THE AUSTRALASIAN

Radio World

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

VOL. 9 ...... NO. 8 JANUARY 15 1945

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★ **Latest—electronic control from spoken words of command.**

★ **Further technical data on the performance of phase-inverters.**

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THE AUSTRALASIAN RADIO WORLD

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ALL-WAVE ALL-WORLD DX NEWS

VOL. 9. JANUARY, 1945. No. 8.

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★ Subscription Rates —

6 issues	5/3
12 issues	10/6
24 issues	£1

Post free to any address.

★ Service Departments —
Back Numbers, 1/- ea. post free
Reply-by-mail Queries, 1/- each

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EDITORIAL

As this is the first issue in the year 1945 it may be permissible to reflect on the problems that have been surmounted in the past and mention the bright prospects for the New Year.

It has been a part of editorial policy to avoid stressing the problems of the times and it has been gratifying to note that our subscribers seem to have appreciated them without our belabouring the subject.

Now, these actual lines are being written in a caravan on Phillip Island, for the holidays. A koala bear is grunting as he nibbles the gum leaves overhead.

The prospects are quite rosy.

Charlie Mutton has recovered from the Amplifier Contest and several articles from his pen are already in the kitty waiting for future issues. Included is a new series on electronics.

From a newcomer, J. G. Du Faur, are some handy articles, too, and there isn't any doubt that these will be highly appreciated. They are of a high standard, like the Du Faur article in this issue.

Enough to make any Editor happy is a fine series of articles on radio theory and fundamentals, written by Charles Aston, already well-known to our readers as a contributor who really can make difficult theory both easy and interesting.

With the paper position easing and the above articles in hand it is clearly evident that 1945 is going to be a happy year for "Radio World" and its readers.

—A. G. HULL.

POWER TRANSFORMERS

How to design and build your own.

■ The average radio enthusiast has a fairly good idea of what a power transformer is and how it functions. However, it is felt that some details of the theory behind these components and methods of their construction in the home workshop may be of interest.

By

J. G. DU FAUR

B.E., A.M.I.R.E. (Aust.)

A power transformer is a piece of equipment by means of which alternating current may be changed from one voltage to another and consists essentially of a laminated steel core a primary winding which is generally tapped for connection to supply mains of various voltages, secondary windings for supplying high tension and filament voltages and the insulation between these components.

The Laminations

The core which is made of thin laminations of special steel (generally silicon steel) acts as a closed magnetic circuit around which the coil windings are formed. If a primary is wound around the core and connected to an a.c. line of suitable voltage, current will flow in this coil and magnetise the core. This current is known as the exciting current.

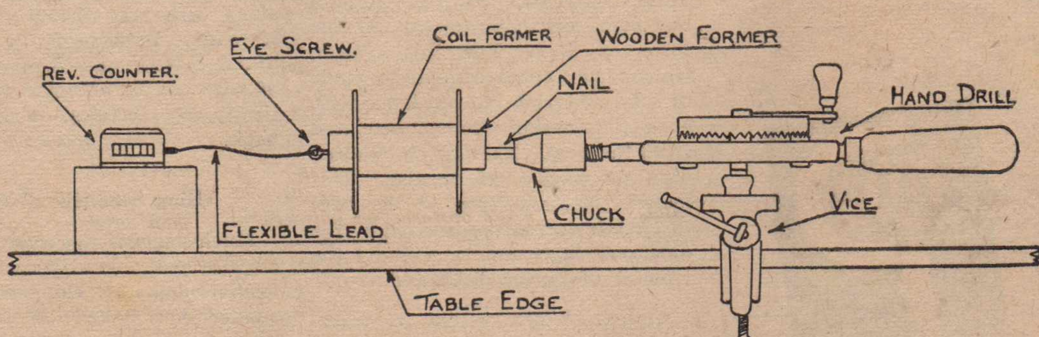
The magnetic flux produced by the exciting current will be of an alternating nature and any turn of wire surrounding the core will have a voltage induced in it by this varying flux. If a second coil (called the secondary) is also wound around the core, it will have a voltage induced in it by the alternating flux produced by the current passing through the primary. The magnitude of the secondary voltage will be proportional to the number of turns on it and inversely proportional to the number of turns on the primary.

When the primary of a transformer is connected to a suitable a.c. supply, the magnetic flux produced, which may be referred to as increasing and decreasing lines of magnetic force in the core, cuts the primary windings twice for every cycle of supply frequency; the flux produces a back voltage in the primary (commonly known as back e.m.f.) which is in direct opposition to the supply voltage.

Core Losses

If the core is made from high quality steel which has only small losses induced in it by the fluctuating magnetisation effect, the back e.m.f. will be almost equal and opposite to the primary applied voltage and thus the current passing through the primary winding will be proportional to the difference of these two voltages. The magnetising current therefore is generally small because in a properly designed transformer little difference exists between the two abovementioned voltages. In the same way as the back e.m.f. is generated in the primary coil, an e.m.f. is also induced in the secondary coil, since it is also cut by the flux established by the primary.

No current can flow in the secondary unless a load such as a re-



Winding Set Up.

Fig. 1

TRANSFORMERS

(Continued)

sistence is placed across its terminals. When a load is applied, current flows through the secondary winding and sets up a further flux which is opposite to that produced by the primary. This causes an overall reduction of flux in the core and thus the amount of current flowing in the primary increases to restore the original flux density caused by the magnetising current. It can therefore be seen that the greater the current drawn from the secondary winding, the greater will be the current which flows in the primary.

Steel cores will only carry a limited amount of magnetic flux and if the flux density is increased beyond a certain point, saturation occurs. With this condition, the core is conducting all the flux it is able to carry and the number of magnetic lines of force cannot be further increased.

Various losses occur in all transformers—these are of three main types—eddy current, copper and hysterisis losses.

Reason for Lamination

Eddy current losses appear as heat in the steel core and are caused by magnetic lines of flux cutting the core and producing currents in it as the core tends to act as a short circuited coil of one turn. These currents, flowing through the core, dissipate energy in the form of heat. For this reason, transformer cores cannot be made of solid material, but are laminated, each lamination being insulated from the next, either by an oxidised film, or a coat of varnish. This makes the resistance of the core to electric currents generated by the flux very high and thus limits the amount of power dissipated.

Copper losses within a transformer also appear in the form of heat and are simply caused by the current flowing through the resistence of the windings.

These losses are, in both cases, the product of the current in amps. squared, multiplied by the resistence concerned in ohms and are measured in watts. To minimise copper losses, it is necessary that the length of windings be as small as possible and that the wires used be as large in cross section as practicable so as to minimise the resistence.

Hysterisis losses in the core result from the fact that energy is required to carry iron or steel through cycles of magnetisation. They may be minimised by a careful selection of the type of material used for the fabrication of the core.

Obtaining Material

As it is now difficult for set builders to obtain power transformers, it is proposed to give practical details of how to make these components at home. The process is a rather long and tedious one, but very efficient units can be accomplished if sufficient time and care is taken.

The first matter for consideration is where to obtain the necessary wire, laminations and insulation.

Secondhand wire is generally not difficult to procure, as most radio shops can supply limited quantities, either enamel or cotton insulated. The main difficulty is that shops are often unable to tell the buyer the accurate guage of the scrap wire they have to sell and it is therefore advisable, if possible, to borrow a micrometer and take this along with you when the purchase is made. Details of the diameter of all S.W.G. and B. & S. gauges of wire can be obtained from practically any electrical or radio handbook.

