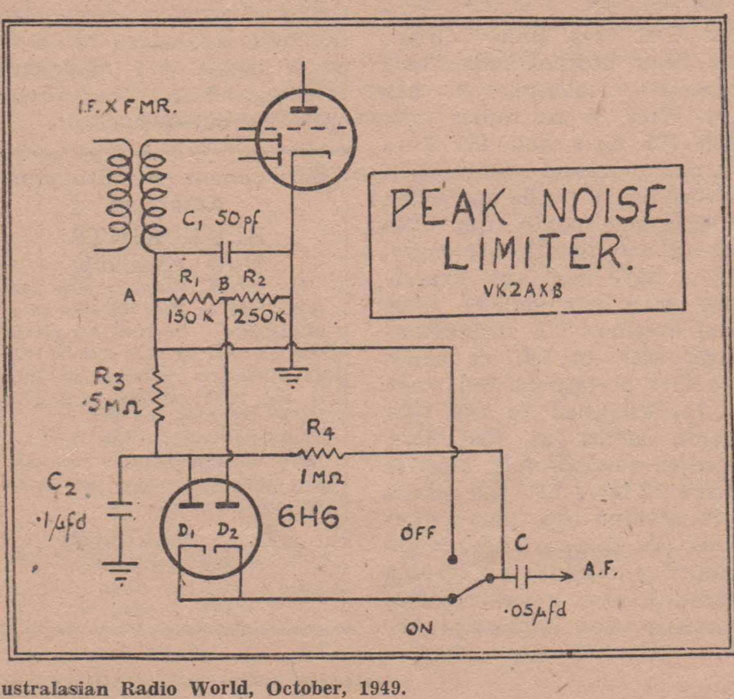
It follows, then, that the use of effective noise-limiting devices is a very desirable feature of the modern communications receiver, and the purpose of this article is to present a new and extremely efficient electronic limiter to those hard-pressed amateurs who suffer from an overabundance of noise in their locations.

The location I had at the time of the development of this circuit was pretty terrific, to put it mildly. On a main highway, there was always plenty of ignition noise, and as there was a junction of two tram lines outside the front door, cake mixers, electric drills and a very old system of conduit wiring in the building, it is not very difficult to imagine that, in so far as radio was concerned, it was very much a modern Bedlam.

A variety of limiter circuits were tried, with varying degrees of success, from the simple series diode gate to complicated noise amplifier/rectifier systems using several valves, but the final conclusion was that the circuit of Fig. 1 was an extremely effective peak noise limiter, and it further has the advantage of using but one 6H6, a socket and a few resistors and condensers.

The detector diode is part of a duo-diode-triode valve, with the normal diode load split into two portions, R_1 and R_2, and in the absence of an incoming noise signal, a normal rectifying action takes place in the diode, so that point B becomes negative with respect to earth, and point A is negative with respect to B. This means that D_2, in the noise-limiting valve, will conduct, from point B, through the cathode of D_2, R4 and R3.

Now, if a sharply peaked noise signal arrives, the impulse will drive the plate of D_2 sharply negative, but, as the time constant of the R4—C_2



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NOISE LIMITER (Continued)

combination is very large compared to the duration of the noise pulse (with the constants shown, it is one-tenth of a second) the cathode will remain at its normal potential, and thus the audio signal will be cut off for the duration of the noise peak. As the noise pulse is of very short duration, the period which there is no audio signal is not noticed by the human ear.

Perhaps you may say that this is just a normal series gate-type of limiter, and, so far, that is all it is. However, no diode is a perfect rectifier, and there will therefore be a certain residential negative pulse at the limiter valve cathodes, which will cause D_1 to conduct through R4, and so effectively short-circuit the noise pulse, removing any residual noise.

We can see from this that we have, in reality, a combination of the series limiter and the shunt limiter, which gives truly excellent results.

On a casual inspection of the circuit, the noise limiter cathodes would appear to be "floating," but they are not floating with regard to the operating potential, since a bias voltage dependent upon carrier strength, is obtained via R3 and R4. This means that the noise-limiter is self-biasing, according to the incoming signal strength, and it follows that sharp peaks of noise, which are higher than the incoming signal, are clipped back to the same level as the carrier itself.

In common with all limiter circuits, there is a slight amount of distortion introduced, particularly on modulation peaks, but for all normal purposes, this distortion is unnoticeable.

It may be worth mentioning that if a duo-diode-triode is used in its normal function of detector, A.V.C., and 1st audio, bias for the audio can be obtained by contact-biasing through the use of a 10 megohm grid leak after the audio coupler. If a gain control is to be used in the first audio stage, then the coupling condenser shown in the diagram would go to the control, and the grid would be fed through another condenser from the moving contact of the control. The A.V.C. diode can be fed from the last I.F. valve plate in a normal manner.

The construction of this limiter offers no great problems, and there is very little to be said on the subject. Layout may be one that is convenient, and no more than normal good practice need be followed in wiring and positioning of components. The I.F. alignment should be carried out with the limiter switched out of circuit.

To conclude, I would mention that this limiter circuit has been proven under very arduous conditions. It has been fitted to car radios with both 175 Kc/s and 455 Kc/s I.F. channels, and results when in very heavy traffic and when directly underneath tram lines (which are notoriously noisy, if you have had any experience with car radios) have been excellent. A B.C.348 receiver with an I.F. at about 980 Kc/s performed well when it was modified to use this circuit, whilst at 160 Mc/s, fitted to a mobile A.M. receiver with a 12 Mc/s I.F., the results were nothing less than miraculous. In this instance, where conditions of ignition noise had rendered communication with a base station impossible before the addition of the limiter, afterwards a normal conversation could be held without any difficulty whatsoever.

—VK2AXB.

NEW H.T. DEVICE

At the recent Dadiolympia in London, Amplion (1932) Ltd. showed a range of power mains units enabling owners of portable and other battery-opera ted sets to dispense with H.T. batteries. Models shown included one for fitting in a portable in place of the all-dry battery; one for any battery receiver, replacing both H.T. battery and L.T. accumulator, a connection to a 2-volt accumulator providing both L.T. and H.T. current from the accumulator without connecting to the power mains supply; a miniature unit for personal portable receivers; and a model for operating a portable from the power mains or a 6 or 12-volt battery, and, while in use, re-energising itself for use away from any source of power. For every three hours the unit is plugged in to the power mains it is sufficiently re-energised for one hour's operation out-of-doors.

ALTERNATING CURRENT IN PRACTICE

Now we come to the most interesting part of our theory course, where we apply the theory to practical applications in receiver design.

By
W. S. LONDEY,
Barkly Street,
Sale, Vic.

IN part III alternating currents were considered with respect to current, voltage, power, phase relationships and the like.

The next consideration is the effect of various circuits on alternating currents, and the reasons for these effects.

The current in a circuit containing resistance only is simply determined by using ohms law as for a direct current circuit. That is I = E/R where R is in ohms, E in volts (R.M.S.) and I is in amperes (R.M.S.).

Very few alternating current circuits are simply resistive as a coil of wire may offer a much greater opposition to the passage of an alternating current than would be expected from its resistance on direct current. This opposition varies somewhat with frequency also.

Similarly, a condenser, which has infinite resistance on direct current, may pass an alternating current quite readily, the exact current being also dependent on frequency.

These effects, and their combinations, are to be studied in some detail in this article as they are very important in radio being involved in coupling and tuning circuits, power transformers and filter circuits.

Inductance.

Consider a coil of wire carrying a current. There will be a field surrounding and threading the coil. This flux is said to link the turns of the coil, the number of linkages being the product of flux and turns (possibly with a correction for leakage as all the flux may not link the end turns).

Now consider what happens when the current in the coil is reduced. As the lines of force can only form closed circuits they cannot simply disappear, but must collapse inwards. In doing so they cut the conductors of the coil, and, by so doing, induce a voltage in those conductors. This voltage is in such a direction that it tends to oppose the change producing it; that is, it tends to maintain the current at its original value. A similar opposition will be presented to any increase in current.

