THE AUSTRALASIAN

Radio World

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1/6

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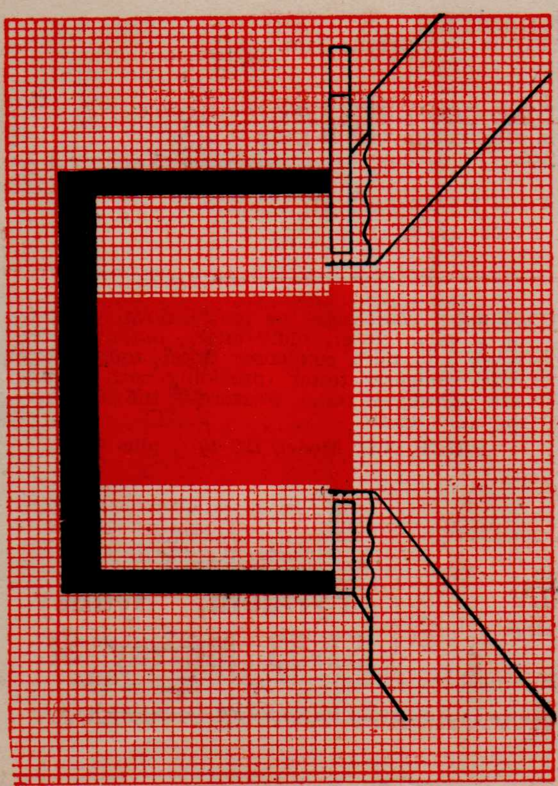

THE AUSTRALASIAN

RADIO WORLD

DEVOTED ENTIRELY TO TECHNICAL RADIO

and incorporating

ALL-WAVE ALL-WORLD DX NEWS

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

Short-wave Editor—
L. J. KEAST,
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'Phone: WL 1101.

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Vol. 13 **MAY, 1949** **No. 12**

CONTENTS

EDITORIAL

THE selling of radio sets is not too easy these days. I have been making contact with a couple of radio salesmen lately, and have found their remarks most interesting.

They tell me that the ballyhoo about television and F.M. has had a disastrous effect. They tell me, even with easy terms, the present list prices of the better-known receivers are so high that they frighten the prospective customer, who probably remembers that he paid less than £20 for the console receiver which has given him ten or fifteen years of faultless service. All of which are points of little interest to the technical man.

There are technical problems, too. Quite a few prospective buyers are not satisfied with the quality of reproduction of modern sets. Having become accustomed to the distortion-free "tone" of an old t.r.f. set with a triode output valve, the modern superhet grates on their ears, even with the tone control at maximum setting. With a view to investigating this point further I interviewed an old lady with a 1926 model Radiola (American). After hearing this old-timer, I could readily understand why its owner would not consider buying a modern set.

I am not in favor of so-called "high-fidelity" for the average set-buyer. I know that sets wouldn't be popular if they tried to reproduce the full audio frequency spectrum. But I do think there is plenty of scope for improvement in the elimination of distortion and the effective reproduction of the lower notes.

Another point which emerged from a few talks with recent buyers of modern sets was that it is not desirable to place too much sensitivity in the hands of inexperienced listeners. They do not appreciate it, and complain that the set is noisy.

—A. G. HULL.

Heterodyne Frequency Meter

Using a Franklin Oscillator Circuit

By

Charles Aston

IN these days of V.F.O's. a frequency meter is a necessity on every amateur station, as not only does it comply with regulations, but also gives the operator of a V.F.O. a comfortable feeling, as it is quite a worry not to be sure if you are on the band.

Frequency meters take many forms, the simplest being the absorption type, which is still often used as a frequency check on low frequency ranges and is very useful for locating the band to which an oscillator or doubler is tuned, and is more useful in this field than the more accurate types.

The absorption wave meter consists of a simple tuned circuit which will tune over the required ranges. This tuned circuit is then coupled to an R.F. coil of a transmitter, and when it is tuned to the same wavelength as the stage a change in plate current in this stage will be noted in the form of a sharp rise or dip, as the wavemeter will absorb a small amount of energy when tuned to the same frequency as the tank. This type of meter will identify the correct harmonic in a frequency doubler or from a crystal harmonic generator.

Sometimes an indicating device such as a pea lamp or a millamp meter used with a detector is incorporated in the wave meter, so it is then unnecessary to have any meter in the circuit under measurement, as resonance is indicated by maximum glow in the pea lamp or maximum meter reading.

Crystal Oscillators

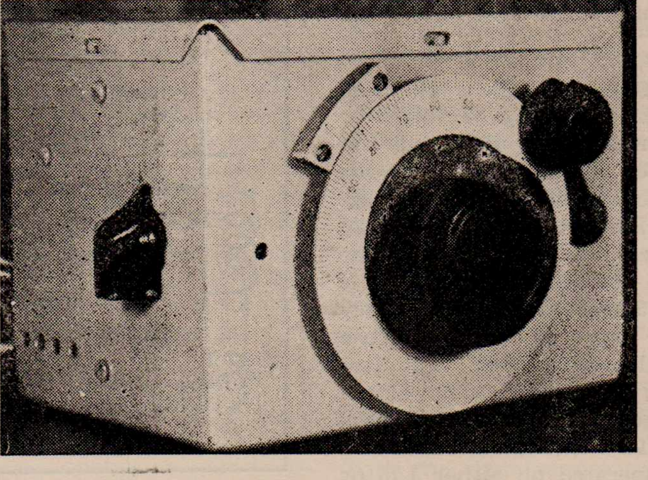
An accurate method of frequency checking is to use a crystal harmonic oscillator of 100 kc/s, and when used in conjunction with a receiver provides accurate checking points every 100 kc/s. A multi-vibrator circuit can be easily locked with the output of such a crystal oscillator, and by adjusting its component values can be simply made to provide checking points every 10 kc/s or whatever is desired. The accuracy of such a device depends on the frequency stability of the crystal and the accuracy to which it has been cut.

A crystal frequency standard is very accurate at the checking points, but if it is desired to measure frequencies other than these complicates matters and is beyond the reach of the average amateur.

Heterodyne Frequency Meter

The most accurate of the simpler types of frequency measuring equipment is the heterodyne frequency meter, which consists of a very stable oscillator which tunes over the frequency it is required to measure. A detector in which

(Continued on next page)



Essential in every "shack" — a reliable frequency meter the output of the oscillator and R.F. are combined so they may be tuned to zero beat, audibly the unknown frequency then being read off the oscillator dial.

The Circuit

The circuit of a hetrodyne frequency meter is very simple and has no more components than a two valve receiver, but the catch is that it is difficult to make an oscillator that is sufficiently stable to retain its calibrations and not to drift. My own experience has shown that the oscillator circuit has very little effect on the stability, and the main factor being the care taken in the construction of the tuned circuit.

After trying several oscillator circuits the only one found to have any worthwhile advantages was the Franklin, and it was found that the drift of this oscillator while the valve was warming up was no greater than that of the operating drift, which is a distinct advantage.

The Franklin oscillator does not require voltage regulation, and the replacing of valves or components has practically no effect on the calibration as with other oscillators. The only possible disadvantage of the Franklin oscillator is that its maximum operating frequency is about 5 Mc/s, but this frequency can be improved upon by the use of high gain valves. The frequency limitation is no disadvantage in the case of a freq. meter for the amateur bands and it is operated on either 1.75 or 3.5 Mc/s, the harmonics of the oscillator being used for the other bands.

The Franklin oscillator consists of a tuned circuit capacity coupled to the grid of a valve, a second valve is connected in cascade with the oscillating valve, and the output of this second valve is capacity coupled back to the tuned circuit and will be in phase with the grid oscillations, thus sustaining the oscillations. The gain of the circuit is quite high, so it is only necessary to provide very loose coupling to the tuned circuit to sustain oscillations, and the coupling condensers require no more than 3 mmfd., and sometimes a lot less depending on the gain of the valves and the frequency of operation.

Operation

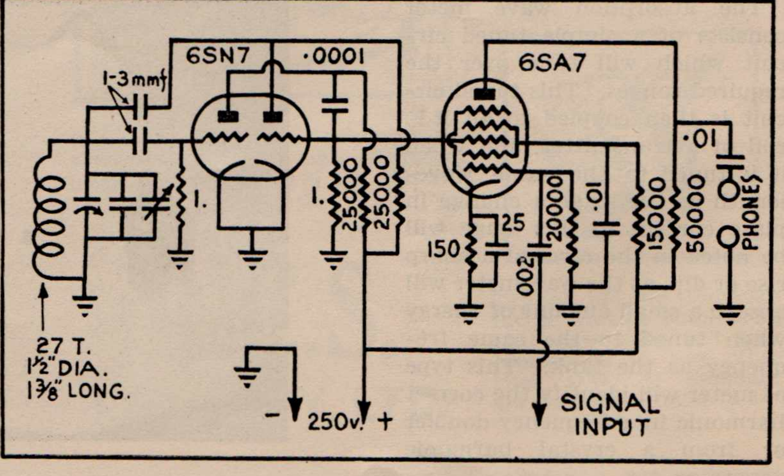
It is obvious that any variation outside of the tuned circuit will be in series with the coupling condenser, so it is impossible for it to effect the tuned circuit by any more than the value of the coupling condenser, and as the tuned circuit is well loeded up with capacity the variation is much less than with other oscillator circuits.

Multi-Vibrator

Another way to look at the operation of the Franklin oscillator is to regard it as a multivibrator in which a tuned circuit is included. As it is a rejector circuit all of the frequencies except that to which it is tuned will not be developed across it.

Construction

The construction of any measuring device is not a simple business, and this applies to frequency meters. Extreme care must be exercised to obtain mechanical rigidity, and only ceramic insulation should be used for all components comprising the tuned circuit, and special care should be taken when winding the coil that the turns are tight and will not shift position. The condenser and coil former should be mounted at both ends to obtain rigidity, and the condenser should be of the double bearing type, preferably with balls at both ends. It is not pos-

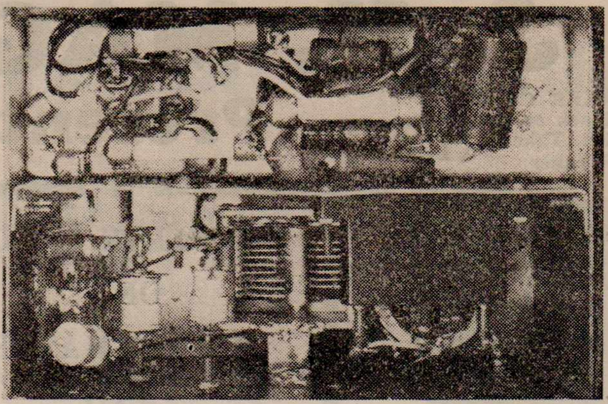


Circuit of the Frequency Meter

sible to make an oscillator any better than the tuned circuit.

The metal box used was one on hand and rather small for the job but has the advantage of being compact, and the larger the box the harder it is to obtain the required rigidity. It will be noticed that an aluminium partition is used down the centre of the box to shield the tuned circuit from the valves, while an unorthodox chassis and mounting is used for the valves, it being so constructed that the chassis has to be removed from the box to remove a valve probably it would be better to use a lid at each end. Owing to the lack of space a tidy lay-out was not attempted, but point-to-point wiring is no disadvantage.

A 6SN7 valve is the obvious choice for the oscillator valve, and it works out well in practice as very litle coupling is required to maintain oscillations, which is what we are after and reduces space required, which is very necessary in such a small box.



Photograph of the sub-panel wiring

Adjustment

When the unit is complete it is first necessary to check the circuit to ensure it is oscillating. This may be best done with the coupling condensers set at a maximum capacity, as the output will then be strongest and easiest to find on a receiver.

In the original set the fundamental frequency was 1.75 mc/s, and if similar LC constants are used, no difficulty should be encountered in tuning to this frequency, and the frequency will be more stable than a fundamental at 3.5 mc/s.

The best way to check the fundamental output frequency of the oscillator is to use a m/a meter in the plate circuit of the oscillator valve, then couple an absorption wave meter to the oscillator coil, and when it is tuned to the same frequency as the freq. meter there will be an increase in plate current and will take the form of a sharp rise.

If it is desired to check the fundamental on a receiver that does not tune to 1.75 mc/s, check the second harmonic, which should fall in the 80 m. band, the third harmonic, and the fourth harmonic, which should fall in the 40 m. band. If this method is used care should be exercised, as it is easy to tune to an image.

It will be noticed that as well as the main tuning condenser there is another midget condenser connected across it, which is a "correction condenser" and is for correcting the oscillator circuit when checking against a reliable crystal. Normally the LC circuit should be so adjusted that this condenser is normally about half mesh. It should also be adjusted to 2.0 mc/s, with the tuning condenser close to minimum capacity. When this is so, check the tuning range of the condenser, and if 1.75 mc/s comes in at the maximum capacity condenser setting then it is alright. If it falls at the half-way mark or so it is then necessary to remove the condenser plates, remembering the minimum capacity is very little effected by it, the main point being to see that 1.75 mc/s does not go off the maximum capacity end of the dial.

A trimming condenser was also included across the LC circuit to simplify the adjustments.

The Loading Capacity

Experiment proved the most difficult item of the circuit to remain stable was the loading condenser. Mica and silver mica condensers that are available through the usual trade drifted all over the place, so be very careful of these components. The one I found to be most satisfactory was an A.W.A. 500 mmf transmitting condenser out of some disposal gear. It is possible that this condenser just suited my particular set-up, but when checked against a Bendix at 1.75 mc/s it was still at zero beat after two hours.

Measuring

To measure the frequency of a signal it is necessary to feed both the signal under measurement and the output into a re-

(Continued on Page 38)

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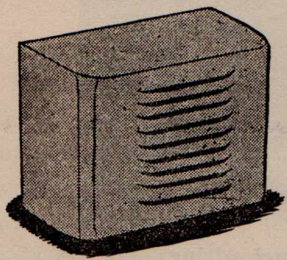

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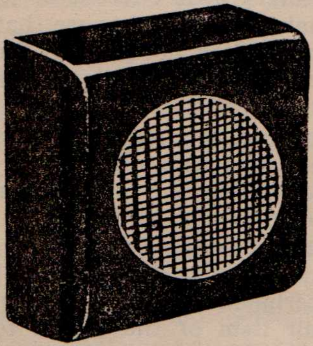

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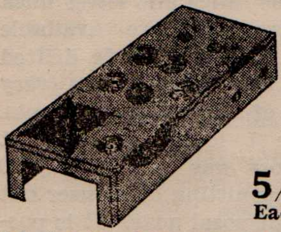

5/6
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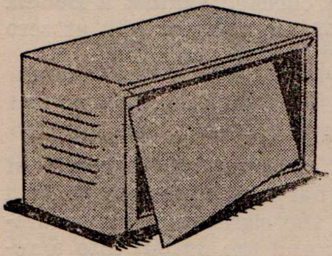

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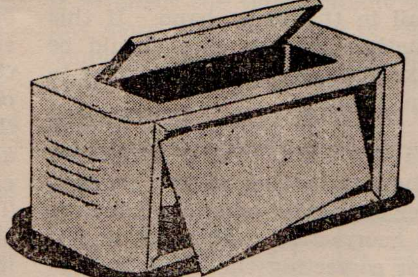

Communication type steel case. Black or Grey wrinkle finish. Detachable front panels. Sized 11 x $5\frac{1}{2}$" x 7", as illustrated at left.

Size 11 x $5\frac{1}{2}$" x 7", as illustrated at left. **25/**

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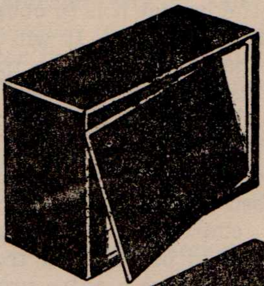

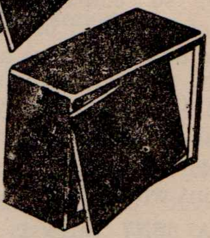

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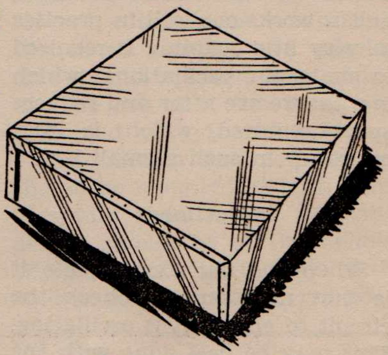

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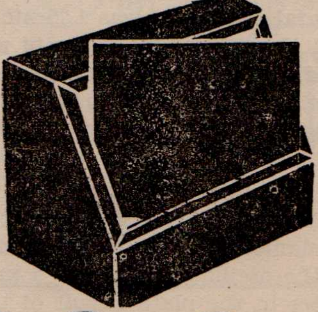

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LATEST IN DIRECT COUPLING

Third Dimensional Amplifier

New developments in direct-coupled circuits come so fast that we have considerable difficulty in keeping pace. Just as we were settling down to decide that last month's suggestion was the last word—well, along comes this stunner.

RECENT numbers of "Radio World" have been a field day for high fidelity enthusiasts, the most interesting feature of which has been the insistent return of direct coupling. All honor to those who have kept the flame of this famous circuit alight, for it went out rather ignominously in the days of directly-heated valves, inadequate output transformers, and speakers of restricted range, all of which tended to expose its disadvantages rather than to demonstrate its frequency-handling capabilities.

By

J. C. Outhred,

46 Braemar St., Essendon, Vic.

Now the scene is vastly different, and with the advent of extended frequency range in speakers and transformers the weak line in the chain from input to output has proved tb be the method of coupling the successive stages. Whatever device is interposed has inherent shortcomings.