Using Secondhand Wire

Much secondhand enamel covered wire available at present has the insulation badly chipped and the enamel has flaked off in various places. This wire is very unsatisfactory for winding transformers in that, if a short circuit occurs between two adjacent turns, the unit will overheat and be quite useless in practice. Therefore, when buying enamel covered wire, make sure that the insulation is in good condition. Cotton and silk covered wires, if obtainable, are less susceptible to this trouble, but as their covering is considerably thicker than enamel, difficulty may be experienced in putting the required number of turns around the core in the space available.

Salvage Cores

Laminations may be easily obtained by purchasing a burnt out power transformer — these are readily available from secondhand wireless shops at a small cost. If you are able to procure a transformer in which the primary winding is intact, this will be an advantage; in this case only new secondary windings need be provided, as in practically all cases the primary is closest to the core. However, since windings on commercial transformers are all put on by machinery, difficulty is always experienced in replacing as many turns as can be taken off. For this reason, it is advisable to purchase a core which is considerably larger than the type used in a commercially built transformer of the size and specification which it is desired to make.

Let us assume that a burnt out unit has been procured and that, as is generally the case, its primary winding is broken, thus rendering the whole unit useless. In this case, the laminations should be taken out and put on one side. Then proceed to unwind the wire and put in on to reels, as it may be handy later on. When all the wire has been taken off, a cardboard or processed paper former, hereafter referred to as the "coil former," will remain. A piece of wood which will tightly and completely fit inside this former should now be made, its length being two or three times that of the former (see fig. 1). A nail, preferably 2in. or 3in. long and at least ¼in. diameter should be driven into the dead centre of this piece of wood in such a manner that it lies along the axis of the former. The head of the nail is now cut off with a hacksaw so that the remaining shaft will fit tightly into the chuck of an ordinary hand drill (see fig. 1.).

Next procure two square pieces of thick cardboard to act as sides and cut holes in their centres so that they fit snugly over the ends of the coil former. These should be just small enough in overall length to allow the core laminations to be assembled over them, without touching. The sides should be fitted and glued to the ends of the former and the whole assembly set up in a vice (as shown in fig. 1). The core former can now be made to rotate uniformly by turning the drill handle at a pace which will enable the windings to be applied fairly quickly.

Rev. Counter Desirable

If possible, a revolution counter should be procured and connected by means of a piece of flexible wire to the rotating former so that the

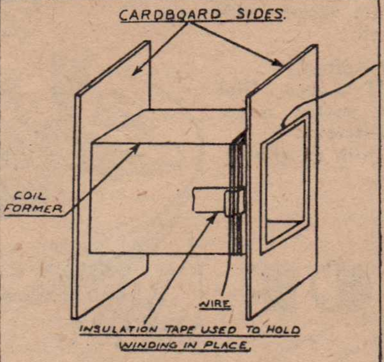
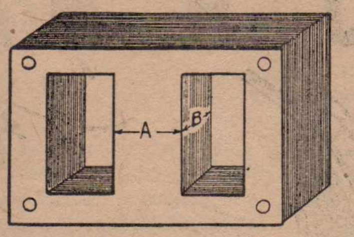


Fig 2.

number of turns wound will be registered. If a revolution counter cannot be obtained, one can often be purchased cheaply in an electrical junk shop as part of an old watt-hour meter. If no rev. counter is available, it is necessary to count the windings as they are applied and this becomes tedious in cases where the number of turns exceeds a few hundred, not to mention the fact that if the count is lost, one must start all over again.

It is now proposed to give simple details of how to determine the number of turns and the most suitable gauge of wire for each winding.

Having selected a laminated core, determine its total cross sec-



LAMINATED STEEL CORE.
CORE AREA = A" x B" SQ. IN.

Fig 3

tional area. This is the area of the middle leg of the core which is generally equal to twice the area of each outside leg (refer fig. 3). It should be at least 1¼ square inches, as any reduction in core size below this value will be poor economy, necessitating an increase in the number of turns on every winding.

The number of turns for the primary is determined solely by the core area and can be calculated from the following equation:—

$$\text{Primary turns} = \frac{5.8 \times \text{Primary Supply Voltage}}{\text{Core area in square inches.}}$$

Thus, if the core area is 1¼ sq. inches and the supply 230 volts, the primary turns will be 1069. If a highly efficient power transformer capable of producing good wave form is required, the number of primary turns may be increased by approximately 20 per cent. The above formula assumes that the frequency of the supply is 50 cycles per second.

The number of turns for each secondary winding is determined as follows:—

$$\text{Secondary turns} = \frac{\text{Primary turns} \times \text{secondary volts} \times 1.05}{\text{Primary volts}}$$

This formula assumes that 5 per cent additional turns are required on each secondary to allow for voltage drop in the winding when the load is applied and will be found to work out quite well in practice.

To determine the gauge of wire

(Continued on next page)

TRANSFORMERS

(Continued)

required for each winding, it is first of all necessary to know the current which will flow.

With regard to the primary, the current can be determined as follows:—

$$\text{Current in primary} = \frac{1.25 \times \text{Secondary volts} \times \text{Secondary amps.}}{\text{Primary supply voltage.}}$$

The factor of 1.25 allows for eddy current, hysterisis and primary magnetising current losses.

If there is more than one secondary winding, the product of the amps and volts required from each of these windings will have to be determined and their total sum found. The current in the primary will then be equal to this figure, multiplied by 1.25 and divided by the primary supply voltage.

Calculating Gauges

Having ascertained the primary current, the correct guage of wire to use is deducted from the table in the text. In practice it is not advisable to use wires thinner than 38 SWG, as these are too easy to break when winding by hand. The gauge of wire used is not critical and may be anything equal to or thicker than the recommended size shown in the table. In any particular instance, the thicker the wire used, the better will be the regulation of the winding and the lower will be the losses caused by current flowing through it. However, it is desirable to use the sizes recommended as if larger wire is used, difficulty may be experienced in fitting the necessary number of turns into the space available.

When the current flowing in each secondary winding is known, the correct gauges of wire for these windings can also be determined from the table. The figures shown are based on the assumption that all windings are capable of carrying one ampere per 1,200 circular mills of cross sectional area of wire.

If a centre tapped high tension

secondary winding is desired for supplying a full wave rectifier, the current in each half of this winding is 0.78 times the rectified D.C. current; in a winding required to supply high tension to a half wave rectifier, the current is 1.58 times the D.C. output current. These factors must be taken into account when deciding the correct gauge of wire to use for high tension secondaries.

When sufficient of the correct gauge of wire for the primary winding has been obtained, a hole should be made with a pin through one of the cardboard sides of the coil former and the end of the wire pushed through from the inside (see fig. 2).

Insulating Core

Before starting to wind the primary coil, which is generally applied first, it may be advisable to wrap a layer of friction tape around the original coil former if this is not in good condition and will not act as satisfactory insulation alone between the primary and the steel core of the transformer. This insulation should be at least 3/32in. thick and before the winding procedure is started, it should be made absolutely certain that the windings will not in any way contact the steel laminations when they are later fitted.

Primary Winding

We can now commence to wind the primary coil by turning the drill handle and guiding the wire uniformly on to the coil former as it rotates; the wire should be kept taut so that the winding occupies a minimum of space. It should commence directly at one end of the former and be applied uniformly over the surface, care being taken that no turns fall on top of one another. When a complete layer has been finished, a piece of heavy brown paper should be cut the width of the layer and wrapped around it for insulation purposes before proceeding to wind the second layer back over the first. This brown paper should be coated with shellac after it is aplied, the varnish improving its insulation properties and helping to hold it in place.

The above procedure is continued until the total number of turns required for the primary windings have been completed, when the wire is cut and a further hole made through the cardboard side of the former through which it is inserted, thus holding the winding tight.