This opposition to any change in current has the effect that, when an inductance is connected across an alternating supply, the current through the inductance lags behind the voltage by ¼ cycle (90 electrical degrees).

The inductance of a coil is usually expressed in **Henries** but the small inductances used in radio work are expressed in millihenries (1/1000Hy.) and microhenries (1/1,000,000 Hy.). The use of iron cores in coils

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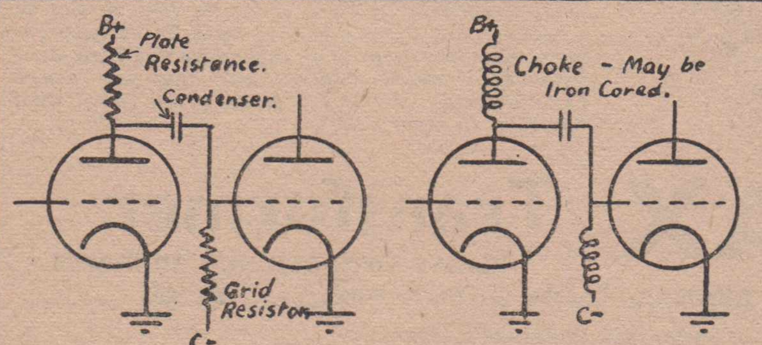


RESISTANCE-CAPACITY. CHOKE-CAPACITY. COUPLING SYSTEMS. Fig. I.

increases the flux and, therefore, increases the inductance.

A coil is said to have a self-inductance of 1 henry if a current change in it at the rate of 1 amp. per sec. induces a voltage of 1 volt. It is this self-induced voltage which causes a spark at the contacts when a current is broken in an inductive circuit.

Capacity.

If two plates, insulated from each other, are placed close together, and the potential of one raised with respect to the other a current will flow into that plate for an instant. If the potential difference be reduced current will flow out again. The space between the plates is strained electrically, and this straining stores energy like a spring stores mechanical energy. Like the spring, the space can be overstrained and break down, when the condenser will flash over between the plates. This space is called the dielectric and the three parts, the dielectric and the two plates make a condenser.

The capacity of the condenser, or the amount of electrical energy it can store for a given (unit) potential difference, is dependent on three factors—

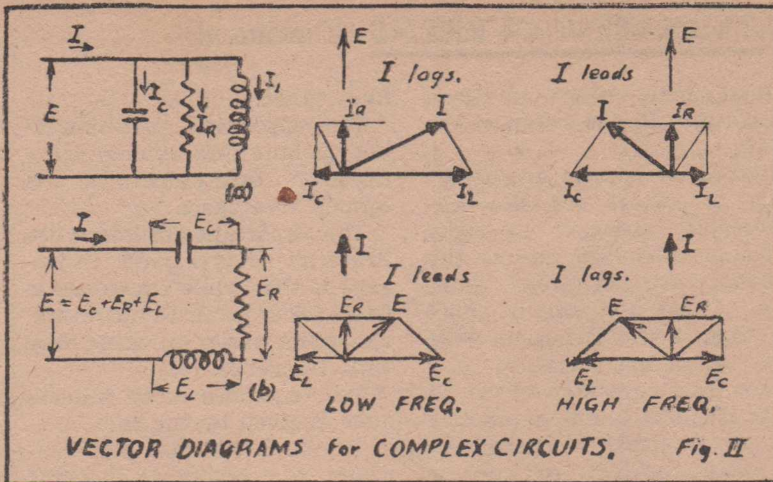
(a) the area of the plates,
(b) the distance between them,
(c) the dielectric material.

If an insulating material other than air is placed between the plates the capacity is generally increased.

The use of mica increases the capacity about six times, glass about seven times, and paraffin paper 2.3 times. These figures are for a given plate spacing and area, but in practice the effect is much greater because the plates can be brought closer together than they can with air as a dielectric.

Of the dielectrics in common use mica is by far the most effective as it is a better insulator, is mechanically stronger than paper, the usual alternative, it is naturally available in very thin sheets but is more expensive than the paper.

Paper condensers are, however, much more bulky than mica condensers of the same rating. Ceramic condensers are being used to some extent —they have a capacity change with temperature opposite to mica and are used in conjunction witih mica for capacity stability.



VECTOR DIAGRAMS for COMPLEX CIRCUITS. Fig. II

Variable Condensers.

The simplest type of variable condenser in use is the common tuning condenser in which the capacity is changed by changing the effective area of the condenser plates. Compression type trimmers operate on the principle of changing the plate spacing. Variable capacities have been made in which the capacity is changed by moving the dielectric in and out between fixed plates but are of little practical use at ordinary frequencies.

Two units of capacity are used; the centimeter and the farad, the latter being the most common. This unit, however, is never used except as a submultiple, the microfarad, the farad being much too large. The microfarad is 1/1,000,000 of 1 farad. The farad is, by definition, the capacity which will store 1 coulamb (1 watt-second) of electricity for a potential difference of 1 volt. Very small capacities are sometimes given in micro-micro-farads (1/1,000,000 mfd). These are called pica-farads in some text books—symbol pf. An easy and useful value to remember is .0001 mfd = 100 mmfd. as it is capacities round this value which are expressed in either form.

The centimeter (cm.) is an absolute unit of capacity; that is, derived directly from the dimensions. To convert cms. to micro-micro-farads, multiply the cms. by 10/9, for example:—

90 cms. = 90 + 10/9
= 100 mmfd.

The capacity of a parallel plate condenser is given by the formula:—

capacity = KA/12.56d cms.
or C = KA/11.3d mmfd.
where K = dielectric constant of the insulation.
A = total effective area of the plates.
= (N - 1) times the area of each plate.
d = distance between plates.
N = number of plates in the case of multi-plate condensers.

When a condenser is connected across an alternating supply it is found that the current through the condenser leads the voltage by ¼ cycle (90 electrical degrees).

Capacities in Series and Parallel.

The capacity of a number of condensers in parallel is the sum of their capacities.

$C = C_1 + C_2 + C_3$ plus etc.

The capacity of a number of condensers in series is given by the reciprocal of the sum of their reciprocals.

$1/C = 1/C_1 + 1/C_2 + 1/C_3 + \text{etc.}$

The resultant capacity of condensers in series is always less than that of the smallest of the parts.

These rules are important in tuned circuit design where condensers may be connected in series and/or parallel to obtain special effects.

For example, the padding condenser in a broadcast receiver limits the maximum value of the tuning capacity in the oscillator circuit to an effective value of about 220 mmfd instead of its maximum of 450 or thereabouts.

In short wave sets small series condensers are used to give band spreading effects

(Continued on next page)

which simply reduce the range tuned over in one sweep of the dial.

Parallel trimmers are necessary to correct for the unavoidable variation in stray parallel capacities due to the wiring, valve electrons, pins, etc. These are usually small so that they will not increase the minimum capacity any more than necessary.

It is quite common practice to use electrolytic condensers in series for high voltages, or in parallel for high capacities, e.g., 2/8 mfd 525V electrolytic condensers.

(a) in series $1/C = \frac{1}{8} + \frac{1}{8}$

$= \frac{1}{4}$

$C = 4$

capacity 4 mfd—at voltages up to about 800.

(b) in parallel $C = 8 + 8$

$= 16$ mfd—

still at 525 p.v.

Re-actance.

The opposition to alternating current flow offered by a capacity, or inductance is termed re-actance.

The important difference between re-actance and resistance is that while resistance is fixed for a given temperature, reactance varies in some way with frequency.

The reactance of an inductance is given by the rule

$$X = 6.28\ fL$$

where X = reactance in ohms
f = frequency in c.p.s.
L = inductance in henries.

That for a condenser is given by a somewhat similar rule—

$$X = 1/6.28\ fc$$

where X = reactance in ohms
f = frequency in c.p.s.
c = capacity in farads.

If the capacity is given in microfarads, as is usual, then the reactance will be given in megohms, unless the factor 1,000,000 is introduced into the top line of the above equation, making it:

$$X = 1{,}000{,}000/6.28\ fC.$$

where C = capacity in microfarads.

Effect of Frequency on Reactance.