In submitting to you my version of the direct coupled amplifier I am not attempting to outdo the several fine amplifiers that have already been published, but to try to adhere as far as possible to conventional design so that the constant aspiration for higher flights of frequency response on the part of your readers shall not involve the acquirement of non-standard parts. The outcome is a completely direct coupled amplifier with a conventional driver stage and a nearly conventional output stage, that is to say—the divided primary of the modern hi-fi output transformer has been availed of to effect a voltage displacement between the output plates and cathodes so that their associated grids may be at the same potential as the plate and cathode of the phase splitter.

The experienced eye can evaluate the merits of this arrangement without me prating about

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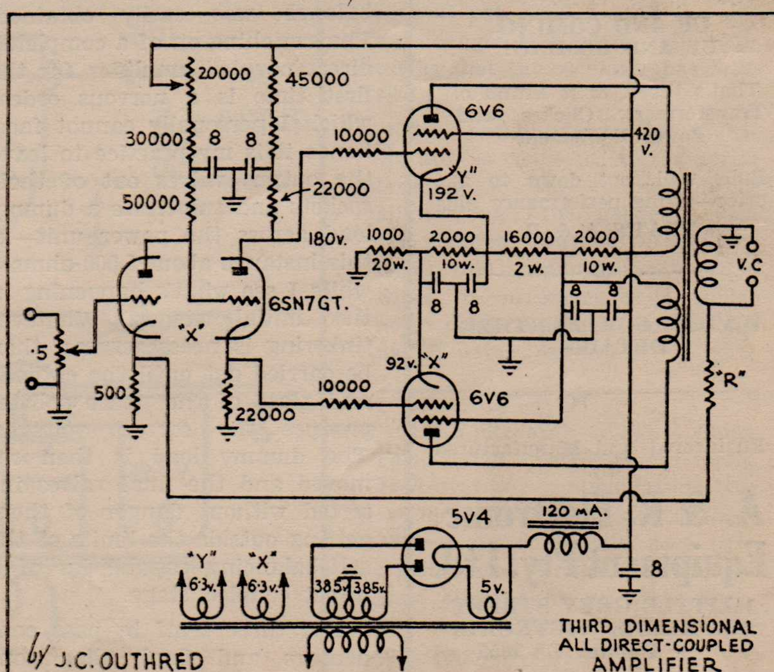


AMPLIFIER (Continued)

its performance. After wallowing in high fidelity for many years I am extremely wary of any dogma regarding any amplifier from the listening standpoint. Suffice it to say that this amplified achieves such depth and purity in the top note register particularly that one can fairly see the instruments of an orchestra in their respective positions. For this season I have dubbed it the "Third Dimensional" amplifier by virtue of its stereoscopic definition.

It requires little explanation. The voltage dividing network serves to feed the requisite voltages to the output plates and cathodes so that they are in correct relationship with the elements of the preceding valve to which their grids are directly coupled. The main purpose of the 16,000-ohm resistor is to reduce the other resistors to stock values. The cost of this little ruse is a bleed current of 7 or 8 milliamps, but the regulation is all the better for this.

The values for the driver stage were determined both by calculation and subsequent experiment, but a variable resistor has been incorporated in the plate circuit of the first stage as a concession to slight differences in individual valves. With this set at about half-way a practical balance was easily obtained. The switching on of a completed direct coupled amplifier for the first time is a nervous ordeal which I personally cannot face, hence it is my practice to leave the output valves out of their sockets and substitute a dummy load across the power unit—in this instance about 5,000-ohms—while I see what's happening in the initial stages. Whatever tinkering is necessary can then be carried out until the cathode and plate of the phase splitter produce the correct voltages. The dummy load is then removed and the final valves inserted without danger of them getting outside the limits of the self-balancing capabilities of a direct coupled stage.

The three 8-mf by-pass condensors and final filter condensor are shown grouped in the diagram as they are actually installed so as to provide the shortest and lowest A.C. impedence path possible in view of the interrupted plate and cathode circuits of the output stage.

The choice of an out-put transformer is, of course, restricted to those in which the two halves of the primary winding are brought out to separate terminals. The Red Line AF and AW series pass muster, and it is believed there are other makes which have the same facility.

The "Axiom Twelve" speaker was used in the test and to whatever better speakers are obtainable or will be obtainable this amplifier will do full justice, in which combination the onus will fall heavily on the broadcasters and record manufacturers to step into line. As things, are, however, the inexpensive Rola 12-0 in a vented baffle gives an impressive output.

I conclude by paying tribute to the many splendid contributions to high fidelity which have appeared in your columns. This contribution of mine seeks only to cater for those enthusiasts who are hard to wean away from the advantages of push-pull and who aree equally diffident about any great departure from simplicity or stock components. For this reason I think it deserves to be included in the ever-widening choice of wide-range amplifiers which is creating such an appetite for better reproduction.

I enclose cheque for 16/- in payment for an annual subscription commencing with the April issue, and I trust that to whatever wider spheres your columns must of necessity be devoted, the cause for "better listening" will always find a corner.

QUERY SERVICE

Owing to a rush on our reply-by-mail service, we have been completely snowed under and cannot handle any more queries until further notice.

MULTI-VIBRATOR

By
H. M. Watson,
89 Botting St.,
Albert Park, S.A.

A twin triode is used, each section giving the necessary phase shift of 180 degrees required to sustain oscillations.

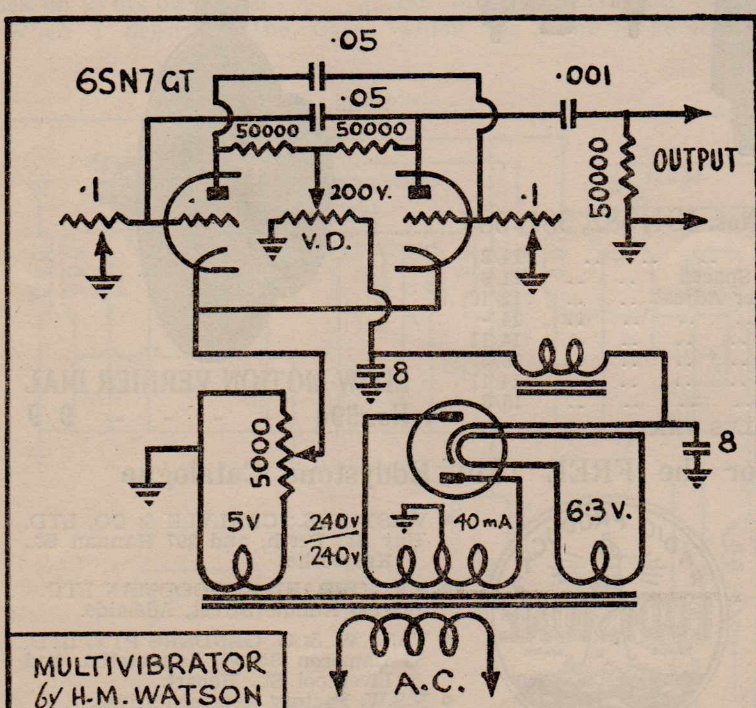
Oscillations are commenced by some minute voltage at one of the triode grids, e.g., a positive potential on the grid of VI. This voltage is amplified by both triode sections and is fed back to the grid of VI. This action takes place over and over again, the grid of VI rising abruptly to a positive potential; at the same time the grid of V2 becoming so negative as to bias its section to plate current cut-off, causing amplification to cease, VI drawing heavy current whilst V2 is not conducting. Electrons leak away through the grid resistors and gradually bring the grid potential back to normal. Amplification will be just on the verge of re-commencing when some minute voltage will change the potential enough to start amplification in the opposite direction. This time the grid of VI will suddenly become negative and the grid of V2 positive. Electrons again leak away through the grid resistors and the process takes place over and over again.

The Multivibrator is a very unstable oscillator, rich in harmonics. The frequency of oscillations can be controlled by injecting into its circuit a voltage having a multiple or submultiple of the oscillation frequency, thereby causing the oscillator to "lock in."

If we employ variable grid leaks, the setting of same will govern the charge and discharge of the condensers in series with them, thereby varying the fundamental frequency. The .1 pots. are therefore calibrated roughly in terms of frequency, and the pot. in the cathode circuit used to lock the oscillator to some harmonic of the 50 cycle mains voltage which is conveniently stepped down by the spare winding on our power transformer.

The .1 pots. are set to give us a fundamental of 500 K/cs. and the cathode pot. rotated until the signal changes to a purer note, indicating that the oscillator has locked in.

The outlet from the multivibrator is connected to the aerial terminal of the receiver being aligned, and the padder peaked for maximum output without the usual dial rocking manipulation which is necessary when padder adjustment is carried out by the use of a test oscillator.



E.H.F. Record?—What is claimed to be an amateur record for E.H.F. two-way communication was set up when a frequency of 2,350 Mc/s was successfully used over a distance of 13 miles. The stations were situated at Brighton Racehill and Salvington Hill, Worthing, England.

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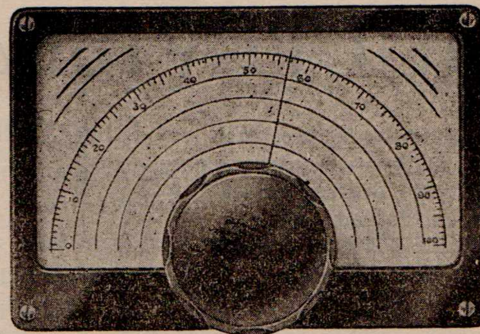

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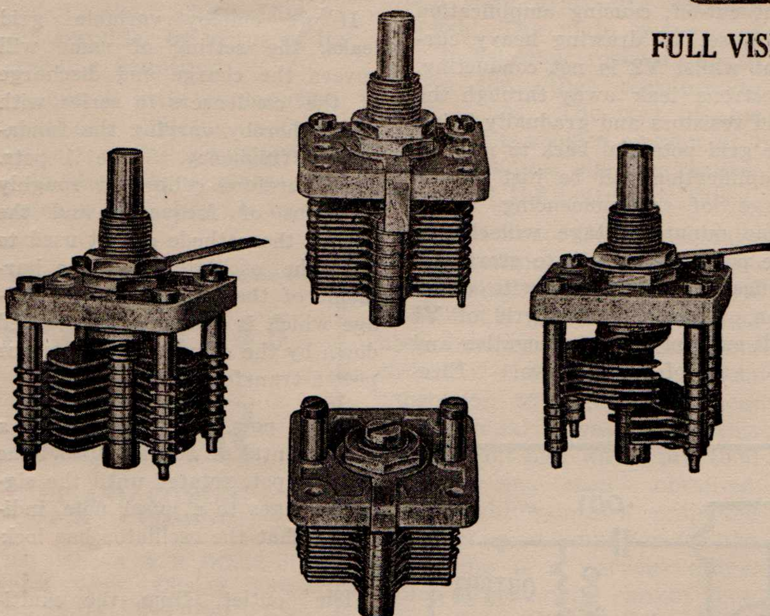

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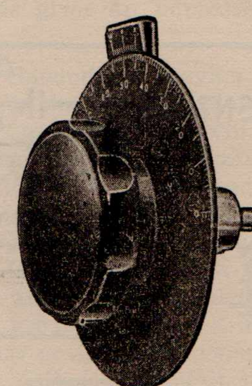

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OUR FEATURE ARTICLE

THE CAR-LECTRIC MK.111.

Servicing a car radio set is greatly facilitated if it can be operated from the A.C. power. This set operates from either a car battery or the power mains.
Any further details required will be furnished by the author, Paul Stevens, of 21 Fletcher's Avenue, Bondi, N.S.W.

WHEN describing the R4841 in the Oct., 1948, issue of the A.R.W., I made the daring claim that only a receiver design that had gone through the mill of commercial production can really be justly described as stable, foolproof and reliable. I did not guess then how soon this statement would boomerang back on to my own head.

When I described the Car-Lectric in A.R.W. a few months ago I had only built one set of that type, and it certainly worked well. We then went "into production" with it by making up a batch of five. I found out very soon that there were quite a few amendments and improvements necessary before the Car-Lestric could hit the market.

There was first of all the matter of the maximum volume, which was found to be still too soft for a car on undermodulated stations such as many nationals. To improve this we changed the reflex circuit to the version shown in fig. 1, whereby audio is taken in the conventional way from the plate circuit instead of the screen. Bias was provided by a 5 meg resistor between oscillator grid and EBF grid return, instead of the 3 meg to the AVC

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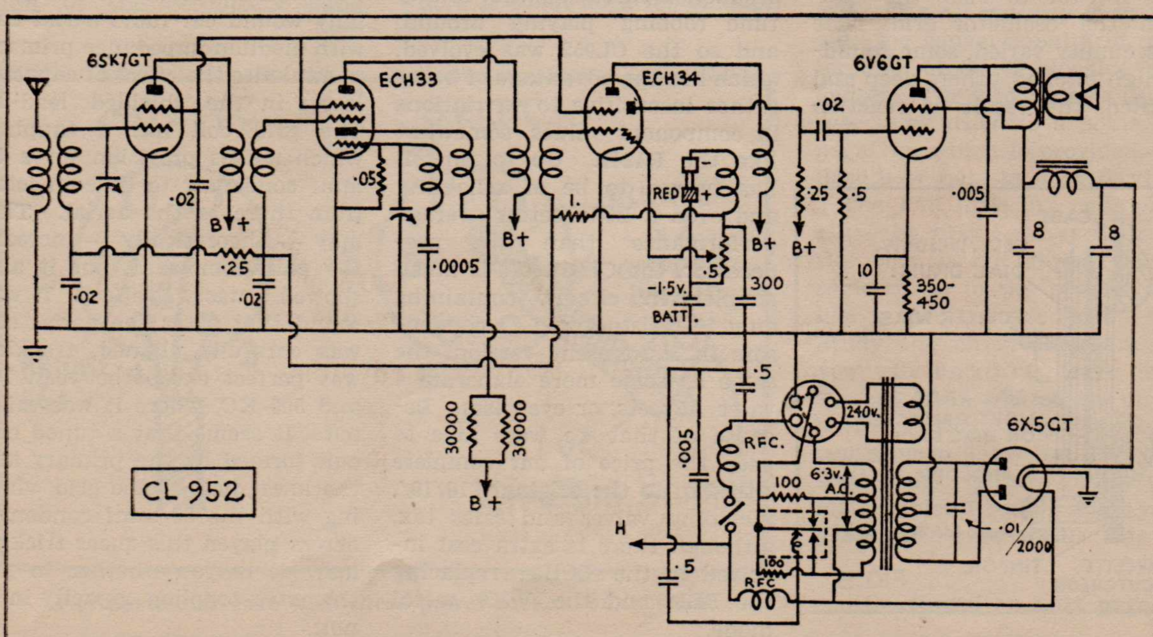
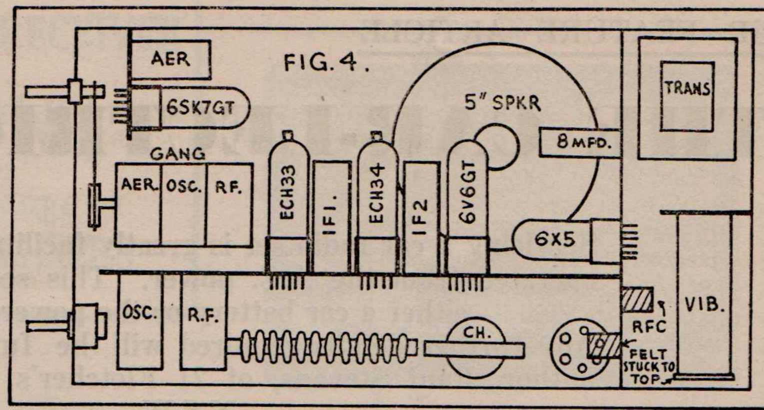


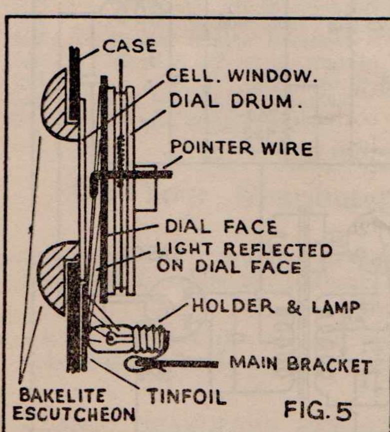
CAR-LECTRIC (Cont.)

line. We also included 2 100 ohm resistors between the outer vibrator contacts and the reed for smoother running. There were other minor alterations, which, like the ones just mentioned, were all described on a roneoed sheet, which was included in every kit and sent to all inquirers. We thus tried to make up for the shortcomings of our first model.



Unusual layout of the components

The CL951, as we called this Car-Lectric Mark II, has been going strong ever since, but, although it has been successful with most of our kitset clients, it took up too much finishing time in production. Out of a batch of ten, for instance, we found five to work O.K. after the routine testing and aligning was done. The others played up in some way or other. Some had tendencies for either high pitched or low rumbling oscillations, the former requiring an extra .0002 mf bypass at the EBF grid return, the latter a lower than 5 meg resistor to bias the EBF from the oscillator grid. The tone quality varied, some sounded high pitched, others deep and muffled, the result of reaction effects, which could be overcome by slight side tuning of the IF transformers in opposite directions. There were also variations in the maximum available volume. All this was traced down to variations in resistor and some condenser values, as well as in the characteristics of valves, especially the EBF35. These things make little difference to the home builder, as he can always straighten them out by a little experimenting; but for production there must not be any time robbing playing around, and so the CL952 was evolved, which has the advantage of being rather insensitive to vavriations in component values, somewhat like the R4841. Up to now it has proved to be of reliability and even a little better average performance than its predecessor, the CL951. It is much simpler in circuit, containing only 19 resistors and 11 condensers in its present version, the same as some more elaborate 4 valve AC sets, or even less. Because of that we were able to keep the price of our complete kit down to the original £16/19/, including valves and sales tax, although there is extra cost involved in the ECH34 replacing the EBF, and the WX6 metal diode.



As can be seen from our circuit diagram, the CL952 is actually a very simple 6 valve circuit, although there are only 5 valves in the conventional conception. The ECH34, the octal version of the ECH4 triode hexode, is used in its hexode section as high gain IF amplifier, while the triode part with high slope and an amplification factor of 22, looks after audio amplification of the "Westector" detected signal.