Primary Tappings

If it is desired to make tappings on the primary winding so that the transformer can be used on different supply voltages, external wires must be soldered to the winding at the apropriate number of turns and brought out through the cardboard side in the same manner as the ends of the coil are treated. Any flux remaining after the soldering has been completed must be cleaned off before proceeding further with the winding. At any place where a tapping or joint is made, this should be wrapped with two thicknesses of brown paper to act as insulation for the connection.

When the primary is finished, at least three layers of friction tape or alternatively seven or eight layers of brown paper are wound over it before any attempt is made to start winding the secondaries. The thickness of the insulation between the primary and secondary windings is most important and the constructor should not proceed with the secondaries unless he is thoroughly satisfied that adequate insulation exists between the two windings, as the primary is connected to the supply mains and therefore, lack of insulation between it and the secondary can be exceedingly dangerous. A break down between these two windings may place the chassis in which the transformer is to be used in direct connection with the mains.

Secondary Windings

All the secondary windings required can be applied in the same manner as described above, sufficient insulation being applied between each.

Some difficulty may be experienced in tightly applying the heater windings, as they are generally made of heavy gauge wire. This may be easily overcome by looping a piece of friction tape around the first turn of a coil and then winding on the following turns so that they are applied over the tape and thus hold the coil in place (see fig. 2). The end of each coil is held in position by applying a layer of friction tape over it.

Insulation

The thickness of the insulation between windings is determined by the peak voltages existing between them. The resistance between the high tension secondary (if there is one) and filament windings has to be high, as five or six hundred peak volts may exist between them. Filament windings alone, being of low voltage only, require a minimum of external insulation, with the exception of the rectifier heater winding which is normally at a high poential above earth.

When the windings have been completed, the laminated core may be assembled around them and bolted together; care being taken to see that the core does not touch any of the outside windings. Preferably a layer of insulation should be wrapped around the outside coils before the laminations are assembled.

After assembly, it is advisable to dry the transformer out in a very low oven for a few hours, particularly if it still contains wet shellac on the brown paper insulation between the windings. This drying out procedure will often raise to a considerable extent the insulation properties of the unit.

When the transformer is finished,

(Continued on next page)

ELECTRONIC PHOSPHORS

The war has accelerated research in the field of phosphorescents, the tiny crystals which convert invisible radiations to visible light. Some phosphors are so sensitive that currents smaller than one hundred-millionth of an ampere will excite descernible luminescence, whereas similar materials in coatings as thin as tissue paper can withstand high-voltage electron bombardment of sufficient intensity to crack an underlying Pyrex glass disc. Practical applications of phosphors are found in television kinescopes, fluroescent lamps, oscilloscopes and "magic eye" tuning indicators.

TRANSFORMERS

(Continued)

it is most desirable that insulation tests be carried out before connecting it to the mains. An ordinary multimeter may be used for this purpose; the highest ohms scale should be used and the insulation resistance checked between each winding and the steel core. If the insulation is satisfactory, these resistance values will be so large that the meter will not indicate other than an open circuit. The resistance between windings and the core should be at least five megohms, but most commercial multimeters are incapable of reading as high as this figure.

It is generally not necessary to make a terminal board for mounting to a home-made transformer, as the ends of the windings can be soldered directly to the valve sockets in the set or test equipment in which the unit is to be used. It is advisable to cover the leads from the transformer with spaghetti insulation which should be pushed well up into the winding so that shorting cannot posibly occur between the leads and the chassis where the transformer is mounted to it.

If a terminal board is required for the sake of neatness, the one belonging to the original burnt out unit can be re-used and mounted in the same way as before or, alternatively, a new terminal strip can be made up from a piece of thin bakelite with soldering lugs rivetted to it at appropriate distances around the edge.

Not for Audios

A word of warning! Do not imagine it is easy to wind a satisfactory audio transformer merely using the data given in this article. Good audio transformers are very difficult things to make and precise details of the permeability and flux density of the core material under various conditions are necessary before a satisfactory unit can even be designed.

Once again, as the wire used in these units is generally very fine and many thousands of turns are required, they are horrible things to attempt to make by hand. Practically any radio shop is able to supply new or second-hand audio transformers for a few shillings, which will probably be much more satisfactory than a home-made unit.

S.W.G. Wire Gauge	Nearest equivalent B. & S. Wire Gauge	Maximum R.M.S. Current permissible in winding
14	12	5.4 amps.
16	14	3.4 „
18	16	1.9 „
20	19	1.1 „
22	21	0.65 „
24	23	0.40 „
26	25	0.27 „
28	27	0.18 „
30	28	128 m.a.
32	29	97 „
34	31	71 „
36	32	48 „
38	34	30 „

Table showing current carrying capacity of wires for transformer winding.

Tales of Phase Inverters

The past history of resistance-coupled push-pulls.

■ In a recent issue we published some observations about phase inverters in general and about the A504 (Radiotron) circuit in particular. In this article our contributor expressed his opinion that the type of phase inverter used in this circuit was not as good as it should be. His remarks have drawn a reply from the Amalgamated Wireless Valve Company Pty. Ltd., and the reply is published in full on another page in this issue.

By

A. G. HULL

TALK of phase-changers brings back memories to the writer, almost to a sentimental degree, and so these words on phase inverters in general have been written.

Going back to 1928 or so, the keen radio enthusiasts of the day discovered push-pull, and found what could be done with the big 210, 250 and 245 type valves which had been introduced shortly before that date. Almost in every case a push-pull audio transformer was used and the merit of the Ferranti AF5C was duly appreciated. Few people of the time ever imagined that there could be such a thing as push-pull without an audio transformer. The years rolled by. About 1931 there was a visitor to Australia, a famous English radio engineer, Captain Eckersley, who was a keen exponent of a plan to re-introduce long waves (1,000 to 2,000 metres) for Australian broadcasting.

Use Long Waves

The Eckersley plan did not meet with official approval and the use of long waves does not appear to have been thought about since. This may or may not have been a wise move, and there are some old-timers who still say that long waves are the only way to ensure good country service in daylight. Whilst the Parliamentary Committee on Broadcasting is so active it should try to get a copy of the pamphlet on the Eckersley plan which was published at the time of his visit. If television and frequency modulation systems are to be sponsored we might as well have long-wave broadcasting as well!

Which is slightly beside the point.

At an interview Eckersley let drop that his home set had a paraphase audio system. At the time I was technical editor of "Wireless Weekly" but had only the vaguest idea of what "paraphase" meant, in fact, I probably thought that Eckersley said "paraphRase," but I rushed off and got to work in the lab., and, in due course, appeared a super-technical article on how to build "Eckersley's Own." I mention all this because it was my first encounter with push-pull, other than from an audio transformer.

Paraphase amplifiers did not get far at that time, but at least an inquisitiveness was aroused, and a wistful eye was kept open for anything to do with ways and means of dodging the expensive audio transformers normally associated with push-pull output.

Some time in 1932 an article on cathode drive was noticed in an overseas magazine and although it did not deal directly with push-pull it gave me an inspiration and I tried out a set with a pair of push-pull pentodes, driving one from the plate circuit and the other from the cathode circuit of the detector. Results were mighty good to the ear, and I was extremely elated for a short time, but just couldn't realise that I had stumbled across something of great interest.

Theory Adrift

Trying to convince myself that it really was push-pull, I shorted one of the output grids to earth, and when this failed to cut back the performance by fifty per cent. I made the fatal mistake of presuming that it was not really pushing and pulling. The "Barnes" mystery circuit came later.