(a) Inductive Reactance.
Consider the effect of variation of f in the formula:

$$X = 6.28\ fL.$$

when f = O, that is for D.C., X = O, and as f increases, X increases.

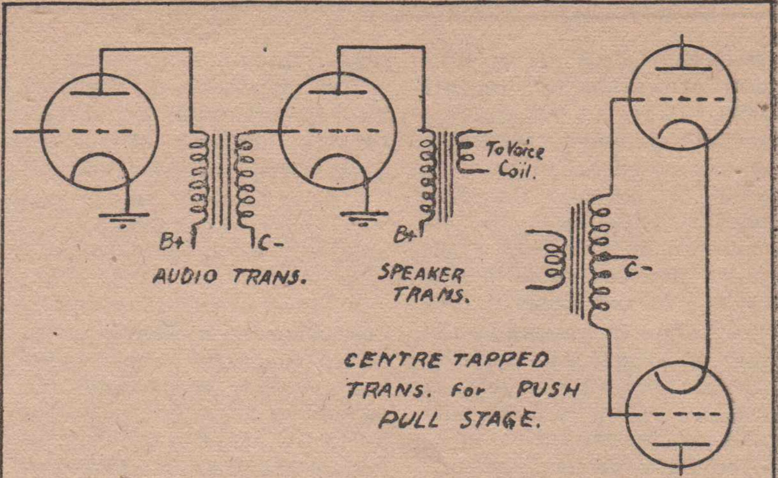
This means that an inductance offers no opposition to the passage of direct current, but any alternating current will be opposed to a greater or less extent depending on the frequency. This principle is used in filter systems where the choke—which is simply an inductance with an iron core—offering only a small resistance to the direct current, strongly opposes the passage of 50 or 100 cycle hum which is present in the rectifier output.

A 20 henry choke has a reactance of over 12,000 ohms at 100 cycles per second, which is many times its resistance of about 250 ohms.

Interstage transformers operate in a somewhat similar manner in passing the plate current but opposing any changes in value.

(b) Capacity Reactance.

Taking the formula X = 1/6.28 fC. it is seen that when f is zero, X = 1/0, that is X is infinite. As f increases the capacitive reactance becomes less so that for very high frequencies X is quite small even for a small capacity—incidentally a large capacity has a lower reactance than a small one at a given frequency. This is important in resistance (or choke) capacity coupling. In this type of coupling (fig. 1) uses the property of condensers having infinite reactance on D.C. to prevent any of the high voltage from the valve plate from affecting the grid voltage of the second valve, while any alternating voltages of suitable frequency are allowed to pass with little loss. For radio frequencies a small capacity such as .0001 mfd. is quite enough (reactance of .0001 mfd. condenser is 3,420 ohms at 465 Kc), while for audio frequencies a capacity of .05 to .1 mfd is required (reactance of .05 mfd condenser is 63,700 ohms at 50 c.ps.).



TRANSFORMER COUPLING. Fig III

Impedance.

When a circuit, as it usually does, consists of resistance, inductance, and capacity, connected in series or parallel, the combined effect is called impedance. Impedance may be simply defined as the ratio of the voltage to the current; that is, Z = E/I

where Z = impedance in ohms
E = voltage (R.M.S.)
I = current (R.M.S.).

It will seem rather confusing to have resistance, reactance, and impedance all in ohms yet apparently different but this is explained by phase effects. The current through a resistance is always in phase with the voltage, that through a reactance is always 90 degrees out of phase, either lagging or leading depending on the reactance being inductive or capacitive, while the current through an impedance may lag or lead any amount; the exact phase angle depending on the make-up of the impedance. An impedance that is predominately resistance will draw a current nearly in phase, one in which the inductance predominates will draw a lagging current, while a suitable capacity in a parallel circuit allows the phase angle to be adjusted to any desired value (towards the lead).

Fig. IIa shows a parallel circuit with the vector diagrams of the currents in the three branches of the circuit. One diagram shows the vectors for a low frequency, while the other shows them for a higher one. The resultant current is shown and is found by adding the three current vectors.

Fig. IIb shows the corresponding circuit and vector diagrams for a series circuit. In this case the current, being the only common factor, is used as a reference, the resultant voltages being added as vectors. Note that in IIa the current vector for the inductance was set down 90 degrees behind (to the right) to show it lagged, so in IIb the voltage across the inductance was set down 90 degrees ahead (to the left) of the current used as a

(Continued on next page)

reference. These vector diagrams show that the parallel circuit will draw a lagging current at low frequencies, while the series circuit draws a leading current at low frequencies. The latter current would probably be very small unless the condenser in the circuit were very large.

The reference vectors in the above diagrams are not to scale as they only indicate a direction; they are usually made long to keep them clear of the other vectors.

Mutual Inductance.

It will be remembered from part I that a current is induced in a conductor moving to cut the lines of force of a magnetic field. The voltage depends on the strength of the field and the rate of cutting. Similarly, if a field moves so that its lines of force cut a conductor there will be a voltage induced in that conductor.

The movement of the field may be produced by several different means:

(a) the motion of a magnet.
(b) the motion of a coil carrying a current.
(c) the change of current in a coil.

It is the last of these methods which is very important in alternating current work. We have already seen that any current change in a coil induces a voltage in that coil to oppose the change. If a second coil be arranged close to this coil so that the lines of force (flux) from the first coil or **primary** thread it, then, as the current in the primary changes, there will not only be a voltage induced in the primary but a voltage will also be induced in the second or **secondary** coil, as the flux cuts both coils during the change. The voltage induced in any conductor is proportional to the number of lines cut per escond and as each line cuts every turn of the coil the voltage will be proportional to the number of turns in the coil for a given rate of change of flux. Now if the primary has 10,000 turns and the current changes at such a rate as to induce a voltage of 100 in that coil, and the secondary has 3000 turns the secondary voltage will be 30 (in practice a little less than 30 because the two coils cannot be so close together that all the primary flux threads the secondary coil, there is generally some leakage).

The Transformer.

If instead of a changing direct current in the primary, the primary is connected to an alternating current supply the inductance of the primary will prevent a large current flowing but there will be a voltage induced in the secondary.

This secondary voltage will have the same wave form and frequency as the voltage impressed on the primary (provided none of the magnetic circuit becomes saturated during any part of the cycle).

The magnitude of the secondary voltage will be the primary voltage multiplied by the ratio of the secondary turns to the primary turns. For example—a transformer has a primary of 720 turns and a secondary of 330 turns has 240 volts R.M.S. connected to the primary.

$$\text{Secondary volts} = \frac{\text{Primary volts} + \text{Sec. turns}}{\text{Pri. turns}}$$

$$= 240 + 330/720$$

$$= 110 \text{ volts R.M.S.}$$

Iron cores are used wherever practicable in transformers because they improve the coupling between the coils and, because of the high permeability of the iron, less turns are required for a given inductance. A high inductance is required so that there will be only a small magnetizing current in the primary when the secondary is unloaded. The iron cores are laminated because, if they were solid, the core would act as a short-circuited coil and a large circulating current world be produced in it which would cause heating and losses. Although iron cores cannot be used at radio frequencies cores made of finely divided iron dust in some binding material are used to improve the coupling and to reduce the number of turns required.

Types of transformers used:

(a) power transformers,

(b) audio coupling transformers,

(c) radio frequency coupling transformers.

(a) Power transformers are, of course, wound on laminated iron cores and the number of turns in each coil depends on the operating frequency, the voltage and the core cross section.

Fifty cycle power transformers having a core of 1 square inch cross section require about 6 turns per volt, 1½sq. in. about 4 turns per volt, 2sq. in. about 3 and so on. Most radio transformers have 4 or 5 turns per volt.

For example a transformer having a 240v. pri., 385/385 h.t. sec., and 5v. and 6.3v. filament windings on a 1½sq. in. core would have the following turns in its coils, using 4 t.p.v.

Primary $240 \times 4 = 960$. This could be tapped at 800 and 880 for 200 and 220 volts.

Secondaries h.t. $385 \times 2 \times 4 = 3080$ tapped at 1540.