The aerial feeds into a specially wound car radio aerial coil with medium impedance primary to minimise the effect of capacity losses in the shielded lead-in. The grid coil has a tapping, which makes provision for a 50 mmf condenser to be connected from there to the aerial. This may — theoretically — increase the gain somewhat, but it also showed a nasty byeffect. It was found that after the aerial coil was carefully aligned, tracking was perfect except between 700 and 800 KC, where it was miles out. It seems that a tuned circuit formed by the primary and the lower half of the grid winding with the 50 mmf condenser across played this queer trick. I leave it to you whether to put the extra coupling capacity in or not.

The RF valve is the 6SK7GT, which, although a single ender, did not give any stability trouble in this circuit, as it works with somewhat reduced screen voltage. Coupling between RF valve and converter is conventional via a tuned circuit. The ECH33, due to its high oscillator slope, actually requires a special loosely coupled oscillator coil. But as the O.P. voltage (together with the screens of the first 3 valves) is reduced to a no-signal value of 60 to 70 volts, a standard coil can be used, with even the 100 mmf grid block omitted. The I.F. is kept to the usual 455KC, the transformers being high gain types. 175KC, which we tried out first, gives similar gain with far better selectivity. Although this may be very desirable, in my opinion almost essential, in a good long range receiver, it was found to be a nuisance in the car set. Most people, especially women, were absolutely unable to tune in any station properly, so we decided to abondon the idea. The tuning condenser is a 3 gang midget type, with a maximum capacity of about 380 mmf, as against 420 mmf of the Stromberg gang. The coils are specially made to suit this gang, so is the dial.

Now we come to the "piece de resistance" of the circuit, the ECH34 and the Westector diode. The hexode section of this valve is not internally connected to the triode, the injectr grid being fed to pin 1 on the socket, and, in our case, is earthed. Under full operating conditions it has a slope of 2200 mmhos, which is far in excess of most standard valves, even of continental type. It is somewhat reduced by the low screen voltage, but this is necessary to keep the current consumption down, and the loss in amplification is not great.

Signal detection and AVC is supplied by the WX6 metal diode, which is connected in the same fashion as the electronic version, the red (pos.) end to chassis, the negative end to the second IF transformer. Special precautions have to be taken when soldering the Westector in. Leave the pigtails at full length and hold the one you solder with a pair of long-nosed pliers. This intercepts the heat and prevents it from reaching the metal diode, where it could do a lot of damage that would cost you 7/6 for a new one.

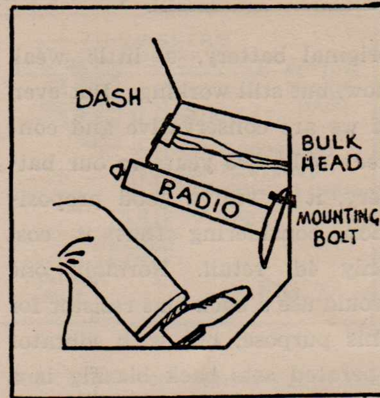
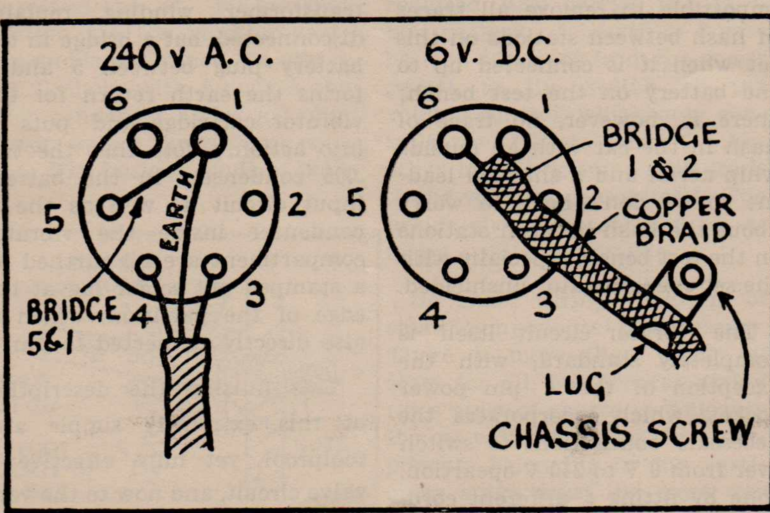


Diagram Showing Installation

The volume control (.5 meg) forms the diode load, with simple AVC taken from the top in conventional way. The grid circuit of the triode can be connected in several ways. We can feed from the moving arm of the pot directly to the grid, where by the AVC voltage will provide the bias. This is a simple way often used in the past with triodes of this kind. There is some theoretical distortion in it, whether it disturbs you in practice you will have to find out for yourself. The second way is to provide the conventional grid resistor and .01 or .02 blocking condenser. The grid resistor in this case is returned to a point 1.5V negative, which is provided—believe it or not—by a battery!

The 1.5V little dry cell, which gives the first 4 valves their initial bias, is not clipped in but soldered on to the resistor strip like a medium sized condenser. Study the circuit diagram and you will find that there is no current drain whatsoever on the battery, which, under these circumstances, may last for years if kept dry. I have got an ohm meter which I bought eight years ago and which still has its

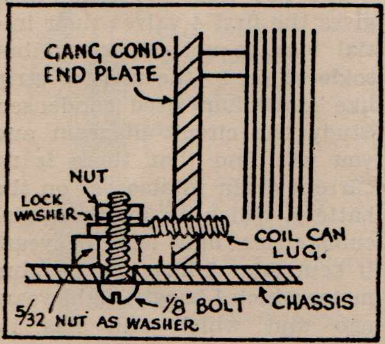


Pay particular care with these power socket connections

(Continued on next page)

CAR-LECTRIC (Continued)

original battery, a little weak now, but still working. But even if we are conservative and concede only two years to our battery, it is still a good proposition, considering that it cost only 4d. retail. Normally one would use a back bias resistor for this purpose, but with vibrator operated sets back biasing is a ticklish problem from the hash point of view. 1.5V may seem somewhat low as bias for tuner valves, but the reduced screen voltages as well as the undelayed A.V.C., fully justify it. There is little to be said about the 6V6GT as output valve, except that the plate current is kept low by overbiassing with a 450 ohm resistor. The total current drain of the set is slightly under 40 mA, the output about 1 watt. Although the amplification of the triode section of the ECH34 is well below that of a 6B6, it gives ample power reserves to drive that valve to the limit. By increasing the bias resistor to 350 ohms or even less, the power handling capability of the 6V6GT can be increased, but this causes increased battery-drain as well as extra strain on the power transformer, which, however, should be able to take it. It all boils down to



Mounting the Condenser

the fact that you can't have it both ways. If you want to stick to a battery drain of about 3 amps you will get around 1 watt output; if you want more power, your battery consumption will considerably increase.

The power pack, although made for both 6 and 240 V, is still simplicity itself. A non-synch vibrator is used in conjunction with a 6X5 rectifier. This is now almost general practice for car radios, as it gives a more reliable service and freedom from hash to, an extent where the usually critical filtering becomes rather simple. The oblong design of the Car-Lectric, with the RF stage on one end and the power pack on the other, make things even easier in regards hash elimination. It was found that 2 loo ohm resistors between the vibrator contacts and the earthed reed gave much reduction in hash; on the other hand, I was informed by one of my kitset clients that he removed all RF chokes from the vibrator circuit and it did not cause the slightest increase in hash. However, it seems to be impossible to remove all traces of hash between stations on this set when it is connected up to the battery on the test bench; there is, however, no trace of hash in the car with an outside whip aerial and a shielded lead-in; so we don't have to worry about the hash between stations on the test bench, especially with the set open, vibrator unshielded.

The vibrator circuit itself is completely standard, with the exception of the 6 pin power socket, which incorporates the necessary connections to switch over from 6 V to 240 V opeartion, done by fitting a different cord. The earthing wire of the vibrator

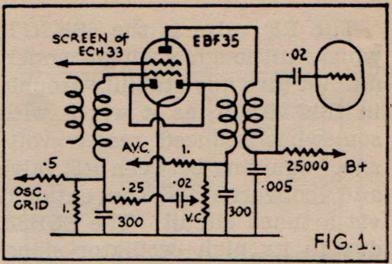


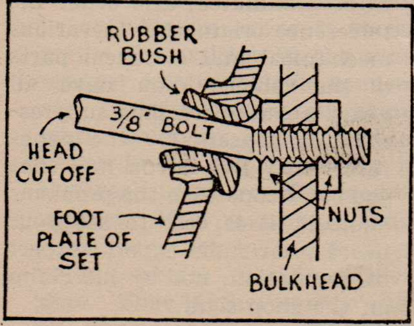
FIG. 1.

cartridge is connected to pin 5 of the socket, with the cold end of the 6.3 V heater winding (an extension to the vibrator winding) going to pin 2. The terminals for 240 V AC are pins 3 and 4, while the two thick pins are reserved for the battery leads. This is not quite correct, however, for although pin 1 carries the hot battery lead, it was found of advantage from the hash point of view to run the earthed lead to a separate screw near the socket, so that the earthed pin 6 serves merely as a contact point for the earthing bridges to be discussed now. For 240 V operation the vibrator is silenced by leaving its chassis return via the socket disconnected. A bridge inside the 6 pin female plug on the power lead connects pins 2 and 6 (fig. 2), thus completing the AC heater circuit. For battery operation the heater transformer winding remains disconnected, but a bridge in the battery plug between 5 and 6 forms the earth return for the vibrator cartridge and puts it into action. Note that the two .005 condensers in the battery input circuit as well as the .5 condenser inside the vibrator compartment are all earthed on a stamped out solder lug at the edge of the partition, which is also directly connected to pin 6.

This finishes the description of this extremely simple and foolproof, yet fully effective 6 valve circuit, and now to the very unorthodox chassis design.

Chassis and cabinet are combined into a single, oblong and flat case, 16½" x 8" x 2¾". From these measurements it can be seen that the set is a flat-as-a-board affair, intended to fit in horizontal or oblique position between bulkhead and dash of the car, with the 8 x 2¾ dial front protruding under the bottom rim of the instrument board. By tilting it slightly downwards up to an agle of 45 degrees, the set can be adjusted to varying distances between bulkhead and dash according to the make of car (fig. 3). In English cars, with battery and tool box usually forming a "step" in the bulkhead, the Car-Lectric fits at an angle of about 30 degrees and actually takes less leg-room than many other models of car radios.

The lay-out of the main parts can be easily seen in our diagram (fig. 4). It starts with the RF stage at the front (dial) end and finishes with the vibrator power pack at the bottom, putting the maximum distance between these notorious enemies. A partition screens off the power unit from the rest of the set. Within that partition are the vibrator cartridge and transformer, the vibrator L.T. choke with .5 bypass, the buffer condenser and 2 loo ohm resistors across the vibrator contacts. The business ends of both the rectifier and first electrolytic are also in there.



From the partition right up to the front runs the main bracket, carrying most of the components of the receiver with the exception of the RF valve and aerial coil, which are mounted on a separate bracket on the left-hand front of the set. Between these two brackets, screwed to the bottom of the case, is the tuning condenser. The two controls at the front are the spindle of the simple rotary dial on the left, combined switch and volume control on the right. Of the main parts there is only the speaker, transformer, choke and gang screwed to the bottom of the case. They should be fitted with countersunk screws, the heads of which can be painted the same colour as the case so that they become almost invisible.

Between the filter choke and the RF coil extends a 11-lug fishbone terminal strip, which provides ready anchor points for resistors and condensers wherever required, also carries the 1½ V bias battery. A length of 2 core braided wire runs from the power socket to the switch on the volume control, which only controls the battery circuit. Another bit of the same stuff leads to the volume control itself. The braids should be earthed on as many points as possible.

No exact wiring diagram of small components is necessary. There is more than plenty of room for all, but general wiring rules must of course be followed. It goes without saying that components belonging to one particular stage must be kept together, with common earthing points for bypass condensers.

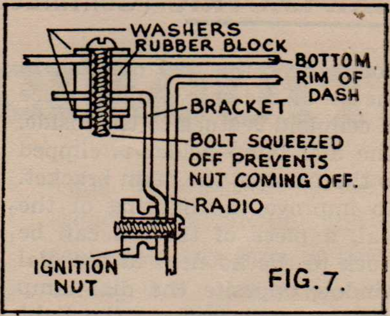


FIG.7.

The AVC condenser for the aerial coil, for instance, must be mounted right there and not on the main bracket a few inches away with a long lead feeding across. Hot leads should be kept as short as possible, the longest of them being the plate lead of the RF stage, which should be run along the bottom of the case past the front of the gang. A busbar should connect all earthing points together, not forgetting the gang, of which the centre section should be made oscillator. The B pos lead from the vibrator compartment should be fed to the choke past the speaker, not via that "hash corner" near the power inlet.

The dial consists of a cord driven revolving disk, to which the celluloid dial face is stuck with Bostik, which is available at every garage. The stationary pointer is made of a piece of galvanised wire soldered to the gang frame and bent over the top and about ½" down the front of the dial face. It can be painted red for better looks. The wing type escutcheon made for magic eye tuning indicators is put to good use with our dial, after the collar, intended to hold the top of the eye in place, has been carefully sawn off 1/16" from the rim. This is stuck with

(Continued on next page)

Bostik over the dial opening in the lid of the case, while a piece of celluloid is stuck to the inside. The dial lamp-holder is clipped to the front of the main bracket. To improve the lighting of the dial, a piece of tin foil can be stuck to the lid next to the dial window opposite the dial lamp (fig. 5). This reflects the light back against the front of the dial.

The lid is screwed on by means of self-tapping screws, excepting the screw near the power socket, which is a 5/32 metal thread affair and holds the earth lug of the battery cable. The fancy nuts used for spark plugs are very handy here. The battery cable can either be braided, as shown, or just two plain wires or twin flex, the hot end connected to the socket, the earth end to a lug that slips under the nut of the just mentioned chassis screw. The braided version may often help suppressing ignition noise, but no general rules can be made in this respect.

A foot-plate is provided to stabilize the set when used standing up for home or hotel use. In this case it is intended as a chairside floor set, with the dial on top and working with a 6ft. piece of wire as aerial.

The installation of the set turned out to be easier than we thought at first. The foot-plate has an extruded hole carrying a special ⅜" rubber bush, which is intended to slip over a pin protruding from the bulkhead (fig. 6). This is the unthreaded shaft of a bolt with the head cut off and held in a hole of the bulkhead between two nuts and washers. The sides of the lid, about 1" from the front, have 2 holes for 5/32" threads to be tapped in. The screws, 5-8" long, are screwed through from the inside and are intended to hold two side brackets which are fitted to the bottom rim of the dash. As shown in our drawing (fig. 7), they carry the well known gang condenser mounting rubbers on top, through which they are screwed (not too tight) to the dashboard. The set is thus entirely floating in rubber, which cushions the sharp vibrations that usually plav havoc with car radios. The 2 mounting screws on the side of the set carry spark plug nuts to hold the brackets on. The set can be quickly taken out of the car by unscrewing these nuts, slipping the brackets off the bolts and pulling the set off the 3-8" bolt which holds its rear end up against the bulkhead. The two brackets remain on the dash.

To get rid of ignition interference is a special science. Before putting suppressors to the plugs, first try to eliminate as much as possible by other means. We found that the earthing point of the battery lead is of major importance. Standard car radios, screwed firmly to the bulkhead, have not got this advantage. After mounting the aerial and shielded lead in the normal way, you actually have the set already earthed via the braiding of the lead-in; so if you only connect up the hot battery lead the set will go into action, after being switched on, of course. You can then try at your leisure to find the best grounding point for your battery lead, which gives the least interference. There is absolutely no rule for the location of this point, in my car, for instance, it is one of the handbrake brackets. It is often found of advantage to use shielded wire as battery lead, the braid then being connected to the contact screw on the set and earthed to the best point. A floating fuse has proved to be more of an evil than a blessing, as it often forms a high resistance contact ,reducing the voltage on the set. The voltage on the set must be checked for maximum value, being about 5.8V with the battery not charging. This can be done by pulling the power plug slightly out of its socket and putting the meter on the exposed pins. If the voltage is too low, the battery must be checked and the leads from the battery for high resistance joints. Remember that such a high resistance point need only have a fraction of an ohm to lower the voltage, you can only test it by voltage tests, not with the ohm meter. The total resistance of our car radio is only 2 ohms!

With the car radio properly installed and working, there remains the residual ignition noise to be eliminated, also other interference originating in various mechanical and electrical parts of the vehicle. You have all heard about spark plug suppressors, condensers for the generator, etc. But if you find that you can't cope with the problems yourself, it is best to see your nearest car radio expert—expert by reputation, not by his claim on the shop sign.

HOW TO READ CIRCUITS

G. W. Butterfield,
"The Broadcaster"
Perth

LAST month we described the method of following the wiring of a circuit diagram and the symbols used to indicate the symbols used to indicate condensers and R.F. inductances. Before going further, I should point out that the order from left to right in which the symbols are shown simply follows the order in which they come into the circuit and has nothing to do with the actual layout of the components on the chassis. All these points are usually given in the instructions accompanying the particular set which the circuit represents, and although there is a general rule to follow, it would require too much space to include it in this article.

Continuing with the description of the various symbols, we now come to fig. 22. This represent all resistors of the fixed type, that is, those of a fixed value. Where this value has to be variable an arrow is shown across the resistor in the same manner as the variable condenser, or inductance, or again, more commonly in the manner shown in fig. 23. The arrow in this case indicates the moving contact. Most variable resistors these days are in the form of potentiometers, or voltage dividers. That is, they can be used as a straight variable series resistance to drop the voltage, or as a divider resistance, in which the value of the resistance remains fixed, the various voltages required being obtained by tapping the connection at suitable points along its length. The potentiometer is commonly used for volume controls and tone controls, etc., and is in a circular or rotating form having three contacts, one each end of the resistor and the third as the variable contact. The divider is really the same except that it is usually in the form of a horizontal resistor with one or more semi-fixed contacts which can be adjusted along the resistor for different voltages. Either type is shown as in fig. 22.