So the "1933 Standard" as it

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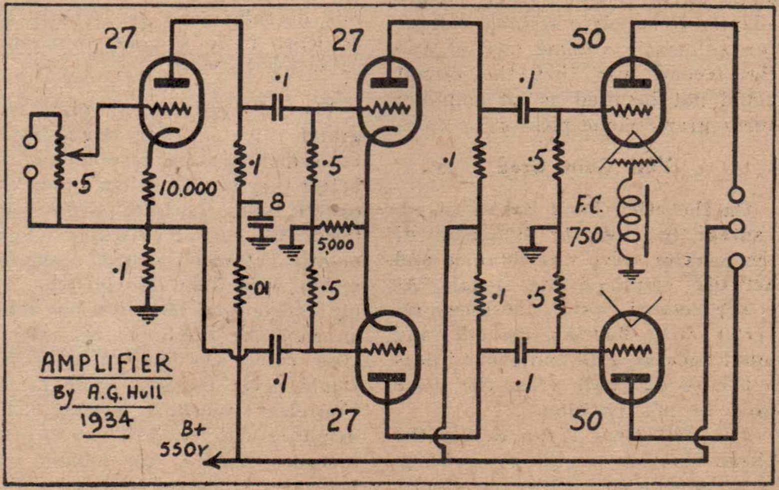


PHASE INVERTERS

(Continued)

became known, remained on the bench for many months before I had sufficient courage to release it publicly.

Actually the release came about through a visit by Mr. E. H. Scott, from Chicago. Mr. Scott is a millionaire who makes the world's most expensive receivers. He was in Sydney on a visit and I had been showing him the lookout from Bulli Pass and so on, and eventually invited him to come out home and hear the "freak." Mr. Scott was greatly impressed and I was sufficiently encouraged to make the splash which brought the "Standard" into the limelight. It was an extremely popular set for home builders and enthusiasts. Just how popular I never really knew until a few weeks ago when a coil manufacturer happened to tell me that he sold 12,000 kits of coils for the Standard in the first two months after the circuit was published.

Floating Input

The "Standard" circuit used a phase inverter of somewhat similar type to the one under discussion elsewhere in this issue, but with a major difference. In my "Standard" circuit I applied the input between grid and cathode, not between grid and earth. This was possible with the diode-biassed detector circuit, but had two big drawbacks which eventually resulted in its loss of popularity. The first was that the diode circuit could not be readily adapted to supply a suitable voltage for automatic volume control and the second was that the circuit could not be used as an amplifier for a gramophone pick-up.

Full Gain Used

On the other hand it had an advantage in that the full gain of the inverter valve was obtained and actually amplified the signal. As is appreciated to-day, the phase inverter with floating cathode and input between grid and ground does not have any gain from the valve used in this position.

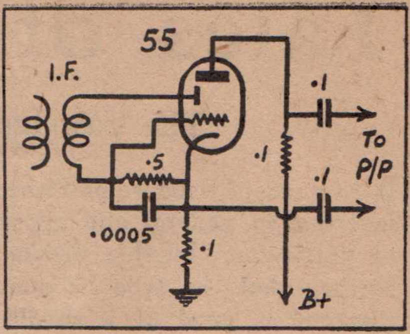
The first time I ran across the phase inverter of the type which later became so popular in circuits such as the A504, was at the amplifier championship which I conducted on behalf of "Wireless Weekly," in 1934. The winning amplifier had a pair of big 550 volt pentodes in the output stage, driven from a phase-changer. A comparitively narrow band of audio frequencies was handled, but it was backed by plenty of power and most of the distortion was lopped off with the lopping of the highs. The lows were fairly well lopped to balance and the nett result more satisfactory than you might expect, although you've probably guessed as much, for the amplifier was the ultimate winner of the championship and received much commendation from both technical and musical judges as well as those enthusiasts who comprised the audience.

After all, it takes a lot of distortion to grate on some people's nerves. Not that such a statement should be taken as my comment in this latest phase-changer controversy.

A Quality Amplifier

The next milestone in the phase inverter business as it concerned me, was in 1934 when I built up an amplifier using a pair of 50 type output triodes, driven by a pair of 27's and these driven by a phase inverter, the whole rig being resistance coupled throughout. This amplifier sounds good to me and I was not surprised to find, on having it tested at the Lekmek Laboratories, that it was flat from 30 to 20,000 cycles within half a decibel. As mentioned in last month's issue, this doesn't mean everything, but at least it is a good foundation on which to work.

The 50 type output valve is a grand valve in every way, too. I remember in this case how much better they sounded than either 2A3 or 45 types, both of these being tried in similar circuits. Some months before I had been discussing valves with John Moyle, who was my assistant at the time and I had an emphatic statement that the 50 type valve was out of date and would never be used again in any "Wireless Weekly" circuit. The amplifier with the 50's was so good, however, that I ate humble pie, made my apologies to John, and so



Detector circuit of the original "1933 Standard"

the circuit was published as a Hi-Fi Amplifier of 1934.

Input to the phase-changer was again between grid and cathode, not grid and earth. This meant that neither side of the pick-up could be earthed, and precautions had to be taken to avoid hum trouble. The use of half meg grid leaks in the grid circuits of the 50 type valves brought down the wrath of the valve importers, who stated that this was against the recommendation of the makers. In practice I found that the valves did not appear to mind the high grid resistance, although I took care to see that filament voltage was correct and that no parasitics were around to cause any overloading. The valves in the original amplifier served me for a couple of years and then I sold the outfit when I left Sydney on a world trip. So far as I know it is still going strong. The above reminiscences are all to do with the inverter with the input signal "floating" above earth potential, and I have not had more than passing experience with the type of inverter used in the A504. Consequently I do not wish to become too involved in the present controversy.

I am a great believer in the corelation of laboratory work with practical listening and as a final check on any laboratory work I like to test any set or amplifier under actual listening conditions. I have come across some horrible examples of mis-applied theories in the past and I think the worthy Flight/Sergeant took a big risk when he made such sweeping state-

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IN DEFENCE OF "A504"

■ From the Amalgamated Wireless Valve Co. Pty. Ltd. comes this comprehensive coverage of the subject of phase-inverters and their performance

IN the issue of November 15th there appeared a contributed article entitled "Research into Phase-Changers" which refers to Radiotron Circuit A504 which we feel might lead some of the readers of the "Australasian Radio World" to make incorrect inferences regarding the phase-splitting circuit. This type of circuit is, of course, quite an old one but it has been very well tried out over a number of years and its popularity during recent years in U.S.A. has been marked, particularly in view of the earlier American preference for the twin triode circuit which the writer of the article recommends. This twin triode circuit is capable of giving quite good results when correctly adjusted but it requires accurate adjustment of the tapping which feeds the grid of the second half of the twin valve. Unless this adjustment is made accurately the two sides of the push-pull amplifier will be out of balance. If an attempt is made to use fixed resistors in the form of a voltage divider in place of a variable adjustment, there will be cases when the mismatching of the two halves of the twin triode valve is sufficient to cause noticeable unbalance. It is for this reason, together with some other minor disadvantages which need not be stressed here, that this circuit is not recommended by us for use by the average home constructor.

Inherent Balance

The phase splitter with equal plate and cathode load resistances is inherently balanced and does not require any adjustment beyond ensuring that the two resistors are true to label. In circuit A504 it will be seen that these two resistors each have a resistance of .05 megohm while a further resistor of 5,000 ohms is used to provide grid bias. This grid bias resistor does not affect the balance between cathode and plate sections of the load since the grid of the second 6V6-G output valve is fed from the junction of the .05 megohm cathode resistor and the 5,000 ohm cathode bias resistor. It would have been possible to take the second 6V6-G directly from the cathode of the phase splitter valve, but in this case the load resistance would have had to be reduced to .045 megohm so that the whole resistance between earth and the point from which the tapping is taken off to the following grid is .05 megohm. In passing, the cathode bias resistor may be calculated by dividing the whole load restance (in this case .1 megohm) by the amplification factor of the valve (in this case 20, giving a cathode bias resistor of 5,000 ohms).