Fil. $6.3 \times 4 = 25$

Fil. $5 \times 4 = 20$.

The h.t. sec. may be increased by as much as 8% to allow for the voltage drop on load due to the resistance of the coil.

(b) Audio coupling transformers are designed so that the iron of the core will not ap proach saturation under normal conditions, as this would cause distortion. The ratio of primary turns to secondary turns is usually kept between 2 : 1 and 2 : 1 as higher ratios cause loss of one end or the other of the frequency range. With the usual layer winding the greatest number of turns in the secondary is limited to about 15000 by high note loss and less than 5000 in the primary will probably cause lwo note loss.

Loudspeaker coupling transformers are an exception to this rule but they are stepdown transformers, that is the secondary has only a few turns. Even then, where very good response is desired special winding methods must be resorted to, such as sectional winding of coils, interleaving of windings, etc.

(c) Radio frequency coupling transformers are a special case as one winding, usually the secondary, is tuned to the selected frequency, and the coupling is generally made less than the maximum possible to obtain selectivity. Where both windings are tuned the coupling must be less than 1% or the secondary has an effect on the primary. These properties will be discussed more fully in a later article.

It is an important property of a transformer that a load applied to the secondary causes the primary to draw power from its supply. The power drawn from the supply is greater than that taken from and eddy current) in the transformer. Provided no part sistance, and iron-hysteresis and eddy current) in teh transformer. Urovided no part of the magnetic circuit becomes saturated at any time the wave form of the signal in the secondary is the same as that impressed on the primary.

FOR THE BEGINNER

Effective One-Valve Sets

ONE o the most simple and yet highly efficient single valve receivers is that shown in the circuit fig. 1. The arrangement follows the usual practice of applying grid leak detection with regeneration or reaction. To enable adequate bands spread to be on obtained on short-wave

By

G. W. BUTTERFIELD,

"The Broadcaster,"

Perth, W.A.

operation two tuning condensers are shown across the aerial coil, one 0.00015mfd. and the other 0.00005mfd. or 50mmfd. The larger capacity is used for rough tuning or band setting and the smaller for fine tuning. This combination need not be adhered to strictly: one single condenser could be used if a good slow motion tuning dial is used, particularly if only intended for broadcast reception. As a separate aerial coupling is not used in this circuit a small series condenser of the trimmer or semi-variable type is required to control selectivity and also to improve regeneration control. Regeneration is controlled by the 0.0002mfd. condenser connected between earth and the plate or reaction coil; the H.T. voltage being series fed via the L.F. choke and the R.F. or H.F. choke as shown. This is different from the common practice of feeding the H.T. voltage direct through the phone windings commonly done in single valve receivers. The phones in this case are coupled between earth and plate via a 0.2mfd. fixed condenser. In this way, only the required audio component is passed through the phones which eliminates the danger of burnt out windings besides removing the necessity of correct polarity phone connections. Better results are also obtained with this method as the tendency of the D.C. to "saturate" the phones is eliminated thereby increasing their ability to handle the full audio voltage. With this method, it is more than ever essential to use a first class quality R.F. choke. The plate L.F. choke should also be of the high impedence plate coupling type. It would be better to use the ordinary series phone connection method rather than the arrangement shown with a poor quality L.F. choke. If you would prefer to do this, connect the phones in place of the I.F. choke, eliminating the 0.2mf coupling condenser. The rest of the circuit needs no comment. Any general purpose triode such as the type 30 can be used. If you prefer to use the more sensitive R.F. pentode type this this can be done by applying the required screen voltage. This will have to be adjusted to suit the reaction but will probably be around 22 volt. A suggested chassis layout and dimensions

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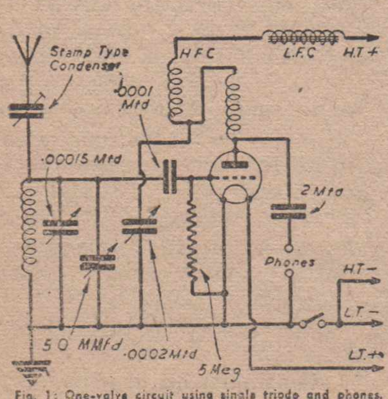


Fig. 1: One-valve circuit using single triode and phones.

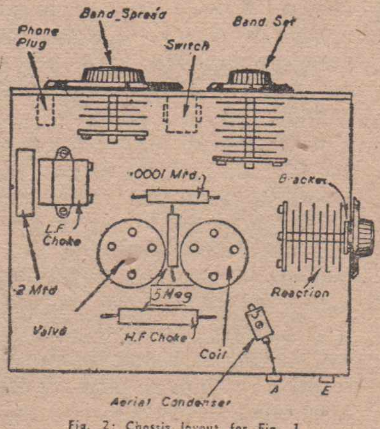


Fig. 2: Chassis layout for Fig. 1.

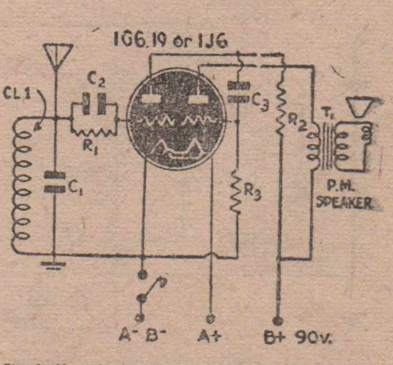


Fig. 3: Very simple twin-triode non-regenerative circuit.

suitable for plug-in coils is shown in fig. 2.

Twin Triode.

Another single valve receiver of the twin triode type is shown in fig. 3. If anything, this is more simple than the single valve circuit just described, as no regeneration is used. Instead, extra amplification is obtained by connecting each triode contained in the valve in cascade. In other words, you have two-valve operation with the one valve.

One triode serves as an ordinary grid1leak detector and the plate of this is coupled by means of the fixed condenser C3 to the grid of the second triode section which serves as a L.F. amplifier, the output being taken from the plate to either a pair of phones or speaker as shown. This set was mainly designed as an emergency hook-up to give L.S. results on local stations. Sensitivity is not exceptionally high and selectivity is not as good as would be the case if regeneration were also used; but this can easily be added by including a tickler coil in series with a condenser between the plate of the detector section and earth. An R.F. choke would be necessary also between the same plate and C3. Alternatively, the method as used in fig. 1 could be adapted—both methods of obtaining regeneration are much the same.

The values of components used are much the same as in the previous circuit and not at all critical. CL1 can be an ordinary commercial B.C. coil. The Reinartz type would be satisfactory; the aerial coupling and reaction coil could be left disconnected, and used later if it is desired to include the reaction as mentioned, or improve the selectivity further by inductively the aerial instead of the direct method shown. Alternatively, approximately 70 turns of, say, 36-gauge enamelled wire wound on a 1¼in. diameter former would serve the purpose, with a 0.00025 mfd tuning condenser C1. C2 and R1 can be the usual 2 meg grid leak and 0.00025 mfd condenser and C3 0.02 mfd. Both grid and plate resistors R3 and R2 are 0.5 meg. A fairly high speaker transformer input impedance will be required for maximum results, although the usual 7,000 ohms as used for pentode operation will work. Any of the twin triodes shown will work, but the 1G6 has the advantage of requiring only a single cell for the 1.5 filament voltage. For the 2-volt type, it would be advisable to connect a filament rheostat in series with the filament as you will have to use two 1.5 cells to obtain this voltage unless you care to use a 2-volt storage battery.

Triode—Pentode.

Probably one of the best single valve arrangements is that shown in the circdit fig. 4. As with the circuit just described, it functions as a two-valve, but instead of using a twin triode, advantage is taken of the extar gain and sensitivity which can be obtained from a triode-pentode such as the 1D8GT—or, to be more correct, diode-triode-pentode; but the diodes in this case are not used.

The Triode section characteristics are well huited to grid-leak detection and on a moderately powerful signal enough gain is obtained to drive the power pentode section to its full output of 0.2 datts which is sufficient to drive a speaker. Also, different to the twin triode the 1D8GT is functioning in a normal manner except for the addition of the regeneration, whereas the twin triode is designed as a "B" class power output valve. Apart from other advantages, this means that the normal speaker transformer in-put impedance of 12000 ohms can be used, thus ensuring correct matching of the output.