Fig. 24 brings us to the L.F. section of a circuit, and this represents any form of low frequency (L.F.) inductance or coil. Such an inductance—different to those used for radio frequencies (R.F.), as previousy described—consist of a coil wound on an iron core. Low frequency chokes and transformers come into this category. L.F. chokes of whatever value are shown as in the illustration, and in cases where tappings are used these are indicated on the coil the same as described for the R.F. inductances. In fact, all the signs are the same except for the addition

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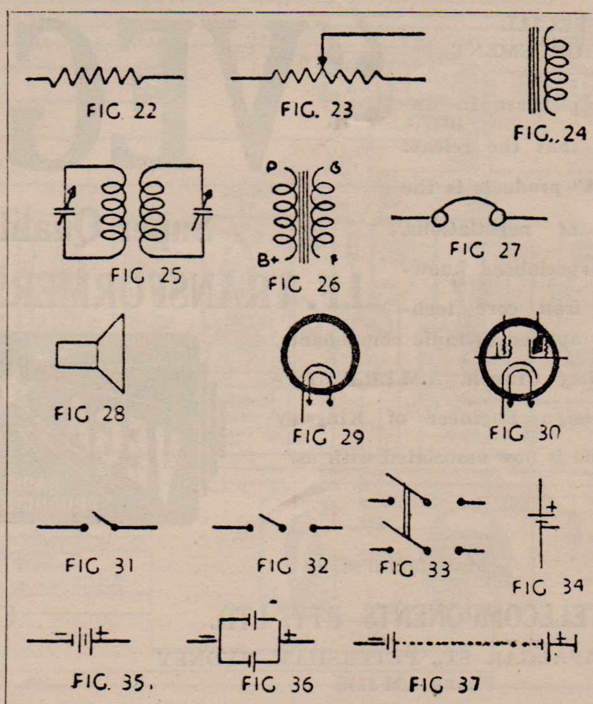

of the vertical lines indicating the iron core.

Thus where inductive coupling between two L.F. coils is required, the two coils will be shown together the same as described with R.F. inductances, but the vertical lines indicating the core will also be shown between them as in fig. 26, and when shown in this manner it represents an L.F. transformer, both coils being wound on the same iron core. Without the iron core shown, the symbol would represent an R.F. transformer or R.F. coupled coils, as previously described, both really being transformers, although for convenience such coils are generally referred to as the tuned R.F. coils.

In superheterodyne circuits, however, another frequency is used which, although still in the R.F. region, is termed the I.F. or intermediate frequency. This part of the circuit is coupled by inductively-coupled tuned R.F. coils, as in fig. 35. But for convenience and to distinguish these coils from those used in the input or R.F. stages, they are called I.F. or intermediate transformers. Of late years, however, a special powdered iron core is used in many makes of R.F. and I.F. coils or transformers. This type of core is indicated by a mass of small dots instead of the vertical lines, as shown, for the ordinary iron core of the I.F. inductance, and sometimes by a single line. However, there is little chance of any confusion in the two types of iron cored inductances as L.F. coupling transformers are very seldom used these days, except in some small one and two-valve straight circuits and for speaker matching to the output valve.

This does not include the

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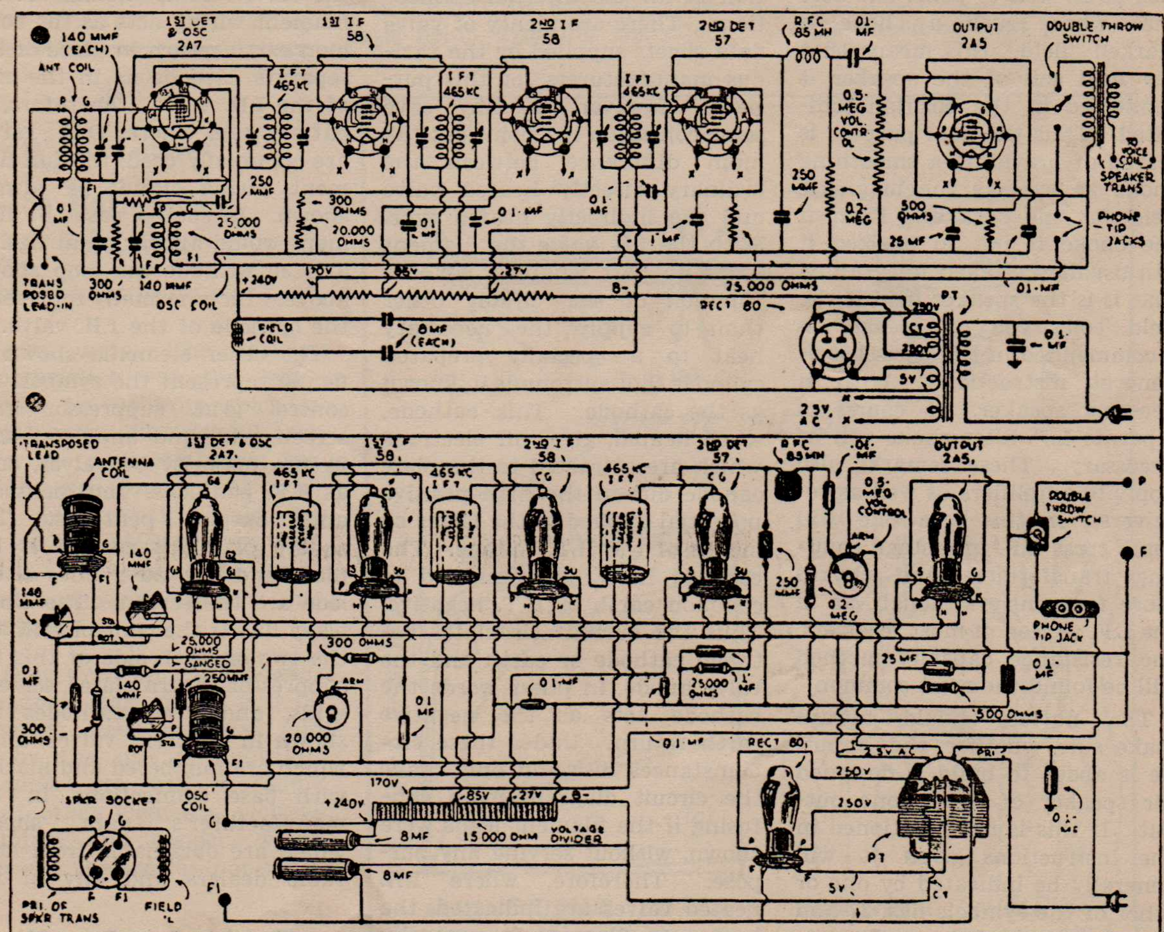

power transformer, which is common to all A.C. circuits and can easily be recognised by the three separate coils on the secondary and the single coil on the primary. This is indicated by the coils and vertical lines showing the iron core as in any other L.F. inductance. The three coils are H.T. voltage, rectifier valve filament voltage and the voltage supply for the rest of the valve filaments. The primary coil goes to the A.C. mains. L.F. chokes are also generally confined to the power supply circuit where one, or perhaps two, will be indicated for smoothing the rectified H.T. voltage. It would also be as well to point out here that where such a choke is marked "field," this means that the field coil of the speaker is connected in the position indicated. Thus the dual purpose is served of providing a smoothing choke as well as the magnetic field for the speaker. Even if the choke is not so marked it can usually be taken for granted that it is the speaker field if the field coil type of speaker is recommended in the parts list or general instructions. With a per-mag speaker, of course, a separate L.F. filter choke will be necessary. These remarks also apply to amplifiers as well as receivers. In this case one will come cross L.F. interstage coupling transformers and chokes more frequently although, as in the L.F. section of most receivers, the resistance capacity method will be found the most common.

The novice should always make sure whether the circuit he is about to build is designed for speaker of headphone output. If this is not mentioned in the instructions given it will generally be indicated by one or other of the symbols figs. 27 and 28, which are obvious. I mention this because it is no uncommon thing for the novice to expect speaker results from a set designed for phones and, as this is a function of the output valve as well as the amplification properties of the circuit, the size or the number of valves in the latter may not always be an indication that a speaker can be used although, except in special circumstances, this can usually be taken for granted in sets containing more than two or three valves.

There are numerous types of valves, therefore it is not proposed to give a detailed description of all the internal connections. There are plenty of valve data sheets supplied by the various manufacturers for this purpose. However, it may save some confusion if I point out the main difference between the ordinary directly heated valve and the indirectly heated type. With the I.H. valve the filament plays no part whatever in the function of the circuit other than to supply the necessary heat to a specially prepared cylinder that surrounds it, known as the cathode. This cathode, when heated, gives off electrons which are attracted to the plate oanode due to the high positive potential applied to the latter by means of the H.T. voltage. The cathode itself is connected to common earth or H.T. negative. Thus the current circulates between cathode or earth and the valve anode, in other words the cathode acts as the negative earth return. Under these circumstances it would only make the circuit diagram more confusing if the filament leads were shown, without serving any purpose. Therefore, where I.H. heated valves are indicated, the heater or filament is generally indicated as shown with the two arrows in fig. 29. Sometimes no indication is given other than the loop or inverted V representing the heater, and actually no indication is needed because in all cases it is understood that there is only one place for these connections to go, and that is to the power transformer filament winding.

When dealing with directly heated valves, that is when no separate cathode is used, the filament itself acts in the latter capacity in giving off electrons, and therefore must be earthed one side with the H.T. negative to complete the circuit through the valve. Thus one side of the filament wiring acts as the common earth return in place of the separate cathode as in the case of the I.H. valve. Therefore, in battery sets where D.H. valves are commonly used, the full filament wiring circuit is always shown. In such a case the filament would appear as in figs. 29 and 30 without the loop shown above, which normally represents the cathode of the I.H. valve.

The other elements shown in fig. 30 represent the symbols for control grid, suppressor grid, screen grid, and anode as used in the majority of valves, such as R.F. pentodes, Vmu pentodes and output pentodes. The square or black section is the plate and the wavy lines either side are the screen. The single wavy line is the control grid and the two on each side of this the suppressor. Extra plates, screens, grids, and even cathodes are shown in different valves, all of which are numbered and marked with base connections in the manufacturer's data sheets, which are obtainable from most radio dealers and any of the

(Continued on Page 30)

Magnets and Magnetism

Here is the first part of a new course in fundamentals, starting now, and to be carried through the next half-dozen issues.
Make sure of a thorough grounding in theory by following these articles.

By
W. S. Londey,
8a Barkly St.,
Sale, Vic.

MAGNETS and magnetism are very important to radio and electricity as nearly all electrical apparatus has a magnet of some type in it, or acts as a magnet itself.

Magnetism is a property peculiar to certain elements, alloys and compounds. The earliest known magnet was the lodestone, an ore of iron which is naturally magnetic (not all ores of iron are magnetic, most are not). It was found that iron, nickel and cobalt could be attracted by a piece of lodestone, and that steel could be magnetized and would retain this magnetism.

As time went on more powerful magnets were made, first by laminating steel magnets, and then by the use of alloys of iron, nickel, etc., with the addition of other elements such as aluminium and copper, which which are themselves non-magnetic.

These alloys are known by several trade names such as alnico, and form much more powerful magnets than do simple steel magnets. During recent years these alloys have been greatly improved, one of the most recent developments being the cooling of the alloy during manufacture in a strong magnetic field. This has the effect of permitting the alloy to be much more strongly magnetized in one direction, that of the field during cooling. This allows a great increase in retained magnetism for a given magnet weight, and is the principle used in making anisotropic alnico,

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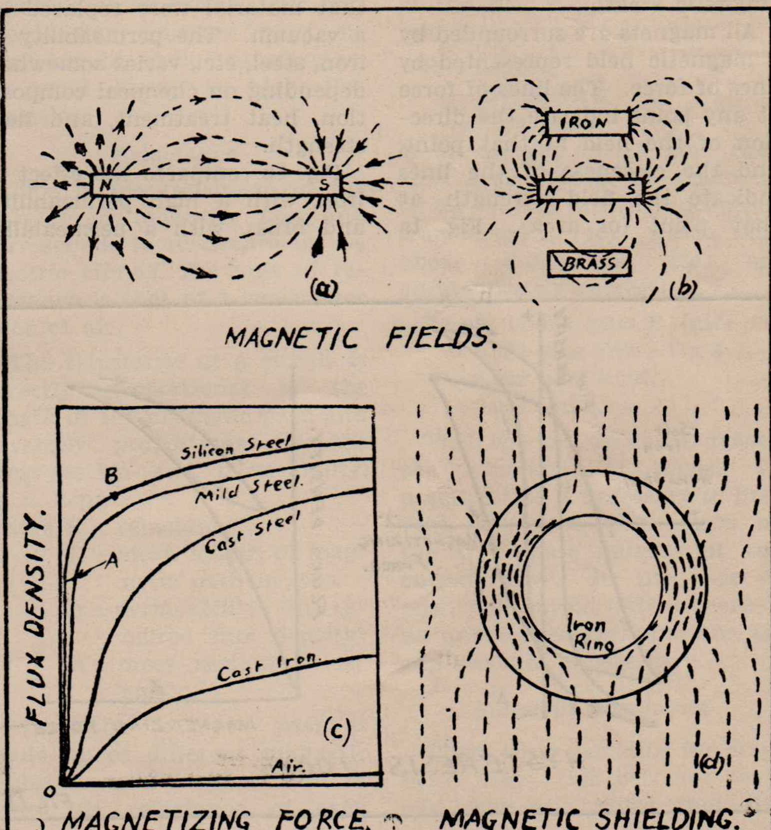


FIG I

ticonal, etc., used in modern permag. dynamic speakers. Anisotropic means—not equal in all directions.

In electrical work it is also desirable to have magnetic materials which will retain as little magnetism as possible or which can be very easily demagnetized; an important matter where flux reversals are required as in the case of transformers and relays. For this purpose magnetically soft materials such as soft iron or silicon steel (about 4 per cent. silicon) are used.

There are quite a number of terms which apply particularly to the magnetic properties of materials and a short explanation of the more common of these terms would not be amiss.

Magnetic Field.

All magnets are surrounded by a magnetic field represented by lines of force. The lines of force at any point indicate the direction of the field at that point, and the closeness of the lines indicate the field strength at that point (or area). Fig. 1a shows the simple field of a bar magnet.

Flux Density

This is a measure of the number of lines of force per unit area. The unit usually employed is the gauss, which is one line per square centimeter, so that when a speaker is said to have an air gap field density of 10,000 gauss, it has 10,000 lines per sq. cm. in the air gap.

Permeability

It is found that a piece of magnetic material, if placed in a magnetic field, has the effect of increasing that field. The magnetic material, therefore, offers less opposition to the passage of the lines of force than does air. The ratio of the flux produced in a given material to that which would be present if that material were replaced by a vacuum. The permeability of iron, steel, etc., varies somewhat, depending on chemical composition, heat treatment, and field strength.

Fig. 1b compares the effect of iron, with a high permeability, and brass, with a permeability of unity, on the field of a bar magnet. Note how the lines of force tend to crowd into the iron, while the brass has no effect on the field.

Fig. 1c shows curves of flux density v. magnetism force for various steels and for air. The permeability at any point on a curve is the slope of the line joining that point to the origin. The permeability of silicon steel is a maximum at "A."

The permeability of soft iron and mild steel ranges from 800-4,000, hard steel about 600, cast iron 300. That of nickel is about 500 and of cobalt 100.

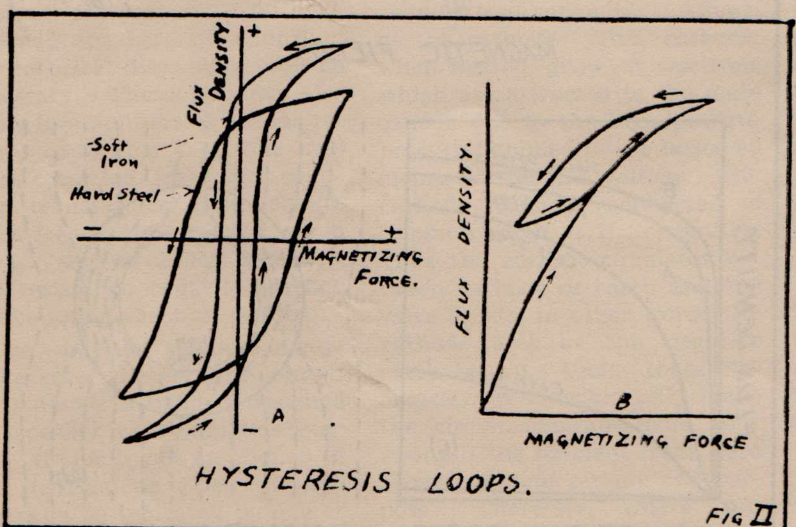
Special alloys having high permeability have been developed, the most notable being permalloy, an iron nickel alloy having 78% nickel, permeability up to 85,000, and mu-metal (75% nickel, 22% iron, 5% copper), permeability up to 70,000.

Saturation

It will be noted that in Fig. 1c the flux density increases rapidly as the magnetizing force increases up to a certain point (A for silicon steel) and that the rate of increase falls off thereafter. This is termed saturation and at point B silicon steel has practically reached its maximum flux density, and the material is saturated (magnetically). The saturation flux density for soft steels is about 15,000 gauss.

Hysteresis

If a piece of magnetic material is magnetized in one direction and the magnetizing force reduced to zero there will be considerable magnetizm remaining in the material and a certain negative magnetizing force is required to reduce it to zero. The magnetism remaining on removal of the magnetizing force is called the **remanence** and the force required to reduce this to



HYSTERESIS LOOPS.