Balanced Loads

This type of phase splitter irrespective of the circuit in which it is used, is inherently self balancing since the current that flows through the cathode load resistor is the same as the current that flows through the plate load resistor (assuming that no grid current is flowing) and the audio voltages across each section of the load are, by Ohms Law, equal to the current multiplied by the resistance. We thus have a delightful type of phase splitter which is as nearly fool-proof as any circuit could be. Its inherent balance between the two sides of the push-pull amplifier is due only to the values of these two resistances and is not in any way affected by the valve which is used. Any type of triode valve, or pentode connected as a triode, may be used in this position with satisfaction provided that the necessary adjustment is made to the cathode bias resistor. A general purpose valve having an amplification factor of about 20 is therefore more desirable than one having a very high or a very low amplification factor. A valve with a very high amplification factor has a limited grid swing and limited plate swing and may overload when used to drive a final stage having a high grid bias, such as a triode valve. In any case, even apart from this divider, there is very little point gained by increasing the amplification factor above about 20. A valve having a very low amplification factor (e.g. 6F6-G triode or 6V6-G triode) is less desirable since the reduction of distortion is due to negative feedback which is reduced by the reduction in amplification factor, so that the distortion would be slightly

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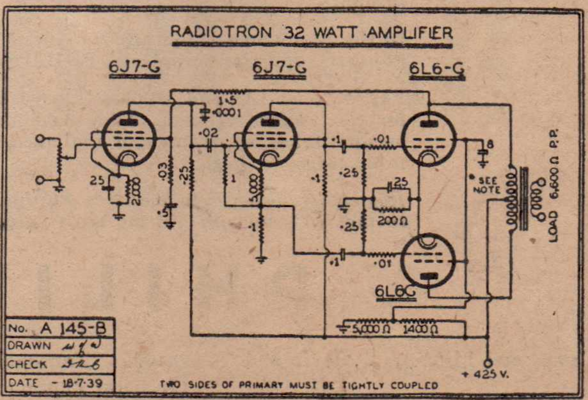
Another circuit from A.W.V., using the balanced phase inverter — the A145B.



A504

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higher than with a higher amplification factor. There are, however, cases in which it is necessary to use a valve with a low amplification factor, e.g., when it is required to operate power valves having a very low resistance between grid and filament, such as types 2A3 or 50 on fixed bias.

Good Features

This flexibility regarding the choice of a suitable valve, and the fact that the balance is independent of the valve are very strong reasons for the use of such a circuit provided that it gives equivalent performance. The theoretical analysis of such a phase splitter is rather complicated and only the results will be referred to here. The input resistance is much higher than that for an ordinary amplifying stage and is something like 10 times the resistance of the grid resistor. With a grid resistor of 1 megohm, as in circuit A504, the input resistance would be about 10 megohms. This beneficially affects the bass response for a given size of coupling condenser from the preceding stage. The whole stage is "hot" and any attempt to measure voltages across either cathode or plate sections of the load resistance is likely to cause error, even when a valve volt-meter is used. The preferred method of checking balance is either through measuring the grid current with a micro-ammeter, or in the plate circuit using two separate transformers or chokes in place of a centre tapped transformer.

A capacitance connected between the cathode of the phase splitter and earth has the effect of causing treble boosting in this side of the amplifier, and even the very small capacitance between cathode and heater is sufficient to give a slight amount of treble boost which causes a slight degree of unbalance, at high audio frequencies only, between the two sides of the push-pull stage. This small unbalance, which occurs at high frequencies only, is of no practical importance since the power handled at these frequencies is so small that the distortion is negligible in any case; one half of the amplifier could easily handle the full output at these frequencies even if the other half became inoperative.

Improved Highs

This tendency towards treble boosting has been used as a method of providing a "treble boost" form of tone control which has been described in overseas periodicals. Even the large amount of unbalance brought about by a fairly large capacitance between cathode and earth is not sufficient to result in any practical increase in distortion over the whole amplifier.

With Feedback

A further feature of the phase splitter is that the output impedance of the cathode section of the load resistance is different from that of the plate section of the load resistance. This is brought about by the negative feedback and those who have studied this subject will appreciate that the cathode section is subject to negative voltage feedback while the plate section is subject to negative current feedback. The actual formulae for the output resistance across these two sections of the load resistance are given on page 45 of the Radiotron Designers Handbook under the heading "Editor's Note" (recent impressions only). From the description given in your article, it seems likely that the 6V6-G valves were unstable

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right from the beginning of the experiment and although this instability was cured by the insertion of 50,000 ohm grid stoppers, nothing was said to indicate that the same method was tried with the A504 type of phase splitter. It is quite type of phase splitter. With any possible that the instability in the output valves was the cause of the "pip" on the peak of the wave form instead of being the result of the type of amplifier, and particularly with one incorporatiing negative feedback, it is highly desirable to keep the leads between the two plates and the output transformer as short as possible.

Percentage Feedback

A further point is in regard to the percentage of feedback used. This percentage is proportional, not only to the ratio of the voltage divider resistances in the feedback circuit but also to the voltage gain between the point to which the voltage is fed back and the point on the output stage from which the feedback voltage is taken. In the case of circuit A504 the gain in the phase splitting stage is slightly less than unity whereas in the amplifier using a twin triode the gain is approximately (23) times in this stage. This amplifier therefore has a very much higher degree of negative feedback than that used in circuit A504. The reason why a higher degree of negative feed back was not used in circuit A504 was in order to make possible the use of a conventional type of magnetic pick-up. Any increased percentage of feedback would make it necessary to use a pre-amplifier with all but the most sensitive types of pick-up.

DISTORTION

For perfect reproduction the sound issuing from the loudspeaker should be an aural replica of the sounds in the studio. When this fails to happen as judged by a critical ear, or by the movements of tell-tale meter needles inserted at correct positions in the power feeds, distortion is occurring.

Contrary to popular belief, the high-frequency portion of the circuit is often the cause of more distortion than the low-frequency side. The introduction of so many high-powered broadcasting stations has made the question of selectivity rather an acute one.

PHASE INVERTERS

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ments after a few looks at an oscilloscope hitched up to a single example of a phase inverter. There will always be the doubt that the true fault was something in the way of a "dud" valve or other component.

THE TELECHROME

■ The Telechrome, Mr. J. L. Baird's latest invention, eleminates the revolving discs and lenses previously necessary for colour and stereoscopic television.

THE colour and stereoscopic pictures now appear directly upon the screen of the cathode ray tube, so that colour and stereo television can now be received on apparatus as silent and efficient as the pre-war black and white receivers.

The Telechrome differs from the black and white cathode ray tube in having two cathode ray beams and a transparent double-sided screen. The front of the screen being coloured blue-green and the back red, one cathode ray beam produces a blue-green picture on the front surface, the other a red picture on the back surface, the two blending to give a picture in natural colour.

Coloured Glasses Used

For stereoscopic viewing coloured glasses are used, the left and right eye pictures corresponding to the left and right eye images (a principle well known in the cinema). Stereo television without the use of glasses has been demonstrated by Mr. Baird, but this is still at too early a stage to be practically applied.

Britain is well ahead in the field of colour and stereoscopic television. Both are British inventions and were shown for the first time by Baird in 1928.

Stereoscopic television is unique to this country and has never been demonstrated abroad, while the only colour demonstration staged in U.S.A. employ Baird's original revolving disc system.

Television in colour has previously been accomplished by three methods. In the first demonstration of colour television revolving discs were used by Mr. Baird to accomplish the scanning and also supply the colour component. In his second method the scanning was done by the cathode ray tube and the colour supplied by a revolving colour disc. In his third method images produced side by side on the face of a cathode ray tube were coloured by stationary colour filters and superimposed by projection upon a viewing screen.