The circuit has no "tricks"

(Continued on page 34)

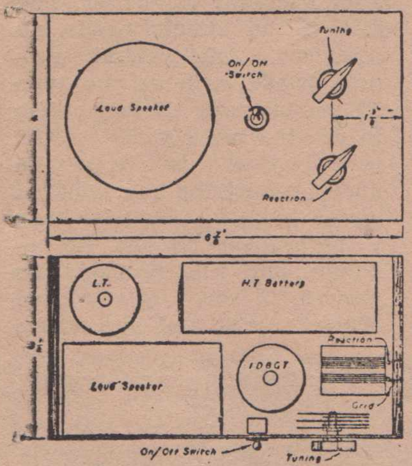


Fig. 5: Chassis and layout for Fig. 4

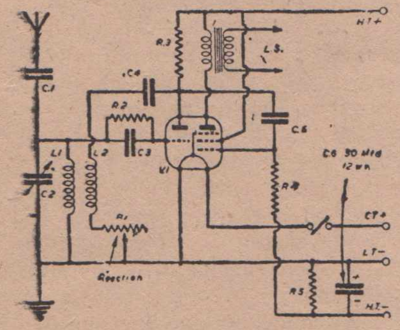


Fig. 4. Highly efficient triode-pentode circuit.

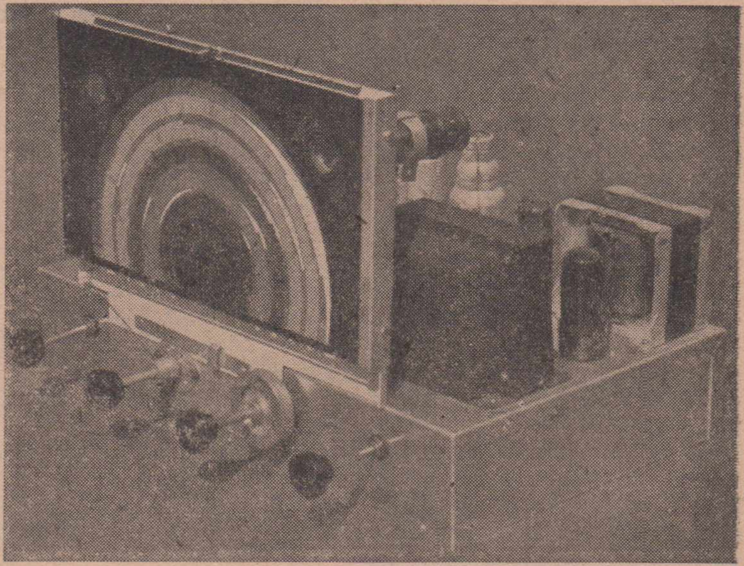
FOR AMATEUR SET BUILDERS

Tuning Unit For A Powerful Receiver

THE Aegis Manufacturing Company has just released a new tuning unit which should appeal to the ambitious set-builder who wants a receiver with wide coverage and exceptional performance.

The unit is really the complete front end of a receiver and comes to you as a unit, with tuning condenser, dial, switching and all wired up. It is a particularly simple job to build the unit on to a suitable chassis, thereby dodging the main difficulties in the construction of big sets.

The unit is a fine example of well-engineered r.f. construction, with a carefully calibrated dial, 29 to 1 ratio drive, flywheel spin tuning, and electrical band-spread.

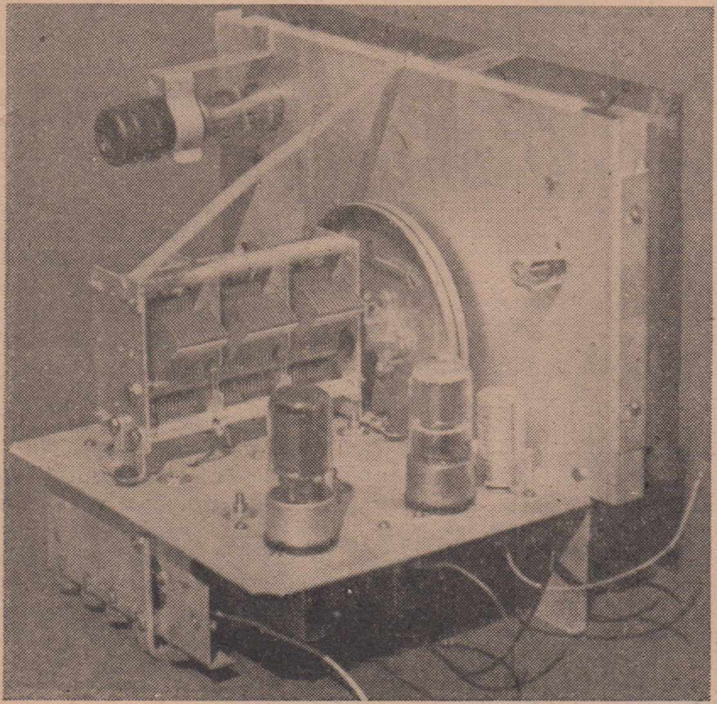


A TYPICAL RECEIVER BUILT TO EMBODY THE AEGIS KC5 UNIT.

The coverage is particularly thorough, with indicated bands on the dial for 16, 19, 20, 25, 31, 40, 49, 80 metres and the full broadcast band right down to 1630 Kc. These bands are split up into five switch positions with an automatic band indicator on the attractive dial, which has the different bands set out in bright colors, making them easily recognised.

The unit is fitted with all the condensers and resistors associated with the r.f. and converter stages, so that it comes ready for feeding into any good 455 Kc. intermediate channel.

We hope to give further details of this unit and suitable circuits in next month's issue.



REAR VIEW OF THE UNIT, SHOWING R.F. AND CONVERTER VALVES

QUALITY AMPLIFIER (Continued)

the amplifier with a phase-splitting valve ahead of the 6SN7GT, which then allows one side of the pick-up to be earthed.

It makes the job more suitable for use with a radio tuner, to. It is possible to get split-phase detection, and feed it direct to the grids of the 6SN7GT, but, again, the scheme is a little too unconventional to be appreciated.

Voltage Checks.

To make sure that the amplifier is in proper operatinig condition a check of voltages should be made with a multimeter having an internal resistance rating of 1,000 ohms per volt.

As will be expected from the unconventional power supply arrangements, voltage checking is also unusual. The first suggestion is to check the plate voltage of the output valves, measuring from centre-tap of the output transformer to the cathode terminal on the 807 valve sockets. This should read about 375 to 400 volts.

Bias for the output valves is read across the 300 ohm bias resistor, and should be 35 to 40 volts.

High tension for the driver stage should be checked at the h.t. end of the 50,000 ohm plate feed resistors and should be about 250 volts.

Bias on the 6SN7GT should be from 3 to 4 volts.

Troubles.

Of the troubles reported from builders who have built up direct-coupled amplifiers from the articles in the April and June issues, the only one worth mentioning is hum. There seems to be some funny effects possible with the two high tension supplies at different potentials. Possibly the phase of the rectified current comes into the picture. In some cases a reversal of the leads to either one of the rectifier valves will result in a curve. Just change over leads from plate to plate.

If hum is encountered the first step is to discover whether the hum comes in with the signal from the pick-up, or whether it occurs later on in the amplifier. If the hum decreases with the operation of the volume control, it is assumed to be picked up by the pick-up leads, or the pick-up. Shortening and shielding leads can be tried. Earth the pick-up frame, also the motor frame.

If the hum is constant, irrespective of the volume control setting, then it can be assumed to be in the amplifier itself, and the reversal of the rectifier plate connections can be tried. If this fails, or makes the hum worse, an electrolytic condenser can be tried with its positive terminal on the negative side of the 385 volt high tension, and the negative terminal earthed to the chassis, which is also the negative side of the 250 volt higih tension supply. This condenser should not affect the reproduction in any way, but if it makes the hum worse it indicates that the rectifier connections want reversing as mentioned above. With three versions of the original amplifier whicih we have built we have not had any hum trouble at all, and all three operate in such a manner that you need to listen intently to discover whether they are switched on or off.