FIG II

zero is termed the **coercive** force. This coercive force is very important in the case of permanent magnets when it should be as high as possible to prevent demagnetization by a stray field. Materials to be subjected to reversals of magnetism—laminations for transformers, etc.—should require a very small coercive force. The relationship between flux density and mag. force when (a) a piece of steel and (b) a piece of soft iron are subjected to a cycle of magnetization are shown in Fig. 11a. The curve is called a hysteresis loop and the area inside the curve represents the loss per cycle to a suitable scale. Lamination materials are designed to have a small hysteresis loss. The area inside the cast steel loop is many times that for the soft iron.

There will be some hysteresis loss when a piece of magnetic material is subjected to a variable flux even without reversal. Fig. 11b shows this type of hysteresis loop.

The loss per cycle is given by

$$W = \frac{A \times S1 \times S2}{4 \times 3.1416 \times 10{,}000{,}000}$$

where A=area of loop.

S1 & S2 are vertical and horizontal scales.

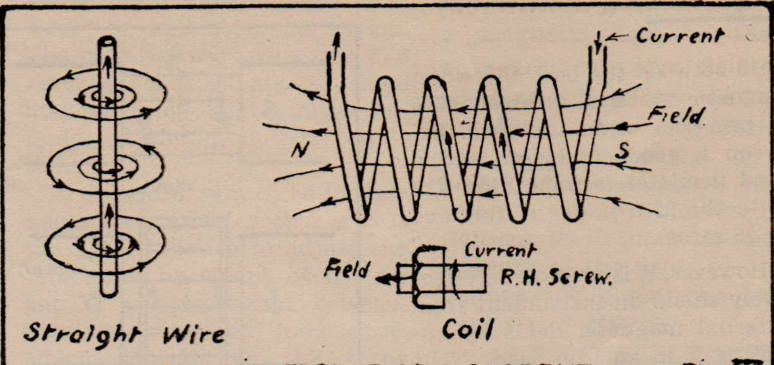
W = loss in watt-seconds per cycle per cubic centimeter.

The relative hysteresis losses of the various magnetic materials are:

Silicon Steel 1.
Mild Steel 4.
Cast iron 13.
Hard Steel 25.

For example, the loss per cycle for a 4 lb. soft iron core subjected to a reversing flux density of 5,000 gauss is approximately 0.075 watts-seconds per cycle.

At 50 cycles per second, loss = .075 x 50 watt-sec. per sec. = 3.75 watts.



MAGNETIC EFFECT OF A CURRENT. Fig. III

If the flux peak is increased to 10,000 gauss, the loss will be about three times as great, about 11 watts. Reducing the peak flux to 1,000 gauss will reduce loss to about 1/13 or 0.29 watt.

At a frequency of 1,000 cycles the loss would be 20 times as great as at 50 cycles. For this reason flux densities must be kept low in audio transformers to avoid losses at high frequencies.

Reluctance

This is the resistance to the passage of magnetic flux and corresponds to resistance in the electric circuit. The unit of reluctance is that of 1 centimeter cube of air.

The reluctance of a circuit is directly proportional to the length of the magnetic path and inversely proportional to the cross-section and permeability.

R = L/pA

where R = reluctance

L = mean length of magnetic path in cms.

p = permeability (at required flux density)

A = cross section in sq. cms.

When the magnetic path is made up of different magnetic materials and cross-sections in series the reluctance of each portion must be determined separately and the results added. Two similar parallel paths may obviously be treated as a single path having double the cross section of one part.

Example: A transformer core has a mean magnetic path 12 cms. long and 3 sq. cms. cross-sect. The permeability is 2000 at the flux required. Find the reluctance.

R = L/pA
= 12 / 2000 x 3
= 0.002 units.

If an air gap of 0.2 mm. (0.02 cm.) is inserted in the magnetic circuit (usual practice in output transformers, for which the above dimensions, etc., are approximately correct).

R = R (iron) plus R (air)
= 0.002 plus 0.02 / 1 x 3
= 0.002 plus 0.007
= 0.009 units.

Then the air gap has increased the reluctance 41 times. In practice this is necessary to prevent saturation of the iron by the D.C. plate current of the output valve. In the case of push pull output valves there is no unbalanced D.C. and the air gap becomes unnecessary.

Magnetic Insulators

There is no insulator for magnetic fields—this becomes obvious when we realise that the

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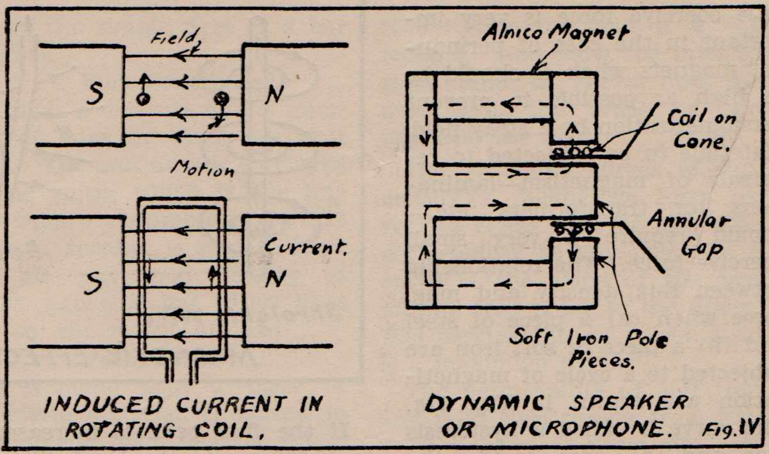

ratio between the best and worst magnetic material is about 4000 in practice, while the ratio between a good conductor and a good insulator is something like 10 to the 25th power (1 followed by 25 zeros).

However, it is possible to effectively shield an instrument from external magnetic fields by enclosing it in an iron case. The lines of force of the field will take the easier path through the iron and little or none will appear inside the case. This is illustrated in Fig. 1d.

This is the method used in protecting cathode ray tubes from stray fields which would cause undesirable deflection of the spot. Either iron or mu-metal tubes surrounding the cathode ray tube are used for this purpose.

Where alternating fields are concerned, particularly at radio frequencies, a case of conducting metal such as copper or aluminium is sufficient to shield anything inside the case from external fields. This method does not use the same principle as the magnetic method.

Electricity

Electricity from its nature cannot be examined or seen but its effects may be noted. An electric current has several important effects:—

1. Magnetic effect. When a current passes along a wire a magnetic field appears round that wire. If the conductor is wound into a coil a much stronger field appears in the coil.

The direction of the field is given by the right-hand screw rule: the north seeking pole of the coil (that is the end which would tend to turn towards the north magnetic pole—like a compass) is the end towards which a right-hand threaded nut would move if turned in the direction of the current flow round the coil. Fig. 3 illustrates the magnetic field round a straight wire and through a coil. The polarity of coils becomes important when two or more coils are to be connected to assist each other magnetically. Reversal of the current in the coil obviously reverses the polarity.

2. Heating effect. When an electric current passes through any conducting medium there is energy dissipated due to the resistance of the medium. This energy appears as heat and becomes important in the design of resistances as the working temperature depends on the energy dissipated and the radiating surface of the unit. High power resistances, therefore, must have a large surface area and may even require fins to obtain sufficient area. Hollow resistances generally keep coolest if mounted vertically and clear of all surrounding parts as the tube acts as a chimney giving better air circulation.

This heating effect is used in thermocouple and hot wire type meters used for R.F. current measurement. The latter type uses the fact that metals expand when heated to move the pointer.

3. Chemical effect. When an electric current passes through the solution of a salt, the salt may be broken up into its component elements and these are deposited on the electrodes, or discarded from the solution as a sediment. In general the metallic radicle (part) of the salt is deposited on the electrode where the current leaves the solution. Given the right conditions the elctrode where the current enters the solution, that is, the anode, will, if of metal, be dissolved to make up the metal lost to the cathode. This principle is used in the production of commercial copper, the crude copper being purified electrolytically. This is also the cause of electrolysis in the windings of transformers and other windings. Any impurities in the impregnating wax or coil former will cause a slow leakage and the wire, being positive is gradually eaten way. This type of failure is easily recognised by the greenish spot of copper salt at the fault. The use of isocore transformers in which the core

and winding are connected together and suspended clear of any earthed metal in insulating compound greatly reduces the possibilities of electrolysis failure.

The magnetic and heating effects of a current are the ones that mainly concern the radio engineer.

Electromagnetics

The relation between the magnetizing effect, called the magneto-motive force (m.m.f.) of a coil and its dimensions, number of turns, and current is given by:—

m.m.f. = 0.4 x 3.14 x N I
= 1.26 N I. gilberts.

where N = number of turns
I = current in amps.

The flux (total) for any magnetic circuit may be calculated from the m.m.f. and reluctance thus:—

Total flux = m.m.f. div. reluctance.

In general the ampere turns are determined rather than the turns and current separately. This is done because the same effect can be obtained from a large number of turns and a small current or a small number of turns and a large current.

In the reluctance problem worked out previously we can now determine the ampere-turns for a given flux. Say a maximum flux density of 10,000 gauss (total flux of 30,000 maxwells (or lines) which is below saturation for most steels.

Flux = 1.26 N I div. R
30,000 = 1.26 N I div. 0.009
N I = 30,000 x 0.009 div. 1.26
= 210 amp.-turns.

If this output transformer has 3,000 turns on the primary then the steady D.C. to give this result would be:—

I = 210/3000
= 0.07 amp.

This is 70 milliamps, so the plate current of a normal output valve (about 40 ma.), together with superimposed A.C. would be well below saturation. The peak upward swing of a 6V6 reaches about 90 ma. so there may be some slight distortion under maximum output conditions.

In designing iron cored inductances such as filter chokes it is the usual practice to adjust the reluctance by means of the air gap to a compromise between obtaining maximum inductance, which depends on the turns squared, and preventing saturation, which depends on N I. The use of the air gap also makes the inductance more constant for a range of D.C.

Induced Currents

An important principle of electromagnetics is that which states: if a conductor moves in a magnetic field so that it crosses or cuts that field there will be a voltage induced in that conductor. The magnitude of the voltage depends on the length of the conductor and its velocity (both measured at right angles to the field) and the strength of the field.

$$\text{Voltage} = \frac{\text{Flux density x Length x velocity}}{100{,}000{,}000}$$

Flux density in gauss, length in cms., and velocity in cms. per sec.

The direction of the voltage is

(Continued on next page)

MAGNETS (Continued)

such that any current due to it would oppose the motion producing the voltage. The polarity of the voltage generated is simply determined by Fleming's right-hand three-finger rule, thus: Consider the thumb, first and second fingers of the right hand to be mutually perpendicular (i.e. thumb up, 1st finger out, 2nd finger at right angles to palm), then, when the thumb points in the direction of motion of the conductor, and the first finger in the direction of the field, the second finger will indicate the direction of the induced current. This is illustrated in Fig. 4.

Conversely, if a conductor in a magnetic field has a current passed through it, it will tend to move across the field. The direction of motion will be such that it would induce a current in opposition to that flowing.

These two principles are very important, the first being used in generators, dynamic microphones and pick-ups, transformers, etc., while the second is the principle of operation of motors, dynamic speakers, moving coil meters, etc.

Thermo-Electricity

When two dissimilar metals are connected to make a closed circuit and one junction heated a current will flow in the circuit. The magnitude of the current will depend on the metals joined and the difference in temperature of the junctions. The insertion of other materials such as meter windings, etc., between the cold ends does not affect the results. This thermo-electric effect is the principle of operation of thermo-couples for measurement of high temperatures and of thermo-electric type R.F. meters.

Piezo-Electricity

If two properly cut slabs of a piezo-electric crystal such as rochelle salt (sodium potassium tartrate) are cemented together with one electrode between them and the other in contact with their outer faces any distortion (of the correct type—some are cut to be sensitive to bending and others to twisting) will produce a potential difference between the electrodes. This is the principle on which crystal pick-ups operate. As with most electrical laws the reverse is also true; that is, a potential applied to the crystal will cause a distortion, this principle being that used in crystal earpieces for hearing aids and the like.

Types of Electric Current

There are two main types of electric current—unidirectional or direct current, and alternating.

A unidirectional current flows only in one direction and may be steady or pulsating.

An alternating current reverses its direction in a periodic manner.

In radio work unidirectional currents are supplied to valve electrodes (except in the case of rectifiers when alternating voltages are applied but by the action of the rectifier the current is only allowed to flow in one direction), while alternating currents appear in aerial coils and leads, transformer secondaries and speaker voice coils, and A.C. supplies.

Part of this New Series is due to appear in next month's issue

Flat Cone For Rola '0-12'

ROLA'S new Model 12-0 12 inch permanent magnet type loudspeaker, the release of which last month attracted widespread attention in trade and technical circles, is now being supplied fitted with an F23 type cone. This new cone gives the loudspeaker response characteristics which are particularly suitable for high quality radio reproduction, and for use with gramophone amplifiers.

The F23 cone response is substantially flat from 60-70 cycles (depending on the fundamental diaphragm resonance of individual loudspeakers) to 6.5 K.C., and does not exhibit the rise in the 1500-4500 c.p.s. region which was introduced into the F22 cone to compensate for the high note loss due to sideband clipping in selective radio receivers.

The overall performance of the Rola Model 12-0 equipped with the F23 cone is extremely smooth and free from undesirable peaks. Though rated only to cover the 60 to 6,500 c.p.s. range, it will be found in practice that Rola Model 12-0 will give a useful output at frequencies well above 6.5 K.C.

Power handling capability of Model 12-0 fitted with the F23 cone is the same as for the F22 cone, i.e., 7 watts continuous, which means that the loudspeaker will handle the full output from a 15-18 watt amplifier.

The two cones may be readily distinguished. The F22 cone has 15 narrow concentric corrugations across its surface. The F23 has 5 wide concentric corrugations.

Retail price of Model 12-0 has been fixed at the extremely competitive figure of 71/6d.

Factory-Made Set Design

By

A. G. Hull

READERS often write in to ask if the performance of the sets detailed in our columns can be expected to approach that of the factory-built sets which are available on the market to-day.

Our reply is invariably that, provided the best of components are used and the set properly built and aligned, the sets described by us should perform just as well, if not better, than factory-built sets of similar type.

Pressed about this subject to the point of exasperation, here are a few circuit details of a prominent factory-built set of the latest type, bearing a famous name and selling well at the moment.

A close examination of this circuit will show that it is quite conventional and simple. It does not contain any mysteries. The performance of any set which is built to this circuit would depend mainly on the efficiency of the components used.

Taking the converter stage, this is quite normal, except for the use of the fixed padder condenser to also serve the purpose of the usual grid condenser. (Incidentally, there is a slight error here in our re-drawing of the circuit; the padder is between the grid terminal of the oscillator coil and the lead connecting the tuning condenser to the oscillator grid.) Next is the ordinary type of i.f. stage, at 455 Kc., but with a little feedback capacity from plate to grid circuit.

The detector stage is simple, too, with a 10 meg. grid resistor to provide bias for the audio portion. The audio end is also conventional along the old-style lines, without such modern ideas as inverse feedback. A fixed condenser of .01 mfds. across the speaker makes a good job of lopping off all high-note response and the distortion which would otherwise abound.

Actually, this condenser is fitted from plate to earth, thereby putting it under additional stress to the normal high tension voltage. In fact, the condenser in the original set had broken down, which was partly the reason why it happened that I was prying into its innards. Why set designers continue to put this tone correcting condenser from plate to earth is beyond me. In such a position it has to stand up to normal high tension

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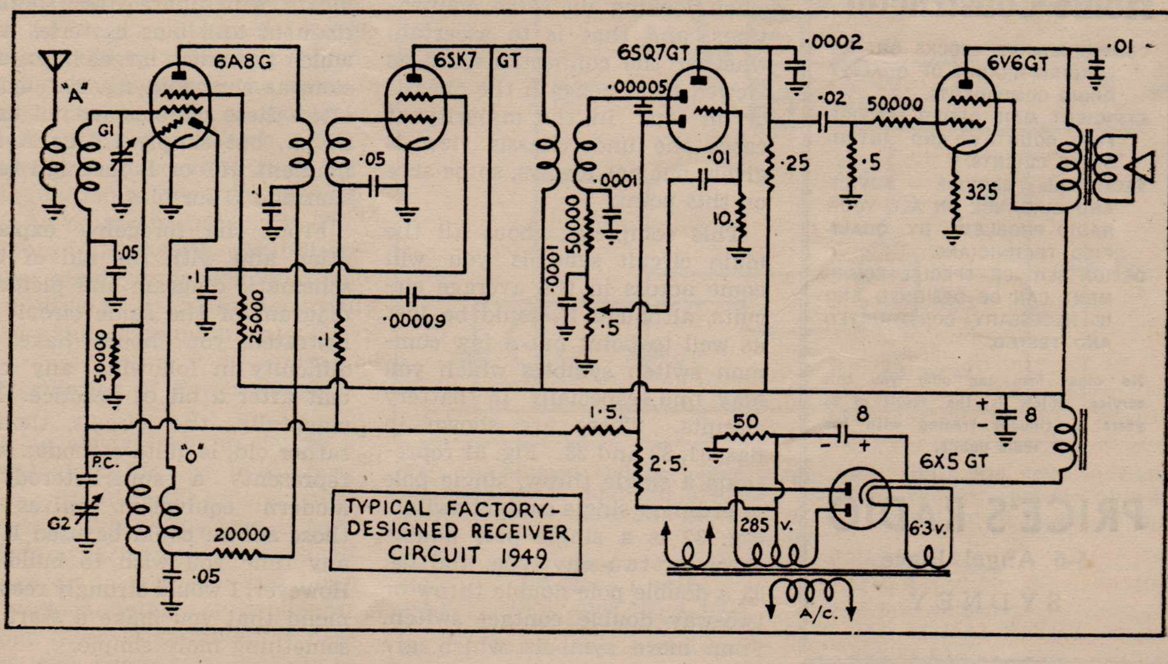

TYPICAL FACTORY-DESIGNED RECEIVER CIRCUIT 1949

FACTORY SET (Cont.)

voltages, plus audio peaks. It is just as easy, and so much safer, to put it across the speaker transformer secondary, from plate to high tension, instead of plate to earth. But in this improved position it has only to withstand the pressure of voltage actually developed across the speaker transformer secondary.