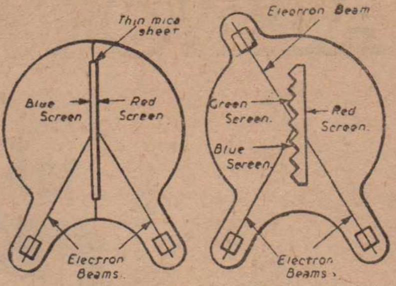
No Moving Parts

Of these methods the first two come within the category of mechanical systems.

The third, which requires no moving parts, might be best described as an electro-optical system, as the colour is added to the image by optical means. This system has the very considerable disadvantage that the fluorescent screen cannot be viewed directly, the coloured image being obtained by projection, which involves a substantial loss of light.

The present system is entirely electronic, the coloured image appearing directly upon the fluorescent screen—two cathode ray beams being required for a two-colour system and three for a three-colour system. These cathode ray beams are modulated by the incoming signals corresponding to the primary colour picture and impinge upon superimposed screens coated with fluorescent powders of the appropriate colours. For example, in a two-colour system the two cathode ray beams scan the opposite sides of a thin plate of transparent mica, one side of which has been coated with orange-red fluorescent powder and the other with blue-green fluorescent powder. Thus the screen has formed upon its front face an image containing the orange-red colour components and on its back face an image containing the blue-green components; these images are superimposed and thus give a picture in natural colour. (See Fig. 2.)

Where three colours are to be used the back screen is ridged and a third cathode ray beam added, the front face of the screen giving the red component, one side of the back ridges giving the green components and the other sides of the ridges the blue component. (See Fig. 3.)



Figs. 2 and 3.—Diagrams of the new tubes for colour and stereoscopic television.

A two-sided tube has been developed and will be shown receiving a picture from a 600-line triple interlaced moving spot transmitter using a cathode ray tube in combination with a revolving disc with orange-red and blue-green filters. The receiving cathode ray tube is shown in the diagram (Fig. 2). The screen is a 10in. diameter disc of thin mica coated on one side with blue-green fluorescent powder and on the other with orange-red fluorescent powder. (The colour may alternatively be provided for the back screen by using a white powder and colouring the mica itself.)

Two-way Tube

The tube shown in Fig. 2 may be viewed from both back and front, but if used in this way one set of viewers see a mirror image, also coloured mica must not be used, and a filter has to be inserted between the back viewers and the tube to keep the colour values correct and compensate for the light lost in the mica and fluorescent powder when the direction of viewing is reversed.

Another type of tube can only be viewed from the front, but having one cathode ray beam perpendicular to the screen simplifies the set-up of the apparatus. The tubes give a very bright picture, due to the absence of colour filters and the fact that special powders are used giving only the desired colours which are seen additively.

The tubes give excellent stereoscopic television images when used with a stereoscopic transmitter.

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FACTORS IN HIGH FIDELITY

■ In the past, many articles have been written in both highly technical and popular radio magazines regarding the subject of high fidelity reproduction.

THOUSANDS of radio amateurs have built amplifiers and radio receivers, each of them endeavouring to obtain perfect reproduction of recordings and radio reception. At the same time, engineers at radio factories have spent long hours perfecting the receivers which their companies manufacture with a view to incorporating small improvements which add to the attraction of their sets insofar as the sound which they reproduce is concerned.

A Definition

The question is—what is high fidelity, and what does this term mean to the average listener, the person who takes an interest in every day radio programmes?

It has been stated authoritatively that a high fidelity piece of sound equipment is that which is capable of uniformly reproducing sound waves within one continuous spectrum in which the product of the lowest and highest frequencies heard is in the vicinity of 500,000, it being assumed that minimum low frequency response is not greater than 100 cycles per second.

To elucidate this definition, take for example an amplifier with a relatively flat frequency response between the limits of 50 and 10,000 cycles per second. This equipment can be regarded as a high fidelity unit, as it will be noted that the product of these two figures is 500,000.

Balanced Reproduction

Similarly, it will be seen that an amplifier which has a minimum uniform response of 100 c.p.s. will have a maximum response of 5,000 c.p.s. if the product of these two figures is to equal 500,000. Such an amplifier will of course, in practice, also reproduce to a lesser extent frequencies below 100 c.p.s. and above 5,000 c.p.s. Therefore, in order to obtain high fidelity output, it is of little advantage building equipment capable of reproducing satisfactorily the very high audio frequencies between 8,000 and 15,000 c.p.s. unless detail is paid to the reproduction of the lower frequencies such as those below 100 c.p.s., thus obtaining balance between the upper and lower audio limits. By effecting this balance of response, the output from the speaker sounds almost identical to the original programme or recording.

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

The average frequency of the musical reproduction heard from a radio speaker is in the vicinity of 700 c.p.s.; therefore another method of calculating the most desirable frequency response limits to be incorporated in the audio amplifier, is to determine the minimum uniform frequency response which can be obtained with the design in mind and divide this frequency into 700; the answer should then be multiplied by 700 and the resulting figure will give the optimum desirable frequency limitation of the equipment.

This effect depends considerably on the resistance of the plate and grid resistors used in the amplifier. Large resistances will permit high overall amplification of the unit, but the greater they are, the greater will be the relative attenuation at the high frequency end of the audio spectrum.

Points to Watch

With this in mind, if high fidelity response is required, the values of all plate resistors in audio amplifiers should be kept to a minimum. The use of low resistances in these positions will, of course, reduce the amplification of the stage concerned, but this defect has to be accepted if good reproduction is required. The limitation of the resistors cannot be carried too far.

Loads for Triodes

If triodes are used as amplifiers, reduction of the value of the plate load resistance much below that of the plate resistance of the tube will result in distortion, so therefore, a satisfactory medium between these two limitations must be determined. When pentodes are used as amplifiers, load resistances can be as small as 2,000 or 3,000 ohms if necessary, without introducing distortion. Values of this nature are however, not economical or necessary in audio equipment, but are common in television video frequency amplifiers where uniform response up to two or three megacycles is required.

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HIGH-FIDELITY

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The average listener to a wireless set fitted with a variable tone control system generally prefers to operate the equipment in such a manner that the "lows" are boosted; such tone controls generally limit the high frequency response above the vicinity of 3,000 c.p.s. owing to the fact that they consist of condenser networks in the amplifier which by-pass the higher notes.

Tone controls of this type effect an amplifier in a different manner to that generally believed, in that they not only limit the high notes, but also reduce the distortion. As an example, let us assume that a certain design of tone control fitted in the output circuit of an amplifier attenuates all signals above 3,000 c.p.s. to such an extent that they may be regarded as negligible. If the output tube is a pentode, as is generally the case, third harmonic distortion will be the most prevalent of the total harmonic distortion present. It is therefore obvious that, as the third harmonic of 1,000 c.p.s. is 3,000 c.p.s., all third harmonic distortion produced by audio signals above 1,000 c.p.s. will be completely eliminated by the tone control. In the same manner, second harmonic distortion originating from signals of 1,500 c.p.s. and higher, will also be abolished.

Mellow Tone Control

It is mainly for this reason that the sound emanating from an average wireless with a pentode in the output and without inverse feedback, is more mellow when the tone control is used to attenuate the high notes; the softer response is only partly due to the limitation of high frequency audio notes which are part of the original transmission.

The above argument, of course, only applies when the tone control is fitted to the plate circuit of the output stage, as it is in this stage that most of the distortion occurs.

Ears Misleading

It is my experience that some listeners proudly tell their friends what excellent reproduction they receive on their particular set and what wonderful tone they think it has, whether the response is good or not. Many receivers simply grate with distortion, yet their owners, having become used to them, are more than satisfied with their performance.