Shortwave Review

Conducted By L. J. Keast

NOTES FROM MY DIARY

FREQUENCY & SHORT-WAVE BEAMS

As more and more listeners each month seem to be taking an interest in Short-wave listening and so many are unfamiliar with the Short-waves I feel sure a portion of an article with the above headline in "London Calling" will be of great service to these newcomers to our grand old hobby.

Dadio waves are electromagnetic waves, and follow the universal law of wave motion—that is, the frequency of the waves multiplied by the length of the waves is a constant, and this constant dedepends only on the medium through which the waves are propagated, and, of course, is absolutely fixed. Radio waves travel with a velocity equal to the velocity of light; that is 300,000,000 metres per second. We can, therefore, specify the particular wave we are using equally well by referring either to its length or to its frequency.

Relationship Between Frequency and Wavelength

In the early days of radio, the use of wavelengths was fairly universal, but later the use of frequencies was found to be more convenient from many points of view, and there is a growing trend everywhere nowadays to use frequency.

You can understand the relation between wavelength and frequency if you think of the simple analogy of sea waves moving towards the beach, and remember that the wavelength is the distance between the crest of one wave and the next, and the frequency is the number of waves which pass a given point in a given time.

To go back to radio waves, the wavelengths most useful for long-distance transmission are those between 11 metres and 49 metres in length. Other wavelengths are more useful for other distances. For short-distance broadcasting, for example, we may use a longer wavelength between 200 and 550, or even up to 1,500 metres; and some modern radio sets use very short wavelengths down to the order of 3 metres.

The frequency of a wave—the number of waves that go past a given point in a given time, or, to put it in another way, the rate at which the current in the transmitting aerial is changing, per second—is expressed either in cycles or in kilocycles or in megacycles, in all cases that number per second. The frequency given in kilocycles is thus the number of times per second, expressed in thousands, that the current changes in the aerial. In megacycles, it is the same thing, expressed in millions.

So if we want to convert a frequency to a wavelength, we divide 300,000,000 by the frequency. The middle of the ordinary, medium-wave band is approximately 1,000,000 cycles per second; and 300,000,000 over 1,000,000 gives us 300, which is the middle of the mediuim-wave band.

If, in the short-wave range, we divide 3,000,000 by the frequency in either kilocycles or megacycles, we get the answer again in metres. Thus, a frequency of 9,600 kilocycles corresponds to 31.25 metres. But 9,600 kilocycles is exactly the same thing as 9.6 megacycles. So we divide 300 by 9.6 and again get 31.25.

If we wan to go the other way round and convert metres into megacycles or kilocycles, we divide 300,000 by the wavelength in metres and get the answer in kilocycles—or divide 300 by the wavelength in metres and get the answer in megacycles.

As a matter of convenience, all the frequencies between 9.5 and 9.7 megacycles are usually referred to as the 9-megacycle band; and the wavelengths to which these correspond and which extend, actually, from 30.93 metres to 31.58 are generally referred to as the 31-metre band.

NEW STATIONS

Radio Noumea, 3.41 m.c. 87.97 met.:

With a slogan, "La Voix de la France dans la Pacifique," this station is heard from 5—8 p.m. Reported by Arthur Cushen.

WWHV, Maui. This is the call of The Bureau of Standards Station recently established on the Hawaiian Island of Maui. Time and frequency standards are being broadcast experimentally on 5,000, 10,000 and 15,000 kc.

The station is modulated with a standard 440 cycle A as well as audio pulses at accurate 1 second intervals. The audio tone starts at the hour and continues for four minutes, followed by one minute of silence. This sequence is repeated throughout the hour. Greenwich Mean Time is given in code every five minutes. All transmissions are interupted for about four minutes on the hour and half-hour and for about 30 minutes at 5 p.m. and 5 a.m. (Radio and Electronics.)

VERIFICATIONS

Mr. Beattie says: "A few verifications have trickled in over the past few weeks:

KGEI (9.79 met.), KGEX (17.78 m.c.), CKCX, CXLX, CBLX, CHOL, CKLO, VLX (6.13 m.c.) TAP and LKQ.

I have had the same experience witih LRY and LRS as others; monthly schedules are arriving by air-mail but otherwise no answer to reports."

SAYS WHO?

Here is a list of loggings from Mr. Allan Beattie, of Sydney:

Voice of America:

KNBI (21.63), K6EI (21.49), KNBA (21.46), KNBX (17.83), Honolulu (17.80), K6EX (17.78), Manila (17.76), Manila (15.33), Honolulu (15.25).—All the above come in at good strength in V. of A Russian session from 1.15-1.45 p.m. All suffer from jamming to a greater or less extent.

Manila (17.76 and 15.33).—Open at 7 p.m.

Manila (15.25 and 11.89).—Open at 8 a.m.

WLWS (17.83).—Opens at 11 p.m.; god signal.

American Relay Station in Europe (11.87). — Good until closing at 8.15 a.m.

XEQQ (9.68).—Fair signal at 2.30 p.m.

XEWW (9.50). — Frequently gets the better or UL13 around 3.30 p.m.

HIZT (9.735).—Good at 7 a.m. and 10 p.m.

VP4RD (9.625).—Fair from 8 p.m.; local news at 8.45 p.m.

TIPG (9.615). — Good from opening at 10.15 p.m.

HH3W (10.135).—Very weak around 10 p.m.

HP5J (9.605).—Weak to fair from around 9 p.m. ,

HP5A (11.695).—Nice strength at 10 p.m.

CE96O (9.595).—Quite a fair signal from 9.30 p.m., after the Indian on 9.53 m/c closes.

Leipzig (9.73).—Fair around 4 p.m.

K2PA (9.535). — Good around 3.30 p.m.

HED7 (15.12).—Fair, both at 8 a.m. and at 11 p.m.

Monte Carlo (9.79).—Good at 4 p.m.

Monte Carlo (7.35).—Weak at 4 p.m.

BEF7 (11.913). — Good in talks at 11 p.m.

BEF8 (15.17).—Good at 8 p.m.

BED9 (7.215).—Announces as "Voice of Free China in Taiwan"; news 8 p.m.

North Shenshi (10.26).—Good nightly.

Radio Malaya (7.20).—Good most nights from about 8.30 p.m.

BFEBS (7.25 and 9.825). — Both really good when relaying cricket.

ZL3 (11.81).—Gives Saigon a better break now; frequency is changed at 7.25 p.m.

Ceylon (21.70).—Very good at 7 p.m.

Hue (7.205).—Fair to good nightly; definitely announces under true colours now.

YD13 (7.295).—Weak nightly.

Bukittingi (10.57). — Weak and noisy.

DZH6 (6.03).—Fair to good nightly.

HERE IS A LIST OF SOME THAT CAN BE FOUND EASILY

Meg.	W/L'gth	Call Sign	Location	Times
6.01	49.92	Radio Bangkok	Siam	10-11 a.m.; 10 p.m.-1.30 p.m.
6.03	49.75	DZH-6	Manila	8 p.m.
6.035	49.72	Radio Monte Carlo		7-8 a.m. (Mondays)
6.05	49.59	GSA	London	News and commentary in English for Europe, 7.45-8 a.m.
6.065	49.46	HC2FQ	Guayaquil	4.30 p.m.
6.08	49.34	Munich III		1.15-8 a.m.
6.105	49.15	WLKS	Kure	Opens at 6.30 a.m.
6.18	48.54	GRO	London	News and commentary in English for Europe, 7.45-8a.m.
6.20	48.4	Paris Inter	Paris	4-7 a.m.; 9 p.m.-12.30 a.m.
6.672	44.96	United Nations	Geneva	News in English at 4.30 a.m.
6.77	44.31	FEBS	Singapore	Opens at 7.15 p.m.
7.105	42.22	Radio Bangkok	Siam	10 a.m.-11 a.m; 10 p.m.-1,30 a.m.
7.005	42.82	Radio Bangkok	Siam	7-10 p.m. (special English service Weds. 8.30-9 a.m.).