Following fairly general practice these days, the rectifier is a 6X5, which operates from the same heater winding as the rest of the valves in the set, thereby making it possible to use a cheaper power transformer construction.

The automatic volume control and bias circuit is a simple and effective one, picking off a negative voltage by means of 50 ohm resistor in the centre-tap circuit of the power transformer secondary. This provides a bias of 3 volts for use as minimum bias for the first two valves, also as delay for the a.v.c. diode. This resistor is also a handy checking point, as a voltmeter across it will give an indication of the total high tension current drain. If the correct voltage appears across this resistor it is a fair indication that voltage and current drain throughout the set is normal.

To sum up, it seems that present-day factory-built sets use straightforward circuits. Tricks of all kinds are avoided, even inverse feedback.

CIRCUITS

(Continued from Page 22)

book shops which cater for the technical man. However, one point should be borne in mind when looking up valve connections, and that is to ascertain whether the connections are as viewed from beneath the chassis or on top. In the majority of cases the underchassis view is given, but not always, so be sure on this point.

This completes about all the main circuit symbols you will come across in the average circuits, although it would be just as well to point out a few common switch symbols which you may find, especially in battery circuits. These are shown in figs. 31, 32 and 33. Fig. 31 represents a single throw, single pole or ordinary single contact switch. Fig. 32 is a single pole double throw or two-way type, and fig. 33 a double pole double throw or two-way double contact switch. Four more symbols which are used in battery circuits and should be understood are fig. 34, which is the conventional sign for the positive and negative connections of a single battery cell, fig. 35, cells in series, and fig. 36, cells in parallel. The number of cells is not always shown, but just sufficient to indicate which are the smaller filament and bias batteries and which the much larger high tension, as shown in fig. 37. Quite often these symbols are not used at all, but simply LT or A for filament, HT or B for high tension and C for bias.

From the foregoing explanation and with the aid of the schematic diagram and pictorial diagram of the same circuit illustrated, you should have no difficulty in following any circuit after a bit of practice. Incidentally, the circuit, though rather old, is quite orthodox and represents a superheterodyne. Modern equivalent valves to those shown could be used if at any time you wish to build it. However, I would strongly recommend that you make a start on something more simple.

FOR THE AMATEUR

VOLTAGE REGULATION

By J. N. Walker (G5JU)

IN the ordinary domestic receiver, the load applied to the power supply is practically constant and the question of voltage regulation is unimportant. On the other hand, in laboratory instruments used for accurate quantitative measurements, it is essential to arrange for voltage supplies constant to within extremely narrow limits and the expense of doing it is justifiable.

Amateur requirements are different in several ways. In the majority of cases, it is to be expected that the voltage in various pieces of equipment will be varying during operation, and sometimes varying over wide limits. Under some circumstances such variations may not matter much—under others, they can be very undesirable, and steps should be taken to prevent or materially reduce the variations. The question of economy comes into the picture but fortunately the laboratory standard —regulation to less than one volt —is by no means necessary. The gaseous type of voltage stabiliser, either singly or in combination, can usually be made to meet most amateur requirements.

Regulation of Power Supply

It is always well to design a power unit, for any given purpose, with adequate inherent regulation. Where the load is constant, or varies only over a small range, as in receivers and Class A audio amplifiers, a condenser input filter is suitable. Where the load current is subject to wide variations (e.g. Class B modulators, keyed transmitters), then invariably a choke input filter should be used. Care should be exercised to see that the input choke is of the correct type (no air gap in the core, and with suitable current carrying and inductance ratings). Such points as low resistance transformer primary and secondary windings, low resistance chokes, low voltage drop in the recitifier(s), all help to improve the inherent regulation.

Receiver Considerations.

In a communications receiver, it is desirable, if not essential, to avoid fluctuations of voltage at points liable to affect the operating frequency. The variations may arise either from fluctuations in the mains supply or by the change in H.T. voltage which is liable to occur when the gain of the variable-mu valves is varied, so causing a change of total current drawn from the power supply. It must, however, be noted that it is the variations of current consequent upon change of voltage, which cause frequency shift. A pentode is a constant current device—small changes of anode voltage affect the anode current hardly at all but changes of screen voltage may have quite a considerable effect on the anode current. In

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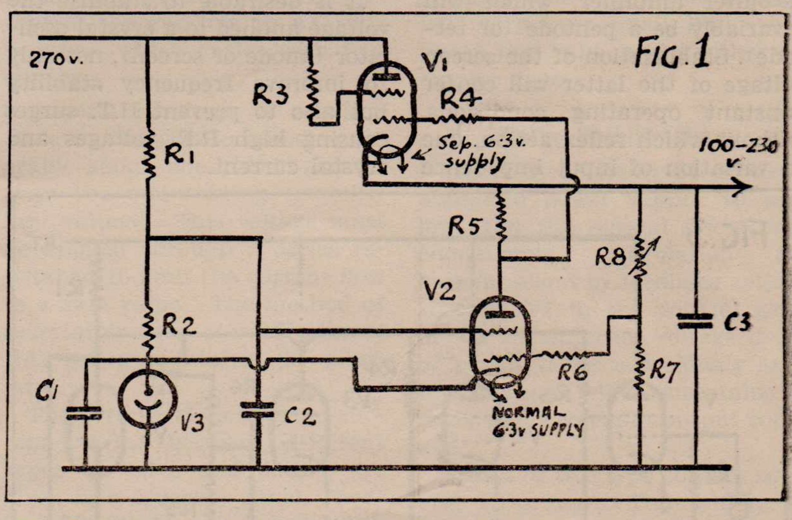

Fig. 1—Constant voltage power supply unit. With 270 volts in from standard power unit, an absolutely constant voltage, variable at will between limits of 100 and 230 volts, at any current up to 70 mA, is obtainable.

R1, 2	25,000 ohms 1 watt	C1	.01 mF. Mica
R3	100 ohms 1 watt	C2	4 or 8 mF.
R4, 6, 7	30,000 ohms (R7 1 watt)	C3	1 mF. or more.
R5	.25 megohm ½ watt	Vs	7475 or 85A1 Mullard
R8	50,000 ohms wire wound	V1	6L6 or EL37
		V2	EF50

a self running oscillator, change of anode current affects the slope and the input and output impedences of the valve and hence is liable to vary the frequency directly. Also, the fact that the internal dissipation changes one way or the other, gives rise to a change of inter-electrode capacity and this again affects the frequency.

Where a pentode or tetrode valve is used as a primary source of frequency control, in a self-running circuit, it is important at least to stabilise the screen voltage and better if the anode voltage also is stabilised. The only difficulty with the latter procedure is that the voltage may be somewhat low for satisfactory operation.

Usually, the oscillator output will be fed into another valve—a frequency changer, or perhaps a buffer amplifier, which will invariably be a pentode (or tetrode). Stabilisation of the screen voltage of the latter will confer constant operating conditions, without which reflex action, due to variation of input impedence and capacity, would affect the oscillator frequency.

Unlike a pentode, a triode is not a constant current device. Change of anode voltage results in an instantaneous change of anode current, and the more constant the anode voltage is maintained the better.

It should be made clear that the addition of a stabiliser will not correct slow frequency drift, other than that consequent upon varying dissipation, mentioned above. A steady oscillator frequency is achieved by attention to the design of the oscillator circuit and constants.

Similar considerations apply to a variable frequency oscillator, used as the primary drive for a transmitter, to a frequency meter and to a signal generator, each of which is based on a self-running, high stability oscillator.

Transmitter Refinements.

It is desirable to stabilise the voltage applied to a crystal oscillator (anode or screen), not only to improve frequency stability but also to prevent H.T. surges causing high R.F. voltages and crystal current.

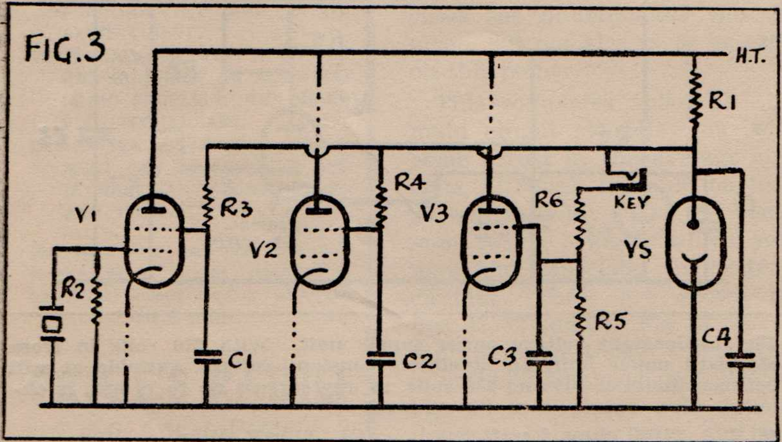

Fig. 3.—Stabilisation of Exciter Stages. All screens are connected to stabilised line.

R2	Usual grid leak.	C1, 2,3.	Usual decoupling condenser.
R3, 4, 6	Low value (47 ohms) decoupling.	C4	.01 mF. Mica.
R5	47,000-100,000 ohms.	R1	See appendix.

Most pentode and tetrode transmitting valves are given very definite screen grid voltage ratings, based on a figure for screen dissipation, an increase in

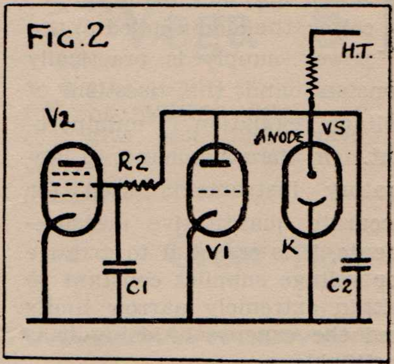

Fig. 2. V1 is a triode oscillator, with tuned circuits omitted for simplicity. V2 is a pentode frequency changer, etc. The anode of V1 and screen of V2 are connected to the stabilised H.T. line.

which is likely to cause harm to the valve. This statement applies particularly to the larger valves (807, 813, etc.) and to the family of double beam tetrodes. When C.W. is employed, the voltage on the screen grid is liable to rise to the full H.T. line value. Possibly, this is not harmful in itself, but the transition from full line voltage to working voltage, when the key is pressed, takes a fraction of a second and makes it difficult, if not impossible, to obtain a clean signal on "make." This rise and fall of screen voltage may, of course, apply to a chain of valves, following the keyed stage, which only makes matters worse. Stabilisation of the screen voltages throughout is the ideal, although not always realisable economically. A separate, small, valve-stabilised power unit is one good method but a combination of stabiliser valves will prove almost equally satisfactory.

Although not so important as

regulated screen voltage, it is good practice to stabilise also the fixed control grid bias, particularly in the case of the final valve(s).

Modulator Applications.

The importance of regulating the screen voltage of audio amplifiers (modulators) running in other than a Class A mode, has previously been pointed out and alternative methods of achieving this object are suggested later. In the article referred to, grid bias was derived from batteries, this being a simple and reliable method. Where it is desired to dispense with batteries, stabilisation of the grid bias voltage becomes necessary and means of doing so are given.

The Gas-Filled Stabiliser Valve.

When a potential is applied between two electrodes in a low pressure gas, the free electrons present attain a high velocity and ionise gas molecules by collision. The new free electrons thus liberated are in turn accelerated and more ionisation by collision occurs. This section is cumulative an drapid, consequently the conductivity of the gas between the electrodes increases quickly with increasing current. A very small increase of voltage at the electrodes results in a considerable increase in the current flow through the gap.

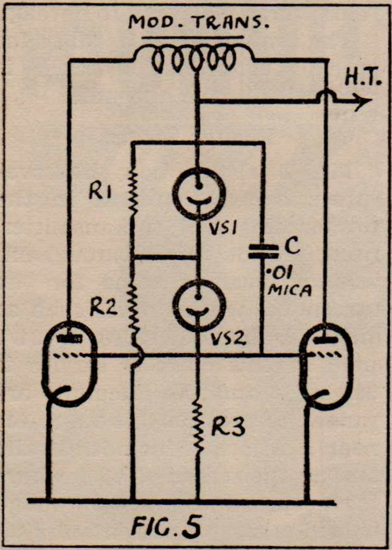

Fig. 5—Two stabiliser valves used in series to provide a constant voltage drop to screens of modulator output valves. Also applicable to R.F. valves. Assuming 807 valves with 600 volts H.T., VS1 and VS2 can be Brimar VR150/30. The resistors R1, R2 and R3 (each .25 megohm) ensure proper ionisation.

By suitable design, the voltage across the gap can be made practically independent of the current passing so that the voltage across a varying load will remain substantially constant. Fluctuations in the supply voltage appear across the series resistance but not across the stabiliser gap.

Since voltage remains practically constant with comparatively large changes of current, the gap has no resistance in the usual sense of the word. Nevertheless, the gap has an A.C. impedance, which varies with frequency.

A certain voltage is required to cause the gap to ionise—generally about one third greater than the maintaining (stabilising) voltage. This voltage must be applied through a series resistance, to limit the current flow to a safe value. The method of ascertaining the correct value of this series resistance is given later.

The permissible maximum current varies between different types of valve and details are given in a separate panel. There is also a minimum current below which ionisation, and therefore the control characteristic, tends to be erratic. With some types, a third current value is mentioned, this being the figure at which the stabiliser should be operated for close control. This

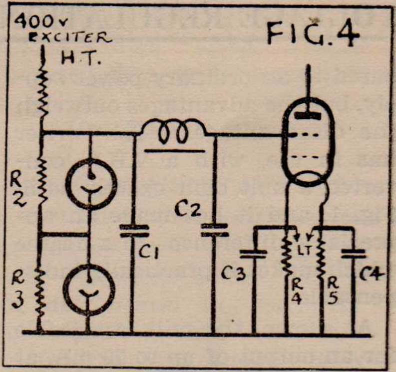

Fig. 4. Screen grid stabilisation of 813,PT15 and similar high anode voltage valves. VS1 and VS2 can be Brimar VR150/30, giving 300 volts. R2, 3—.25 megohm. Shoke 20H 10 mA.
R4, 5—100 ohms or more. C1, .01 mF. Mica.
R1.—See appendix. C2,3,4, Usual by-pass condenser.

latter current is usually somewhat low and is most useful when the valve is used for voltage reference purposes.

It should be made clear that the specified stabilising voltage for any given type is only an average value—the actual voltage will vary over small limits between one valve and another of similar type.

Valve Stabilisation.

Fig. 1 is a circuit of a valve stabilised power supply, to follow after the normal smoothing components. Regulation is brought about by feedback action through VI to the control grid of V2, the internal voltage drop of which varies accordingly and in a manner which maintains a remarkably constant output voltage.

A unit of this type confers several advantages. The voltage is maintained constant despite variations of load current or mains supply voltage, the output impedance is very low and the hum content is reduced. Admittedly additional valves and components are required, com-

(Continued on next page)

VOLTAGE REGULATION (Continued)

pared to an ordinary power supply, but the advantages outweigh the disadvantages. The writer has in use, with a V.H.F. converter, a unit built exactly as in Fig. 1, and it has made an appreciable difference—to a degree which makes it practically indispensable.

As shown, the unit is suitable for an output of up to 70 mA, at a voltage which can be varied between 100 and 230 volts, by adjustment of the potentiometer R8. The transformer in the power supply is an ordinary 300-0-300 volt receiving type—one with a smaller or larger output can be used, according to the desired output voltage.

The whole of the H.T. current flows through V2, which must be capable of handling it. The internal dissipation will, however, be less than in other applications, because the anode/cathode voltage drop will be less. For good control V2 should possess a high mutual conductance, as is the case with the 6L6 suggested. Several other types of valve (807, EL37, PX4) are equally suitable. Where a current greater than 60/70 mA is called for, two valves in parallel will be required in the V2 position.

This circuit is recommended where extreme overall stability is desired, such as in a V.F.O., frequency meter and a signal generator. It is also excellent for providing an independent screen voltage for pentodes or tetrodes, particularly in a transmitter. In the latter case it should be noted that provision is necessary for switching off and on the screen H.T. supply, simultaneously with the anode supply.

The stabiliser valve used in Fig. 1 acts as a voltage reference source. The **Mullard** types 85A1 and 7475 (as specified) are the most suitable types for the purpose.

Separate Stabilisation of a Low Power Oscillator

The circuit given in Fig. 2 shows probably the simplest application of the stabiliser valve. It is assumed that a triode valve, such as a 6J5, EC52, etc., is being used with a more or less steady load current and with an H.T. supply liable to vary over small limits. There are quite a number of stabiliser valves which can be employed in such a circuit, depending on the regulated voltage required and on the current consumption allowable. The **Mullard** 7475 and the **Osram** ST11 are economical types and give close regulation. The voltage is on the low side but adequate for an oscillator in a receiver. The accompanying table provides comprehensive figures for various British made stabiliser valves, from which a type can be selected for higher voltages and for currents.

Where the load current is liable to vary, the selected stabiliser valve must possess a range of current flow equal to the expected variations. Also indicated in Fig. 2 is a pentode valve (V2) associated with the oscillator in one way or another, with its screen fed from the stabilised supply. The condenser in parallel with the stabiliser should be noted. Its purpose is to short-circuit any high frequency currents which may tend to develop.

The value of R1 calls for special consideration and is dealt with in the appendix.

Exciter Stages.

Fig. 3 shows how improvements can be effected in the exciter stages of a transmitter, using tetrode valves throughout. A good average value for the screen voltage in valves such as the 6V6, 6L6, 807, KT8, QV04/7 used in this class of service is 200 volts and the circuit is arranged to provide this value (or near). A jack is included in the feed to the screen of V3 for keying purposes. Since the voltage is held constant, with the key up or down, a clean characteristic is obtained. The current broken is small and, in many cases, a key click filter will be unnecessary.