Recently, the owner of a 5 valve mantel model superheterodyne, which had refused to work any longer, brought it to me for adjustment. When the set had been overhauled, it gave quite good reproduction for the small type of equipment that it was, except for the presence of a slight amount of hum. It was therefore decided to replace the filter condensers in the power supply and following this procedure, the set sounded excellent. However, the owner, after having taken his wireless home and turned it on, was most distressed at what he called the change in tonal quality which had been made and asked whether the original hum could not be reinstated, as he preferred its soothing and softening effect.

Not Commercial

With this sort of thing happening every day with many listeners to wireless programmes, one wonders just how far high fidelity sets should be developed for general use. In the manufacture of high-fidelity equipment, considerable extra cost is involved compared with that of the average radio receiver in use to-day. The additional quality required probably costs £5 more per wireless set and it is doubted whether this extra expense is considered worthwhile by the general public.

Not Pleasing

Recently, I had the pleasure of hearing a special amplifier, consisting of a double push-pull arrangement of directly-coupled tubes which on test with a beat frequency oscillator and output meter, proved to have a practically linear response up to 30,000 c.p.s. This amplifier, connected to a t.r.f. tuner, did not sound at all pleasing when tuned to a local station at which a studio stage presentation was being broadcast. The reason for this unpleasantness was the excellent reproduction of high frequency noises normally not heard on a wireless set and perhaps to a limited extent, the fact that the baffle used on the speaker was incapable of giving very high quality response on the low frequency end of the audio spectrum.

This example once again illustrates the well-known fact that perfect reception is not always the most popular and indicates how essential it is for balance of high and low notes to be obtained in sound reproducing equipment.

Industrial Electronics

According to the report of the British Institution of Radio Engineers to industry generally, radio engineering has been synonymous with entertainment, and, prior to 1939, the application of electronic principles in the industrial field was, save for the most elementary purposes, confined almost entirely to the radio and light electrical engineering industries. That this was so, was not because the equipments in use were unreliable or demanded the constant attention of skilled engineers, but because industry generally had not appreciated or had not even been made aware of the versatility of this new branch of engineering.

War has done much to alter this state of affairs. The vital part that electronics has played, in all phases of war production, has led to a far wider knowledge and appreciation of its industrial scope. The intensive research and development that continues unremittingly is opening entirely new fields of application until now there is hardly a single branch of industry that cannot benefit in one way or another by an intelligent application of electronics.

A large number of applications of electronic devices has been made during wartime in the field of electrical machines and industrial process control. Such devices include voltage regulators, speed and process controllers, motor controllers and welding timers, as well as equipment for the detection and control of radiant energy, the control of heat in resistance welding and the control of temperature in resistive and inductive heating. These devices can be set to operate within precise limits and give indication aurally, visually or mechanically when certain limits are exceeded; the limits can be established in terms of colour, shade or density, time or speed, rotation or vibration, temperature or humidity, physical size or shape, continuity or interruption of flow, silence or noise, compression or expansion or even changes in the chemical or metallurgical composition of a body.

—"Practical Wireless" (Eng.)

The present day public seems to prefer the small mantel model radio set to the console cabinet type and generally, the smaller the wireless, the more eager they are to possess it. This fact can no doubt be partially accounted for by the ease with which a small receiver may be moved in the home, but such a set is unable to give high-fidelity response in view of the fact that the sound baffling system employed in it limits the output of the low frequency notes. Such receivers are, however, capable of satisfactory high frequency reproduction and thus if care is not taken to limit the "highs", unbalance occurs between the maximum and minimum response and produces the somewhat tinny reception often encountered. Further, sets such as these are fitted with small speakers which generally have directional characteristics, particularly in regard to their high-frequency output and thus a listener seated directly in front of the wireless hears more high notes than one at the side of the receiver.

Frequency Modulation

Much discussion has recently taken place in the press re the possible installation of frequency modulation equipment in this country for the transmission of radio programmes to the public. The two main advantages encountered with frequency modulation transmission are, firstly, that man-made and atmospheric static is eliminated and secondly, that, owing to the extremely high radio frequencies at which frequency modulated transmissions are radiated, much greater band width signals are permissible, making very high-fidelity reception possible, provided that the receiver is capable of reproducing the high-quality signals available. However, the cost of

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HIGH-FIDELITY

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frequency modulation receivers with wide band audio amplifiers is much higher than that of present day amplitude modulation sets, many more valves and component parts being necessary in the former type of unit.

Owing to the number of amplitude modulated broadcast stations in Australia at present, it has been necessary to arrange that their carrier signals are only ten kilocycles apart in order that they can all be fitted into the 200 to 550 meter band.

It is therefore necessary that the upper audio frequency limitations of these transmissions be made in the vicinity of 5,000 c.p.s. as otherwise interference would be experienced from one station when listening to the next on the dial, owing to the fact that the audio frequencies concerned modulate the carrier signals and thus determine the width of the side bands. Interference of this nature would be particularly predominant if the "highs" were not chopped on the sidebands of two stations of equal power with carrier signals 10 k.c. apart and which were similarly situated with regard to distance from the receiver.

Side Band Limits

With frequency modulation, however, the side band limits to commercial transmitters may be extended to plus or minus 15,000 c.p.s. if necessary, owing to the ultra high radio frequencies used for their carrier signals, and the fact that frequency modulated stations do not interfere with one another.

However, in view of the above comments, consideration has to be given as to whether the additional fidelity obtained with this greater "side band" width is worthwhile, particularly in view of the extra cost of the equipment required for reception of such transmission and that the general public might not appreciate the improved audio frequency range available.

Ear Response

The ability of the human ear to register decreases greatly above 2,000 c.p.s. and the older people become, the less response they have to the higher audio frequency notes. It is also known that women hear a greater percentage of the high notes than men. The response of the ear also depends on the loudness of the programme or recording listened to. In the reproduction of an orchestra, the same volume of sound should be experienced by the listener as that which he would hear if he were actually listening to the orchestra at the auditorium or studio in which it is playing. When the output from a loud speaker is reduced below normal volume in a case such as this, the response of the listener's ear to the lower audio frequencies commences to drop off. When the volume is very low, attenuation begins at frequencies as high as 600 c.p.s. and below 70 or 80 c.p.s., the response heard is so small that it is over-ridden by inherent receiver noise. On the other hand, when the volume is very loud, the average ear has practically uniform response to all frequencies up to 1,000 c.p.s.; the response rises slightly from there to approximately 6,000 c.p.s. where the ears' ability to hear decreases again as the frequency increases above this figure.

Contest Performance

At the recent amplifier contest held by the "Listener In", some amplifiers with excellent overall audio frequency response reproduced needle scratch noises to an unpleasant extent. While this characteristic indicates the ability of an amplifier to amplify uniformly, it is not enjoyable to listen to and therefore entries having these properties were eliminated from the finals. This testifies that for good reproduction of gramophone records, some means must be incorporated in the sound reproducing equipment, which will attenuate to some extent frequencies at which needle scratch occurs if pleasing reproduction is required. Such means are, of course, adopted by the broadcasting stations for the elimination of all such noises before their signal goes on the air.

Reserve Power Needed

Amplifiers designed for high-fidelity work must have ample reserve power to cope with loud notes which occur in orchestral and band selections, or else these will not be truly reproduced and will appear in the form of distortion.

As an example, a receiver which is reproducing an orchestral concert at say, 2 watts average output, should be capable of a maximum undistorted output of 6 to 10 watts so that the peak response encountered can be completely reproduced.