7.153	41.94	BEF-8	Chungking	6.35-10.35 p.m.; 10.45-1.50 a.m.
7.21	41.61	GWL	London	News and commen. 7.45-8 a.m.
7.225	41.53	VUD-10	Delhi	10.45 p.m.
7.23	41.49	GSW	London	7.45-8 a.m.
7.25	41.38	Munich IV		1.15-8.15 a.m.
7.26	41.32	GSO	London	7.45-8 a.m.
7.32	40.98	GRJ	London	7.45-8 a.m.
7.46	40.21	TGDA	Quezaltenango	Around 3.30 p.m.
9.825	30.53	GRH	London	4-5.45 p.m.
9.69	30.96	GRX	London	News and commentary in English for Europe 6.45-7 a.m.
9.675	31.01	GWT	London	Ditto
9.645	31.11	LLH	Oslo	9 a.m.-Noon in special programme to whaling fleet; English every quarter hour.
9.623	31.17	GWO	London	7.45-8 a.m.
9.525	31.50	GWI	London	6-6.45 a.m., English for Europe.
9.45	31.73	LRY	Bueonos Aires	12.15-3.57 p.m.; News in Eglish at 12.18, 1, 2 3 and 3.52.
9.00	33.36	Radio KOL-IS RAEL	Tel Aviv	Reported opening at 5.30 am. and again at 2.45 p.m., with news in English.
11.65	25.73	Radio Bangkok	Siam	10-11 a.m.; 10 p.m.-1.30 a.m.
11.715	25.61	HEI-5	Berne	5.15-7.30 p.m.
11.74	25.55	Radio Pakistan	Lahore	News in English at noon, 5, 8 and 10 p.m.; 12.45 and 2.30 a.m.
11.78	25.47	ZL-3	Wellington	5-7 p.m.
11.80	25.42	GWH	London	4-5.45 p.m. (Pacific Service).
11.82	25.38	GSN	London	Ditto.
11.85	25.32	LLK	Fredrikstad	8-8.45 p.m.; are asking for reports.
11.865	25.28	HER-5	Berne	5.15-7.30 p.m.
11.86	25.30	GSE	London	News and commentary in English for Europe, 6.45-7 a.m.
11.88	25.25	LRS	Bueonos Aires	8.30-11.27 a.m.
11.913	25.18	BEF-8	Chungking	10.45 p.m.-1.50 a.m.
11.96	25.08		Moscow	English at 11.30 a.m.
15.14	19.82	GSF	London	4-5 p.m.
15.17	19.78	BEF-8	Chungking	6.55-10.35 p.m.
15.18	19.76		Wellington	5-7 p.m.
15.18	19.76	GSO	London	8-10 p.m.
15.19	19.75	OIX-4	Lahti	Heard well around 2 p.m.
15.26	19.66	GSI	London	4-5.45 p.m. (Pacific Service).
15.28	19.63	ZL-4	Wellington	Heard mornings and afternoons
15.30	19.61	GWR	London	Around breakfast time.
15.30	19.61	FEBS	Singapore	Opens at 7.15 p.m.
15.305	19.61	HER-6	Berne	1-2.30 p.m.
15.34	19.56	RW-102	Moscow	Opens at 10 p.m.
15.39	19.49	RW-99	Moscow	English at 11.30 a.m.
15.41	19.46	RW-96	Moscow	English at 11.30 a.m.
17.715	16.93	GRA	London	6-8 p.m.
17.81	16.84	GSV	London	8-10 p.m.
17.825	16.83	LLN	Frederikstad	8-8.45 p.m.; are asking for reports.
21.55	13.92	GST	London	4-8 p.m.
21.47	13.97	GSH	London	8-10 p.m.
21.67	13.84	LLP	Frederikstad	8-10 p.m.; asking for reports.

ONE-VALVE SETS (Continued)

in it and is exactly the same as if a separate triode and pentode were used. As with the other two circuits, capacity coupling from the aerial to grid coil is used C1. Either one of the small capacity trimmer type condensers may be used for this purpose or an ordinary midget variable condenser of 50mmfds. C2 can be 0.0005mfd or you can make use of any other condenser you may have on hand, or again, you may prefer to use the band-spread method shown in fig. 1.

The reaction coil feedback L2 is controlled by the variable resistor R11 which should be approximately 5000 ohms. You may prefer to use the usual condenser method, in which case a 0.00015mfd variable should be substituted for the resistance. I prefer the condenser. R2 and C3 are the usual grid-leak and condenser combination and with the 1D8GT, 1meg and 0.0003mfd will be found about right. An 0.00025 or 0.0003mfd will also be satisfactory for the series condenser. If you decide to use a condenser for reaction control instead of the resistor, the condenser C4 will not be essential. With the resistance method it has to be used to stop the D.C. shorting to earth whilst at the same time allowing feedback to the reaction coil. R3 is the usual 0.25meg plate coupling resitor through which is supplied the H.T. to the anode of the detector, whilst C5, which can be 0.01 mfd, provides the coupling to the grid of the pentode section. R4 is the usual grid resistor of 0.5meg. Instead of this being taken direct to earth it is connected in series with R5 which provides automatic bias; the value being 1500ohms. The condenser shown across R5 is the usual 25 or 50mfd cathode by1pass type which is essential if full quality output is requred. The output to the speaker is taken from the anode via the speaker transformer in the usual way; the screen going direct to H.T. All three circuits described use the series capacity method of coupling to the aerial, but if this does not give sufficient selectivity, inductive coupling may be used by connecting the aerial to a small coil coupled to L1; the other end going direct to earth, as has been described several times in these columns. The set will work quite well with H.T. as low as 45 volts but greater output will be obtained with a higher H.T. voltage.

The set can be built in a cabinet of very small dimensions by using one of the 3½ inch permag speakers and portable type A and B batteries. A suggested layout and panel arrangement being shown in fig. 5.

BARGAIN CORNER

Advertisements for insertion in this column are accepted free of charge from readers who are direct subscribers, or who have a regular order placed with a newsagent. Only one advertisement per issue is allowed to any subscriber. Minimum 16 words. When sending in your advertisement be sure to mention the name of the agent with whom you have your order placed, or your receipt number if you are a direct subscriber.

FOR SALE, RAIO-FA Bedix receiver; R.C.S. TB35 Driver Transformer, 35 mm. sound films, variety of subjects; Steane's Dynaphon and Transformer. Apply J. W. Nairn, Morwell, Vic.

FOR SALE, new counter-balanced ball-bearing Rothermel crystal pick-up; £5. Apply R. Maxwell, 135 Maloney street, Mascot, N.S.W.

FOR SALE, Communications Receiver, KR/CR/11 (AR7), complete in rack with all coils from 140 Kc. to 25 Mc. Operated from 12 volt battery or 240 a.c. Perfect order, as new; £60. B. E. Hardinge, Horsham, Vic.

WANTED TO BUY, Test Equipment, Palec VCT or similar, oscillator and good multi-meter. Write "8513," c/o Radio World, Box 13, Mornington, Vic.

RED LINE

TRANSFORMERS OF DISTINCTION

LINE TO VOICE COIL MATCHING TRANSFORMERS

The correct value of primary impedance for parallel arrangement for equal distribution of the output of an amplifier is found by multiplying the number of speakers by the line impedance. Take, for example, a 30 Watts amplifier, feeding six speakers from a 500 ohms line . . The required primary impedance is equal to the number of speakers in parallel multiplied by the line impedance, i.e., 6 x 500, which equals 3000. Thus, Type LV30 would be selected, as this unit has a primary impedance of 3000 ohms, and the six speakers would be served from the 500 ohms tappings of the output transformer, as 3000 divided by 6 equals 500.

Type LV30, however, will also serve for 12 speakers, if required, but they would then be placed in parallel across the 250 ohms tappings on the transformer, as 3000 divided by 12 equals 250 ohms, and the reflected load would still be correct.