P.A. Stage.

As mentioned earlier, one of

the most important points in a transmitter calling for stabilisation is the screen grid of the P.A. stage, to prevent large variations of voltage.

Where high anode voltages (1000 or more) are employed, it is not desirable to feed the stabiliser from the P.A. high tension supply, as a large series dropping resistor, of considerable wattage, will be necessary. It is better to use the exciter high tension line and Fig. 4 shows how this may be accomplished.

In a transmitter used for C.W. only, the screen of the P.A. valve may be taken directly to the stabiliser anode. If, however, telephony is also employed, this connection will prevent proper modulation, as the relatively low impedance of the stabiliser will by-pass audio frequency currents. In Fig. 4 therefore, a choke is included in the lead to the screen grid—the latter can then follow the modulation but is held at a constant D.C. potential. Two stabiliser valves in series are necessary and the types will vary according to the screen voltage recommended by the makers for the P.A. valve. To assist readers in selecting a combination of adequate current carrying and regulating volage, a panel has been prepared giving information regarding a number of popular P.A. valves. In cases where the final anode voltage is comparatively low (400/500 volts), an alternative method of stabilising the screen supply is the series connection of one or more stabiliser valves. This is discussed in a later paragraph.

Modulator Service.

In a Class AB1 or AB2 Modulator, using tetrode output valves, the screen current is liable to swing over wide limits. This is not detrimental in itself—the trouble is that, when the screens are fed from the anode supply via a series resistance, the screen voltage **drops** when a driving voltage is applied to the control grid. This means that just when more power output is required, the valve is operating under a condition which results

(Continued on next page)

VOLTAGE REGULATION (Cont.)

in less power output—a fact which obviously affects both total power output and quality.

An alternative method is shown in Fig. 5. This circuit anticipates some remarks about the use of stabiliser valves in a series connection, instead of in the more usual shunt connection employed in the earlies circuit.

The stabiliser valves in Fig. 5 ensure a constant **voltage drop** between the anodes—or rather the H.T. line—and screens of the output valves, so that, providing the main H.T. voltage is reasonably steady (a matter of the power supply design), the screen voltage also remains steady irrespective of the screen current. The correct stabiliser valve combination will depend on the anode voltage. For example, if the latter is 600 volts (assuming 807 valves) two VR 150/30 valves in series are suitable.

Stabilised Negative Grid Voltage.

It is not a difficult matter, by suitable choice of valves, to secure a stabilised fixed negative bias voltage between 100 and 150 volts, as required by many power amplifier transmitting valves. Provided the grid current is moderately low, the circuit can be quite simple—a typical example is given in Fig. 6 (a). The Power supply—hardly a proper title in this instance is, in fact, only necessary to ensure that the stabiliser valve strikes, so that it functions whether or not grid current is flowing. Consequently, the power unit can be elementary and as shown, a small filament transformer (in reverse) and almost any small power valve can be pressed into service. If a variable bias is required, the lead to the control grid of the P.A. valve(s) can be taken from the moving arm of a 10,000 ohm potentiometer connected in parallel with VS. The later may be a Brimar VR 150/30 or a Cossor S 130, or equivalent types.

It is not so easy when a low stabilised voltage is called for, particularly when the resistance in circuit must be kept low, as is a requirement in the grid circuit of a Class AB1 or AB2 audio amplifier. A common value of grid bias in such amplifiers is 30 volts, and no stabiliser is available, which will regulate at less than 55 volts. And this one (the S.T.C. G 120/1B requires 100 volts to ensure striking. It therefore becomes necessary to maintain a high rectified current, so that the 30 volts required can be developed across a low resistance. A suitable circuit, using a **Cossor S130 valve**, is shown in Fig. 6 (b). A combination of resistors gives a fixed output voltage of 30 volts—variation can be effected by altering the ratio of the specified values.

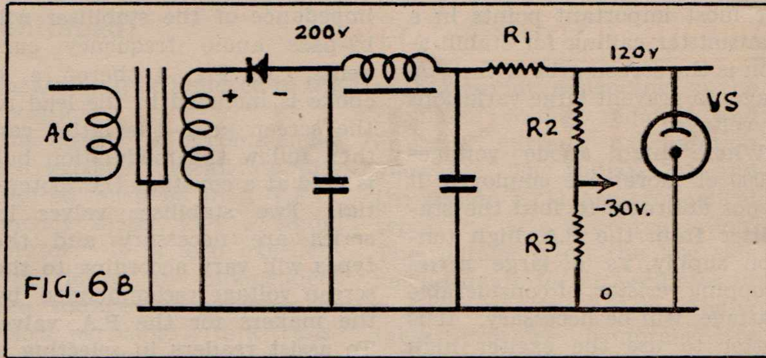

Fig. 5 (a)—Simple method of obtaining stabilised bias supply. Max. (negative) voltage will depend on type of Vs employed.

C1	**8mF.**	**V1, any small power valve (10mA).**
C2	**.01 mF.**	
R2	**10,000 ohms wire-bound.**	
R1	**See appendix (6000 ohms with a small current stabiliser, less with S130, etc.)**	

Transformer—filament type in reverse.

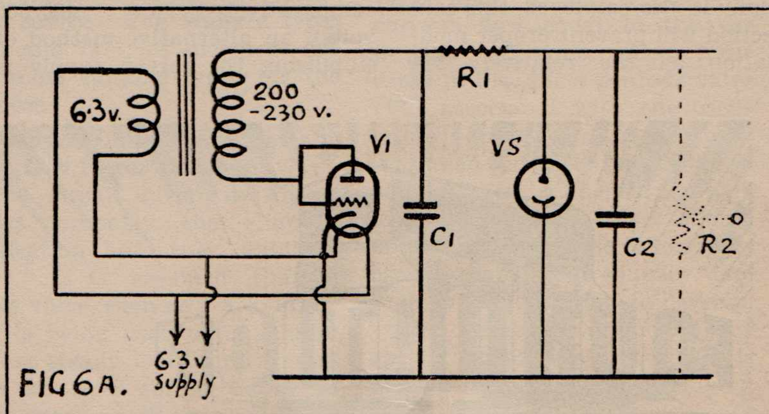

Fig. 6(b).—Modulator grid bias supply. The transformer should deliver 200 to 230 volts, 7 0to 80 mA. Adequate ventilation should be arranged for rectifier and resistors.

C1, 2	**8 mF.**	
Choke	**10-20H 70/80 mA.**	**Vs Type C130.**
R2	**1500 ohms 10 watt.**	**Rectifier Selenium 250v. 80 mA.**
R3	**500 ohms 3 watt.**	**R1 (+ Choke) 1000 ohms 10 watt.**

(To be concluded in next month's issue)

SELL SPEAKERS

SELL SPEAKERS

THINGS are pretty tough in the radio business these days, and the average suburban radioman is hard pressed to keep the wolf from the door. Repair work is available in plenty, but it takes a lot of it to pay the rent. Selling new sets is hard, and isn't made a bit easier by the recent ballyhoo about television.

I have hit on one little scheme for making extra money which seems to be working out fine, and so I am passing on the tip for what it is worth. Briefly, the idea is to sell a new speaker with every repair job, or at least with a great many of them.

Contributed by a successful suburban dealer

In the radio repair room I have a solid console cabinet with one of the new Rola "O" type speakers mounted in it. When a customer comes in to see if the old set has been repaired, I plug it into the Rola, and then mention that the set is now going again, but that it sounds ever so much better on a modern speaker.

It is easy enough to switch over from one speaker to another, and the difference in results is so marked, in most cases, that the sale of the new speaker is a push-over.

The price of the new Rola speaker seems to be moderate enough to be within the reach of the average set-owner, yet sufficient to build up the turnover by quite a considerable amount, if the above suggestion is accepted.

NEW BRAND OF COIL UNITS

AS WILL be noticed by the advertisement in this issue, there is a new name in the coil business. This is "Vega," a name adopted from the astral Vega, a star of the first magnitude. Although the name of the product is a new one to our readers, many will know the men behind the new name, especially that of Lay Cranch, who was a frequent contributor to our columns about ten years ago, was manager of Crown Radio Products at that time. He was later the manager of the Kingsley organization in Melbourne. So, although a new name, Vega has a background of a lifetime of experience in coil design and construction. For a start, the Vega range consists of broadcast coils, short-wave coils and intermediate frequency transformers.

In the i.f. transformers there are the VIF5 and VIF6, the two standard types for all-round performance and maximum gain and selectivity. The same features, but in miniature size, are listed as VIF14 and VIF15. For superhets with two i.f. stages the recommendation is two type VIF11, followed by a type VIF12. All the intermediates retail at 13/9.

In the broadcast coils the standards are types VC1, VC2 and VC3, for aerial, r.f. and oscillator, respectively. VC9 is a reinartz coil for small sets. In miniature sized cans are the VC19, VC20 and VC21, for aerial, r.f. and oscillator. This oscillator coil is suitable for the IR5 peanut, also the ECH33 and 6K8G. VC22 is a standard coil for use with 6A8, 1A7 and 1C7 oscillators. VC23 is for the 6J8 and VC24 for the 6SA7. All broadcast coils list at 8/9.

For short-waves there are the VCH1, VCH2, and VCH3 for the 13 to 42 meter range, and VCH4, VCH5 and VCH6 for the 16 to 50 metre band. They list at 3/6 each.

Frequency Meter

(Continued from Page 7)

ceiver or detector and tuned to zero beat. A 6SA7 was used as a detector and is more useful than a receiver when checking the frequency of a transmitter.

Stability

The stability of the oscillator proved to be extremely good, the maximum drift being about 300 c.p.s., which is perfectly satisfactory, but this figure will vary with the care taken in construction.

The dial is another important factor, and only the best type available should be used. The one shown in the photograph is of Jap origin and can be read to one part in a thousand, but any type of good dial will be satisfactory.

Frequency Coverage

The frequency coverage is from about 2 to 1.75 megs, but can be varied to suit individual requirements. The harmonics are used for the bands that are harmonicly related, as plug-in coils do not allow accurate calibration.

Calibration

The most difficult problem for the home constructor is the calibration of the finished article, the most satisfactory way being to calibrate it against a calibrated freqmeter, such as a Bendix or some other type of frequency standard. Otherwise the going is up-hill. Fortunately there are quite a few amateurs now with a Bendix, so it should not be too difficult to get the use of one.

SHORTS

Rex Gillett says YV5RY, Radio Continente, Caracas, Venezuela, has changed call-sign to YVKM. (If you are not afraid of the noisy area you will find them on 5.03 m.c. 59.28 metres, and best time is when opening at 9 p.m.—L.J.K.)

. . . .

Look out for Radio Athens testing on 7.30 m.c. 41.10 met. between 1 and 1.45 a.m. If you should hear them send reports to National Broadcasting Institute, 4 Righillis St., Athens, Athens, Greece.

. . . .

According to "Radio Call," Jim Paris, of Prospect, South Australia, has logged Radio Pakistan on 10 metres. My set does not get down to 10 metres, but this Bengalese station can be heard most nights on 15.27 m.c. around 10.30, when news in English is transmitted. Further English is given at 12.50 a.m.

Radio Pakistan is situated in Dacca.

Shortwave Review

Conducted By
L. J. Keast

B.C.C.

In March issue I listed the Transmitters of the B.B.C. An error crept in and GWM was shewn as 6.03 m.c. This, of course, should have read 6.09 m.c.

Ever And Ever Better

Doubtless DX listeners have noted the splendid reception from London on the 19, 16 and 13 metre bands.

As I type these notes I am listening to "Radio Newsreel" on the 16 metre band giving a report on the "Republic of Eire." It is unbelievably clear and volume is cut back to "just on." This would bear out the suggestion in "London Callng" that during the ensuing year of reception, sunspot activity must, in any case, be relatively high and this means that radio conditions should, generally speaking, be good, and again tend to favor the shorter waves.

New Stations

Radio Pakistan, Dacca 15.27 m.c. 19.65 met.:

This is a new frequency for this Bengalese station and can be heard at 10.30 p.m. with news in English. Further English session is at 12.50 a.m. As can be expected a good amount of Indian music is transmitted and many Indian dialects are employed. Previously Radio Pakistan has been operating on 6.075 m.c. 49.46 met. and the location was Karachi.

GOA, Nova Goa, Portuguese India 9.61 m.c. 31.22 met.:

Readers will remember in March issue we suggested this station would probably try 9.61 m.c. as 7.23 m.c was of an experimental nature. They are now heard — with difficulty — from 10.30 p.m. till 12.30 a.m. The "difficulty" is VLW-5, Perth, which is on the same frequency.

Help Wanted

When he can't determine it, believe me it's a corker. I am referring to Rex Gillett asking "Who Can Help" with:

"A Latin American heard on approximately 6.965 m.c. from about 10.30 p.m. He thinks it is possibly YNEQ. Signals are fair and musical numbers are interspersed with Spanish announcements."

Another Latin American that has him puzzled is on 6.335 m.c.

(Continued on next page)

and heard around 10.55 p.m. It may be TGTA. Marimba style music was heard at this hour.

VEREFICATIONS

Alan Beattie, of Bondi, brought up his list of veries to 100 by correct reports being acknowledged from VLI-3; YDB-3 (7.27 m.c.); PLB-7 (11.08 m.c.); and five of the Delhi stations.

Since sending me this news he now has cards from: PCJ (17.775 and 15.22 m.c.); Manila (11.89, 15.33 m.c.); DZH-5 (9.69 m.c.); DYH-3 (6.10 m.c.); XGOY (11.913 m.c.); PLB-4 (10.365 m.c.); YDE (11.77 m.c.); YDQ-3 (11.084 m.c.) and H12T (9.727 m.c.).

Miss Dorothy Sanderson says cards and letters recently received are: ZL-2, ZL-3 and ZL-4; HCJB; SEAC for 16 and 19 metres; Denmark 11.80 m.c.; Kuala Lumpur; JKG-2; XGAF; XGOA 17.76, 5.98 m.c.; Trinidad 9.62 m.c.; Norway 15.17 and 9.61 m.c.; Radio Dalat French Indo China 6.18 m.c.; CBLX and Azores.

Mr. Rex Gillett, of Prospect, South Australia, says:

Latest veries to hand are as follows:—Cyprus (11,720) (9650), SUX, Luxembourg (6090), XGOA (9605), "Peer Gynt" (6280), XURA, PLS, Athens (7295), Radio SEU (7117), OLR3A, OLR4A, Singapore (11,880), (11,850), Samarang (11,030), Radio Dakar (11,895), SDB-2, Radio Saigon (11,780), Capetown (5880), ZYN-7, Radio Andorra, CBLX, WRUX (17,755) (11,740), WRUA (9550), WRUS (11,790), WRUN (11,730), HER-7 (1st from Aust.), HER-8 (1st from Aust.), Radio Polskie, Singapore, 7200 test, ZNB, CR7BU, Omdurman (13,320), JKG-2, JKA, Palembang (4855), Algiers (9570), PCJ (21,480), CRGRN, YV5RY, Radio Mediterraneo Valencia, Radio Tirana, Minado (9840).

Mr. Arthur Cushen, Invercargill, New Zealand, reports:

Verifications here include HVJ (9645), Vatican letter, card and schedule from H. Nolan, English announcer; VUD8 (9570), OZH (15,165), HER8 (21,520, 1st N.Z. report), YDQ3 (11,084), W8XAL (6080, propagation transmissions), PHI (21,480), WRUA (17,775), JKG, JKG2, JKA, CR6RF, Munich (6170).

Arthur Cushen, of Invercargill, New Zealand, as usual sends some excellent information. He says:

"Recent reports to KJOY, 8000 kcs., now very much improved to 5.30 a.m. Saturdays, in closing thanks listeners in Australia and New Zealand for reports. Signal every 5 minutes is covered by station JJY, Kemigawa, Japan, the new frequency measurement station, which is also on 4000 kcs. Others written here are Pontianak, 8090 kcs., fair at 9.30 p.m., chimes and news at 10 p.m. ZYC8, 9610 kcs., Rio de Janiero, is very good now, opens at 8 p.m., but at 8.15 p.m. suffers interference from Perth. LRM now good on 6180 kcs. at 8 p.m. now that the U.S. has dropped this frequency, strange Chinese on 6220 kcs. to 9.30 p.m. when blotted out by CE622 opening, HOB (6175), also good opening at 9.30 p.m. Khartoum, Sudan, on 9750 kcs. very good. XEQQ very nice at 1.30 p.m. with English hit parade programme on Sundays. New CBC schedule effective tomorrow is:

Europe, CKNC 12.15-9.05 a.m.; CKCX 12.15-2.28 a.m.; CKCS, 2.30-9.05 a.m.

Caribbean: 9.45-10.25 a.m. on CKRA.

Latin America: CKCX, 9.45-1.35 p.m.; CKRA 10.29 a.m.-1.35 p.m.

UN-Australasia: CKCS and CHOL 2.00-2.40 p.m. Mon. to Friday.

Aust/asia: CHOL, CHLS 6.40-8.35 p.m. Sundays.

BBC reception much better over the past week, due to experimental transmissions, which showed a big increase in strength, especially on 19.16.13 metres, new schedules come into effect on April 10th. Just received a request for special graph

Java Stations

With Indonesia so much in the news the list of stations printed below should be of interest to the short-wave listener.

It comes from Alan Beattie, who received same from Charles Stuart of Radio Batavia. I have varied the order slightly to expedite entry in your register.