In many installations, however, owing to varying noise levels and other modifying factors, each speaker may be called upon to deliver different amount of power. In these circumstances, the primary impedance may be determined by applying the following formula:—

$$Zx = Z\frac{W}{Ws}$$

Where

Zx equals the primary impedance to be determined

Z equals the value of line impedance to be used,

W equals the power in watts from the amplifier,

Ws equals the required power for each speaker.

As an example, a 30 Watts amplifier using 500 ohm line output is to have 5 speakers and each speaker is to have the following power distribution:—

Speaker No.	Watts Each	Method of Calculation Z x W ÷ Ws	Impedance Reqrd.-Zx	Type No.
1	10	500 x 30 ÷ 10	1500	Use LV20
2	8	500 x 30 ÷ 8	1875	Use LV20
3	3	500 x 30 ÷ 3	5000	Use LV30
4	5	500 x 30 ÷ 5	3000	Use LV40
5	4	500 x 30 ÷ 4	3750	Use LV50

Substituting LV20 (2000 ohms) for speaker No. 2, and LV40 (3500 ohms) for speaker No. 5 means that standard units may be used with a slight decrease in power to speaker No. 2 and a sight increase in power to speaker No, 5.

These five transformers when wired in parallel would present a terminal impedance of 515 ohms approximately, which is a negligible degree of mismatching.

HIGH FIDELITY LINE TO VOICE COIL TRANSFORMERS

The following high level line to voice coil or recording head input transformers are complementary to the "A.F'.' and "A.W." series shown last month. These transformers are high fidelity units with an individual insertion loss of not greater than 0.5 db and a frequency range +/- 0.5 db 25 cps to 15 Kc/s.

Reference to their dimensions will indicate the large core structures adopted to keep iron distortion to negligible proportions by the use of low flux inductions at the maximum signal voltages incurred.

ITEM 70 — **Type No. VW15**
Primary Z: 500 ohms 34 db. 15 Watts
Secondary Z .. .. 15 ohms Voice Coil
Base: 2¾x2⅞x3-7/16"H. Wgt.: 3 lbs.
Mntg: V14 .. .. .. "S" is 1¼"

ITEM 71 — **Type No. VW126**
Primary Z: 500 ohms 39 db. 45 Watts
Secondary Z . 12 ohms tapped 6 ohms
Base: 4¼x4x3¾"H .. .. Wgt.: 8 lbs.
Mntg.: VS10 .. .. .. "S" is 2⅛"

ITEM 72 — **Type No. VW84**
Primary Z: 500 ohms 39 db. 45 Watts
Secondary Z 8 ohms tapped 4 ohms
Base: 4¼x4x3¾"H .. .. Wgt.: 8 lbs.
Mntg.: VS10 .. .. .. "S" is 2⅛"

ITEM 73. — **Type No. VW205**
Primary Z: 500 ohms 39 db. 45 Watts
Secondary Z, 2 ohms tapped 0.5 ohms
Base: 4¼x4x3¾"H .. . Wgt.: 8 lbs.
Mntg.: VS10 .. .. .. "S" is 2⅛"

RED LINE EQUIPMENT PTY. LTD.

TRANSFORMER ENGINEERS

WORKSHOP: Cent. 4773, 2 Coates Lane. Melb.
CITY OFFICE: MU6895 (3 lines), 157 Elizabeth Street, Melbourne.

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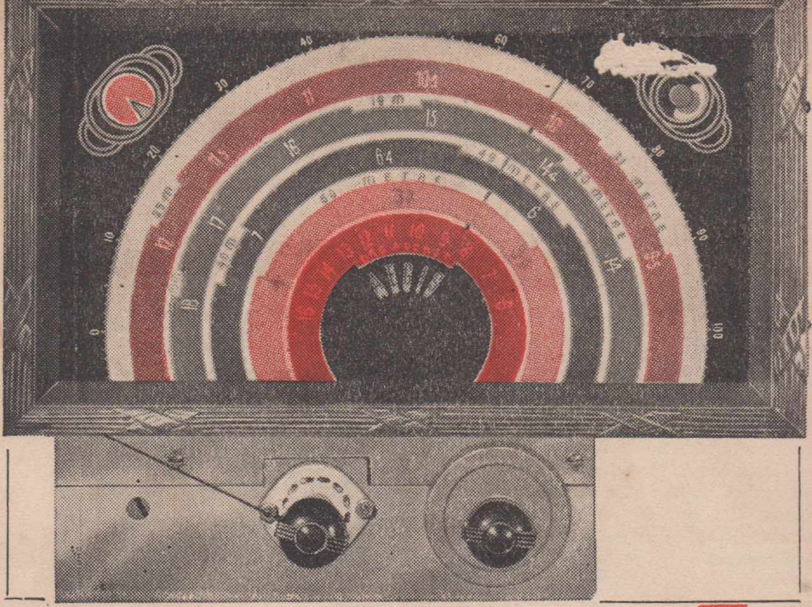


The LEADING 5 BAND

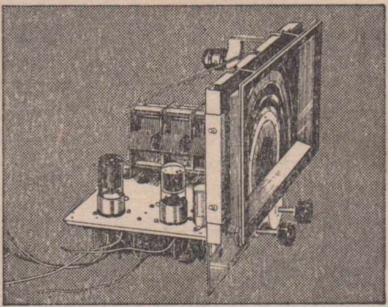
AEGIS KC.5

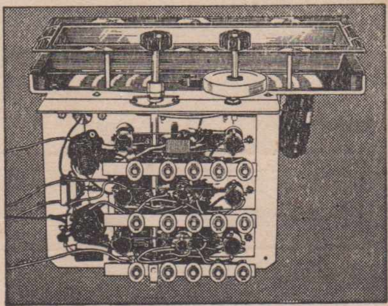
Electrical BAND-SPREADING TUNING UNIT

Aegis does it again! This time it's a multi-band tuning unit, specially developed for the Custom built Console of the modern lounge! The unit is actually the entre "Front End" of a radio receiver, completely assembled and wired and accurately calibrated in megacycles and aligned. For those who are especially keen on listening to exciting Overseas Broadcasts direct from their origin, plus hundreds of amateur radio operators, talking to one another all over the world; small ships at sea, aircraft, police and standard broadcast interstate, we highly recommend the Aegis KC.5. Tuning on the Shortwave Bands is just as easy as tuning the Broadcast. Once a Station is logged on this beautifully clear dial, you can rest assured it will appear at the same position next time.

SPECIAL FEATURES

Complete coverage of all popular bands obtained with FIVE SWITCH POSITIONS. (550-1630 Kc), (3.4-4.05 Mc), (5.8-7.5Mc), (9.4-12.3 Mc), (13.9-18.2 Mc).
Bands indicated on dial include 16, 19, 20, 25, 31, 40, 49, 80 Metres, and Standard Broadcast.
Multi-coloured, full vision, illuminated dial. 12½" x 7¼".
Band change switch operates Automatic Band Indicator on dial face.
Fly wheel spin tuning shaft.
Provision for "Magic Eye" tuning indicator.
Positively no back lash on dial drive with 29:1 Ratio.
Special Perspex dial pointer prevents incorrect logging.
All coils possess high quality, adjustable, iron-dust cores.
Trimmers have high "Q" factor.
Best quality Moulded Mica, Ceramic and Paper Condensers incorporated in circuit.
I.R.C. Resistors used throughout.
Stablised Voltage Control on Screens of both R.F. and Converter valves.
R.F. Stage on all wave bands.
Something New and Exclusive in Dial Escutcheons.
A.W.A. three-gang Tuning Condenser floated on Rubber.
Whole unit may be mounted on four rubber grommets when attached to chassis.
All associated resistors and by-pass condensers included, complete.
Any number of valves and control circuits can be built around this unit to give the desired results. (We recommend two I.F. stages using Aegis J20 and J21 I.F. Transformers).
Only five connections to make, to feed into any 455 Kc. I.F. channel.
Gold Letter Station Transfers for all Australian stations supplied.





AEGIS MANUFACTURING COMPANY PTY. LTD. **208 Lit. Lonsdale St., MELBOURNE**

Obtainable from Selected Wholesalers throughout Australia