YDB	2.24 m.c.	133.9met.	Btvia.
YDB2	4.91	61.10	„
YDB3	7.27	41.26	„
YDE	11.77	25.49	„
YDC	15.15	19.80	„
YDD	2.60	115.4	„
YDD2	4.865	61.66	„
PLB4	10.365	28.94	„
PLB7	11.027	27.27	„
PLF2	19.345	15.51	„
PLD6	17.63	17.02	„
YDA	3.38	88.5	Bandoeng
YDA3	4.945	60.61	„
YDA2	6.17	48.62	„
YDQ	5.03	59.64	Makassar
YDQ2	9.55	31.41	„
YDQ3	11.084	27.06	„
YD12	4.37	68.75	Soerabaja
YD1	3.24	92.59	„
YD14	4.84	61.98	„
YD13	7.295	41.12	„
YDP2	7.21	41.61	Medan
YDL	3.27	91.75	Padang
YDK	4.855	61.79	Palembng
YDH	2.50	120.00	Semarang

and comparison on the past week's reception over general reception here."

Unfortunately I cannot print the exceptionally fine list of loggings sent by Miss Dorothy Sanderson, but the following will be helpful, particularly to the many newcomers to this grand hobby of dx-ing:

TGWA, Gautemala, 9.76 m.c. News in Spanish and good programme of music at 4.45 p.m. The same station but on 15.17 m.c. at 7.30 a.m. is good also.

ZYX-3, Recife, Brazil, 9.56 m.c., has a fair signal at 6.30 a.m., when news in Spanish and music is heard.

PCJ, Hilversum, 21.48 m.c., at 8.45 p.m., give a talk, followed by music.

SBP, Motala, 11.70 m.c. Very good at 11.15 p.m., when talk is usually given.

HEI-5, Berne, 11.71 m.c. Excellent at 5.15 p.m.

Leipzig, 9.73 m.c. News in German at 5.30 p.m.

OIX-4, Denmark, 15.19 m.c. Good programme at 11 p.m. They ask for reports.

PCJ, Hilversum, 15.22 m.c. News in English on Indonesian problems at 8 p.m.

HCJB, Quito, 15.11 m.c. at 9.30 p.m. usual talk and hymns.

HCJB, Quito, 12.45 m.c. Uncle John and the old family Bible session and hymns.

HP5A, Panama News in Spanish at 9.30. Good programme and signal.

International S.W. Stations of U.S.A.

KCBA	15150	19.80	Alaska/Aleu	11.15 a.m.—6.30 p.m.
Delano	6120	49.02	Marianas/Phil.	7 p.m.—12.30 a.m.
KCBF	11810	25.40	Alaska/Aleu.	11.15 a.m.—6.30 p.m.
Delano	9650	31.09	Japan/Korea	7 p.m.—12.30 a.m.
KCBR	15130	19.83	China/Japan	7 p.m.—8.45 p.m.
Delano	6180	48.54	China/Japan	9 p.m.—12.15 a.m.
KGEI	15210	19.72	Mid-Pacific	3.30 p.m.—8.30 p.m.
San Francisco	9700	30.93	Marianas/Phil.	8.45 p.m.—12.30 a.m.
KGEX	11730	25.58	Mid-Pacific	3.30 p.m.—6.45 p.m.
San Francisco	11730	25.58	Phil/E. Indies	7 p.m.—12.15 a.m.
KNBA	15130	19.83	China/Japan	*5.15 p.m.—6.45 p.m.
Dixon	6060	49.50	Hawaii/Aust.	7 p.m.—12.15 a.m.
	21460	13.93	So. Amer.	10 a.m.—Noon
	21460	13.98	Phil.	2 p.m.—2.30 p.m.
KNBI	9650	31.09	Hawaii/Aust.	*5.15 p.m.—6.45 p.m.
Dixon	9750	30.77	Phil/E. Indies	7 p.m.—12.15 a.m.
	11770	25.49	So. Amer.	10 a.m.—Noon
	17800	16.85	Phil.	2 p.m.—2.30 p.m.
KNBX	11790	25.45	Australia	7 p.m.—8.45 p.m.
Dixon	11790	25.49	China/S.E. Asia	9 p.m.—12.15 a.m.
	15250	19.67	So. Amer.	10 a.m.—Noon
	15250	19.67	So. Pacific	3.30 p.m.—6.30 p.m.
KWID	11900	25.21	So. Pacific	3.30 p.m.—9.30 p.m.
San Francisco	9570	31.35	China	10 p.m.—12.15 a.m.
	17760	16.89	S. Amer.	10 a.m.—Noon
KWIX	9570	31.35	Alaska/Aleu.	1.15 p.m.—6.45 p.m.
San Francisco	11860	25.30	Japan/Korea	*5.15 p.m.—6.45 p.m.
KRHO	17800	16.85	China/Phil.	7 p.m.—12.30 p.m.
Honolulu	15250	19.67	China/Phil.	*5.15 p.m.—6.45 p.m.
MANILA	15330	19.57	S.E. Asia	7 p.m.—12.15 a.m.
	11890	25.23	China	7 p.m.—9 p.m.
	11890	25.23	USSR/KOREA	9 p.m.—10 p.m.
	11890	25.23	China	10 p.m.—11 p.m.
	11890	25.23	E. Indies	11 p.m.—12.15 a.m.
	11890	25.23	China	12.15 a.m.—1.15 a.m.

Not on Mondays.

Speedy Query Service

Conducted under the personal supervision of A. G. Hull

T.P. (Northcote) must have been one of the schoolboys we mentioned in a recent story about discounts.

A.—You have gained the wrong impression from the article. We don't want to stop you from getting parts at the best possible price. Our argument was that anyone with technical knowledge enough to know how to use intermediate transformers should get them at trade price. We can only suggest that you re-read the article more carefully, and you will get the right idea.

V.H. (Williamstown) has a set which suddenly started to distort badly, with loss of power.

A.—This sounds like a broken down coupling condenser between the detector plate and the grid of the output valve, but it could be a valve gone dud, or even an electrolytic condenser dried up. Replacing the broken down coupling condenser would be easy enough but we have no clue as to how much practical knowledge you have. If in doubt, it is always best to seek the assistance of some one who knows about these things.

NOTE

There is an error in the circuit of the Third Dimensional Amplifier in this issue. The first filter condenser should be on the rectifier side of the choke.

F.A. (Burwood) is in trouble with the alignment of a Radiola set.

A.—With a well-built factory set it is always safe to assume that the original dial calibrations will be correct, so you can use that as a starting point. Set the dial pointer so that it covers the full sweep of the dial with the full swing of the gang condenser. Then set on 600 Kc. or a station up at that end, and pull the signal into place by adjusting the iron core of the oscillator coil or the padder condenser, according to the type of padding used. Then move down to the high frequency end of the dial and line up the aerial and r.f. circuits, if any. Correct i.f. frequency must be set first of all, of course, in order for the dial to track correctly. All the Radiolas with plated chassis and valve cans have an i.f. at 455 Kc. Older models with blue enamel are 460 Kc.

K.M. (Bairnsdale) has a two-valver which will operate well if he puts a mica condenser across the reaction condenser, but only with a small aerial.

A.—The way the set seems to be too tired to want to oscillate seems to indicate that the valve has just about lost its gallop. If you are quite sure that the coils are in order, with ample turns on the reaction winding and closely coupled to the grid winding, we can only suggest that you use the small aerial or else fit a mica condenser of .0001 mfd. in series in the aerial lead-in. Better still, if you have a small reaction type of midget variable condenser, feed the aerial in through this condenser and adjust it to give you best results and smoothest regeneration. It should have quite a considerable effect on the reaction. Doubt if results ever likely to be 100% with the old valve, and feel sure that you will need to replace it, sooner or later.

B.R. (Albury) has come across an old model set with a 57 type of autodyne converter valve which goes out of oscillation every now and then, sometimes over only part of the broadcast band.

A.—Some other readers with experience with these worries may be able to give you better help than we can about this problem. So far as we know, the only really satisfactory way is to fit a new aerial and oscillator coil and a 2A7 converter valve. New socket and several minor components are required. Check the i.f. channel first to make sure it has normal gain, and that all i.f. trimmers peak. If one doesn't, open it up to see if the trimmer was run back to the oscillator circuit for feedback, as was sometimes done. If so, re-wire the trimmer across the i.f. winding in the normal way and make sure that you do get the peak before going further. Sometimes you can dodge all this worry and expense by fitting a 5,000 ohm pot as a rheostat in place of the 5,000 or 3,000 ohm bias resistor, then adjusting it until the converter will work. However, sometimes it won't work. If any readers have other suggestions, will be pleased to hear from them.

HELP WANTED

Data on disposals valves (English) types VT501 and CV73 is sought by Rev. J. B. Doran, The Presbytery, Lambton, N.S.W. Can any of our readers help?

H.E.D. (Petersham) wants to know why the old American sets of the 1928 era sounded so well.

A.—Actually these sets had a poor high note response, but they were free from harmonic distortion, due to the use of triode output valves and audio amplifiers. Their speakers were heavy, well-energised, with cones having loose suspension on soft leather. Cabinets were solid, with heavy baffle boards, and plenty of weight to stand up to the recoil from the reproduction of low notes. We can sympathise with your client who wants to keep the old-timer in action, and suggest that you suggest a complete re-build to fit a modern tuner, but retain the old audio transformer, speaker and speaker transformer. With triodes in the output stage, you should be able to retain the features of the desired reproduction.

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.

WANTED TO BUY—Cathode ray oscilloscope. 3in. or larger. Price and particulars to 8504, c/o. "Radio World," Box 13, Mornington, Vic.

WANTED—Coil switch unit for AMR200, also dials for above unit. Price, etc., to L. Poynter, 155 Mitchell Street, East Brunswick, N11, Vic.

WANTED TO BUY—Audio oscillator, A.W.A. or similar. Price to 8505, c/o. "Radio World," Box 13, Mornington, Vic.

FOR SALE—Copies of "Radio World," Vol. 7, Sept., 1942, to May, 1943. Vols. 8, 9, 10 and 11 all ,complete (1944, 1945, 1946 1947), price 10/- per volume, or 1/- per copy, plus postage. Miss Sanderson, c/o. Commonwealth Wool and Produce Co., 499 Bourke Street, Melbourne.

FOR SALE.—English "Connoisseur" gramo motor and pick-up, complete with transformer, as new, £18, delivered Melbourne. Write 8502 c/o. "Radio World," Box 13, Mornington, Vic.

RED LINE

TRANSFORMERS OF DISTINCTION

SWINGING CHOKES

The swinging chokes in this section have the same general design and constructional features as the smoothing chokes above. Gap ratios, however, are modified on an incremental inductance bridge to develop large initial inductances, and at the same time to maintain sufficient inductance under full load conditions to comply with the circuit requirements of high efficiency rectifier systems where the maximum possible regulations is required.

ITEM 32 — **Type No. 10255**

Maximum Direct Current, 250mA
D.C. Resistance .... 100 ohms
Voltage Drop .... 25 volts
Swinging L is from 20 hys to 5 hys
Base: 3¾x2⅞x3½in. H. Wt. 5lb. 4oz.
Mntg: V14 .... "S" is 2 in.
Insulation .... 1000 volts

ITEM 33 — **Type No. 5734**

Maximum Direct Current, 300 mA
D.C. Resistance .... 60 ohms
Voltage Drop .... 18 volts
Swinging L is from 15 hys to 4 hys
Base: 4 x 3⅞ x 4in. H. Wt. 7lb. 12oz.
Mntg: Not Shown .... "S" is 2in.

ITEM 40 — **Type No. 60256**

Primary 6v/6v
Secondary .... 250/250v 60 mA
Base: 3 x 2¾ x 2⅛" H. Wt. 2lb. 8oz.
Mntg: V2 .... "S" is 1¼"

ITEM 41 — **Type No. 602512**

Primary 12v/12v
Secondary .... 250/250v 60 mA
Base: 3 x 2¾ x 2⅛" H. Wt. 2lb. 8oz.
Mntg: V2 .... "S" is 1¼"

ITEM 42 — **Type No. 15136**

Primary 6v/6v
Secondary .... 130/130v 15 mA
Base: 3 x2½ x 2⅛" H .... Wt. 2lb.
Mntg: V2 .... "S" is 1"

OUTPUT TRANSFORMERS

The units in this section comprise a useful range of ouput transformers for the sound engineer specialising in amplifiers for public address, "Music - while - you - work," paging systems, etc., where it becomes essential to minimise losses due to the necessary use of multiple speakers at varying distances from the amplifier. They are not "High fidelity" transformers, and are not intended as such. Their frequency response, in all cases, is designed to be plus or minus 2db from 50 cps to 7 K/cs, and particular care has been taken to reduce power insertion losses, which are of considerable importance in this field. Complementary types to match speaker voice coils to line will be listed in the future.

ITEM 43 — **Type No. API**

Primary Z. 5000 ohms .... Plus 29db
6V6 Class A1, 4.5 Watts, DC Max, 50 mA
Secondary Z. .... 500 ohms
Base: 2½ x 2 x 2⅛" H. Wt. 1lb. 8oz.
Mntg: MH1B .... "S" is ⅞"

ITEM 44 — **Type No. OPI**

Primary Z. 5000 ohms .... Plus 29db
6V6 Class A1, 4.5 Watts, DC Max, 50 mA
Sec. Z: 12 ohms tap at 8.4 and 2 ohms
Base: 2½ x 2 x 2⅛" H. Wt. 1lb. 8oz.
Mntg: MH1B .... "S" is ⅞"

ITEM 45 — **Type No. AP2**

Primary Z. 9000 ohms .... Plus 34db
6V6 pp Class AB1 .... 15 watts
Sec. Z: 500 ohms tapped 250 ohm.
Base: 3 x 3⅛ x 2½" H. .... Wt. 3lb.
Mntg: V2 .... "S" is 1½"

ITEM 46 — **Type No. OP2**

Primary Z. 9000 ohms .... Plus 34db
6V6 pp Class AB1 .... 15 watts
Sec. Z: 12 ohms tap at 8.4 and 2 ohms.
Base: 3 x 3⅛ x 2½" H. .... Wt. 3lb.
Mntg: V2 .... "S" is 1½"

ITEM 47 — **Type No. AP3**

Primary Z: 6600 ohms .... plus 37db
6L6 pp. Class AB1 .... or 807's
Sec. Z: 500 ohm, tapped 250 ohm.
Base: 4 x 4¾ x 3¾" H. .... Wt. 6lb.
Mntg: V10 .... "S" is 1½"

ITEM 48. — **Type No. OP3**

Primary Z: 6600 ohms. Plus 39 db
6L6 pp or 807's Class AB1 .... 30 W
Sec. Z: 12 ohms tap at 8.4 and 2 ohms
Base: 4 x 4¾ x 3¾" H. .... Wt. 6lb.
Mntg: V10 .... "S" is 1½"

ITEM 49 — **Type No. AP4**

Primary Z: 2500 ohms Plus 30 db
6L6 (807) Class A, 6W. 72 ma DC
Sec. Z: 500 ohm, tapped 250 ohm.
Base: 3 x 3⅛ x 2½" H. Wt. 3lb.
Mntg: V2 .... "S" is 1½"

ITEM 50 — **Type No. OP4**

Primary Z: 2500 ohms Plus 30 db
6L6 (807) Class A, 6W 72 ma DC
Sec. Z: 12 ohms tap at 8.4 and 2 ohms
Base: 3 x 3⅛ x 2½" H. Wt. 3lb.
Mntg: V2 .... "S" is 1½"

ITEM No. 51 — **Type No. AP5**

Primary Z: 5200 ohms Plus 30 db
809's Class B - 60W - DC Balanced
Sec. Z: 500 ohm, tapped 250 ohm.
Base: 4 x 4½ x 4¼" H Wt. 9 lb.
Mntg: V11 .... "S" is 2⅛"

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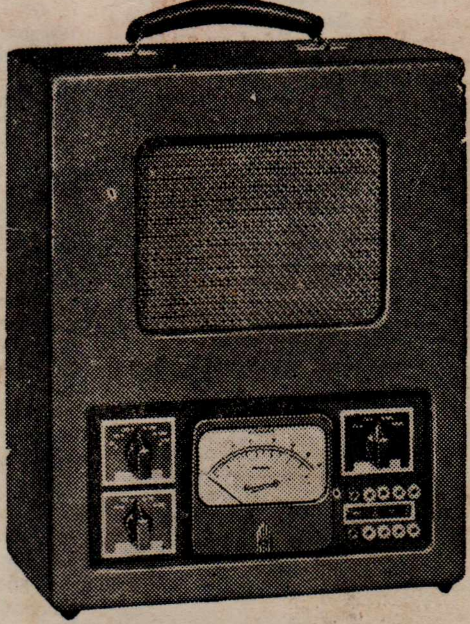

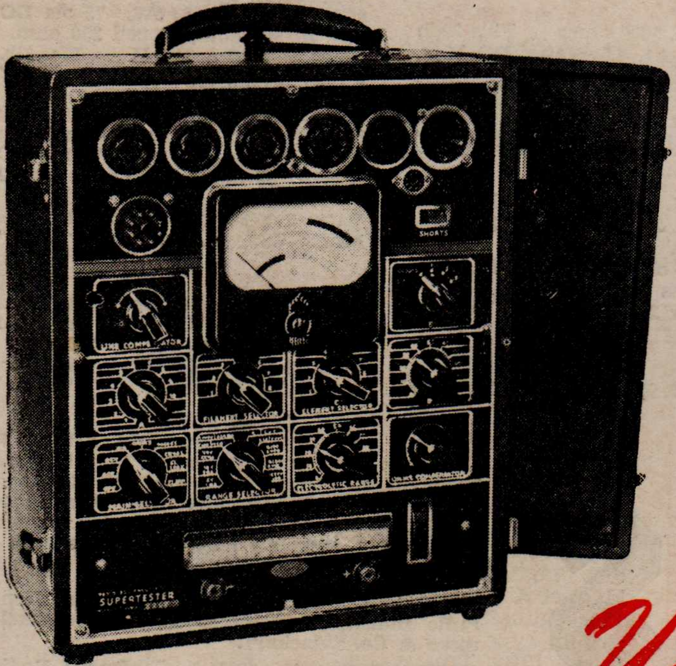

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