If an amplifier is to reproduce with a high degree of quality the input signals applied to it, harmonic distortion within the equipment, must be minimised. Judging from the results of recent amplifier contests, it appears that the most practical, economical and convenient way to minimise such distortion is to use push-pull Class A output valve amplifiers and, if possible, push-pull driver tubes, as with this arrangement, distortion caused by the even harmonics is cancelled out in such stages. With push-pull Class A triodes only very small third and higher order uneven harmonics are produced and thus good quality reproduction is obtained.

Triodes Popular

Owing to the well-known qualities of the output power triode type 2A3 for absence of harmonic distortion practically all amplifier championship winners use these tubes in push-pull in the output stage of their amplifiers. A pair of these valves is capable of giving 7 watts of undistorted output as a Class A amplifier and appears to be very hard to beat for inexpensive good reproduction. Power pentodes in Class A push-pull give good production, particularly when inverse feedback is used in the amplifier system. However, owing to the fact that the major harmonic with these tubes is the third, push-pull operation alone causes little reduction in total distortion.

Phase distortion which occurs as a result of the fact that plate to grid coupling condensers have a lower reactance to high frequency notes than to low ones does not matter very much in audio amplifiers, as it is not noticed by the human ear. However, it is worth mentioning that this type of distortion in television video amplifiers is most objectionable and has to be strictly limited in such equipment.

The Loud Speaker

The final reproduction of an amplifier depends to a large extent on the loud speaker itself and on the gramophone pick-up if one is used. The character of both these components is dependent upon their ability to reproduce uniformly without distortion, the complete range of frequencies in the audio spectrum in the same manner as it is necessary for the amplifier to have these properties.

In some commercial speakers, the impedance characteristic has a bad habit of rising considerably in the vicinity of 70 or 80 c.p.s. and this defect is often very noticeable in the form of "booming" at that frequency.

The speaker is unable to reproduce satisfactorily unless it is sufficiently baffled. Many articles on speaker baffling arrangements are available for those interested. Reference in this connection is made in the "Australasian Radio World", dated February 16th, 1942. It appears generally that an ordinary piece of heavy wood or celotex approximately 4 ft. square or larger gives excellent all round baffling characteristics and a con-

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CIVILIAN SETS IN U.S.A.

"The radio industry and trade is now getting ready to produce and sell a billion dollars of civilian radio products every twelve months, two or three months after Germany falls," declares Dr. Orestes H. Caldwell, former Federal Radio Commissioner, now editor of "Electronic Industries" (U.S.A.) who for many years has compiled the statistics of the radio industry.

The figures assume that no substantial number of television sets will be distributed during the first twelve months of civilian radio sales. Within a few years, however, annual television volume may be expected to duplicate in dollar volume that of radio sets—selling say one-sixth to one-quarter as many television units at prices averaging six or four times those of present radio sets.

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structor who uses such a baffle will experience response comparable in practice with that obtained by most box baffling systems. An instance of the suitability of such a baffling board occurred in the recent "Listener In" contest in that the "Champion of Champions" winning amplifier was fitted merely with a large flat rectangular baffle about 6 ft. long by 4 ft. high. The larger the baffle, of course, the better is its ability to reproduce low notes. The effect obtained by using a rectangular baffle in preference to a square one is that some of the low notes are attenuated more than others, thus giving a very smooth overall frequency response.

Selectivity Effects

It must be realised that in a superheterodyne radio receiver, it is little use employing a high-quality audio amplifier and speaker if attention is not paid to the band width of the intermediate frequency stages. If these stages are of the highly selective type, they will severely attenuate the higher audio frequencies modulated on to the carrier signal, and the amplifier will then only reproduce this attenuated signal which it receives from the second detector. Preferably, intermediate frequency reponse curves should be perfectly square and of a width sufficient to cover a range of at least 10 kilocycles for good reproduction.

Square Response

Many attempts have been made by receiver manufacturers to obtain square response effect in i.f. stages and some excellent results have been obtained, but the cost of receivers embodying this characteristic is generally high. The amateur may obtain fairly good results in this regard by either of two methods. The first is to shunt the secondaries of each i.f. coil with a 50,000 or 100,000 ohm resistor, thus reducing the "Q" of the coils and thereby widening the resonant band width. The use of resistances in this manner however, considerably reduces the amplification of the intermediate frequency stage.

The other method, which gives good results, is to use two i.f. stages in the receiver, i.e. 3 i.f. transformers and off tune these to a slight extent in such a manner that each of the six tuned circuits peak at frequencies varying from minus 5,000 to plus 5,000 c.p.s. off the standard intermediate frequency used. This procedure results in a fairly uniform response over most of the audio frequency spectrum in the side bands. It is not advised, however, that experiments along these lines be conducted unless an oscillator is available which can be used to realign the receiver if satisfactory results are not obtained.

Wobbler for Testing

The most desirable type of test equipment for use in this connection is a wobbleator, used in conjunction with a cathode ray oscilloscope, whereby an actual picture of the band width curve may be obtained and the effect of individual adjustments on intermediate frequency trimmers may be watched.

It is mentioned brifly that random noise heard in the loud speaker is to some extent proportional to the band width of the intermediate frequency stages and therefore, although increasing the band width improves the fidelity response, it also to a limited extent increases noise such as atmospheric static.

Some mention must be made of the fact that when one is listening to an orchestra, the sound comes from the whole stage, whilst a broadcast of such a programme radiates from a point source, such as a loud speaker and thus loses the space effect of the real performance. This deficiency is difficult to overcome in commercial receiving equipment, but considerable improvement can be realised by set building enthusiasts if two or three properly baffled loud speakers are used in the output of the receiver and arrangements made for these speakers to be mounted 10 to 12 ft. apart. This is well worth trying if not considered too bulky and complicated; the effect obtained tends to give true space consciousness of the sound resources. One of the amplifiers in the final heats of the "Listener In" competition reproduced the space effect quite well by the use of two large baffles, each fitted with speakers and mounted side by side.

Freedom from Hum

Finally, the absence of hum from a loud speaker cannot be overstressed if good quality production is required, particularly when the speaker is normally operated at low volume. By the addition of two or three extra semi dry 8 microfarad electrolytic condensers in various parts of the amplifier as decoupling filters, generally hum present in the best of units can be reduced. Although small amounts of hum are not very noticeable from a loud speaker operated at normal volume, the reduction of this ill effect considerably improves the tone of the unit when eliminated.

With all the above factors in mind, it becomes difficult to completely specify exactly what might, in practice, be termed a high-fidelity reproducing unit and it becomes obvious that some types of equipment will be more pleasing to the average listener than others which technically have better high fidelity characteristics.

* * *

More than one hundred and fifty new electronic tubes and three hundred types of apparatus, not made by anyone before the war, have been developed by the Radio Corporation of America for the U.S. Armed Forces.

—"Electronics" (U.S.A.)

TELEVISION NEEDED

A pasha in North Africa has an inter-communicator system that permits him to contact each room in his harem when necessary.

Interested in improvement, he asked Major Baruch, former U.S. announcer, now in Africa, "How is television progressing in your country, Major?"

—Electronics (U.S.A.)

ACOUSTIC TYPEWRITERS

■ There seems to be no limit to the future of electronics. Here are details of electronic devices which obey words of command

ONE of the most spectacular of recent developments in electro-acoustics is the utilisation of human voice sounds for the control of machinery. The endeavours of the American inventor Dudley, to render a typewriter entirely voice operated (American Patents, 2,195,081 and 2,238,555) give an impressive picture of the inherent possibilities of this latest branch of sound engineering. If the pace of the present research work can be kept up, it is quite possible that by the end of the present war a means for replacing manual operations by voice actuation can be put at the disposal of the disabled. In fact, the desire to provide for the needs of disabled war casualities seems to have given a powerful impetus to this development and a great number of patents concerning voice actuated elctro-mechanical devices has been filled since 1940, mainly in the United States.

Audio Auto Telephone

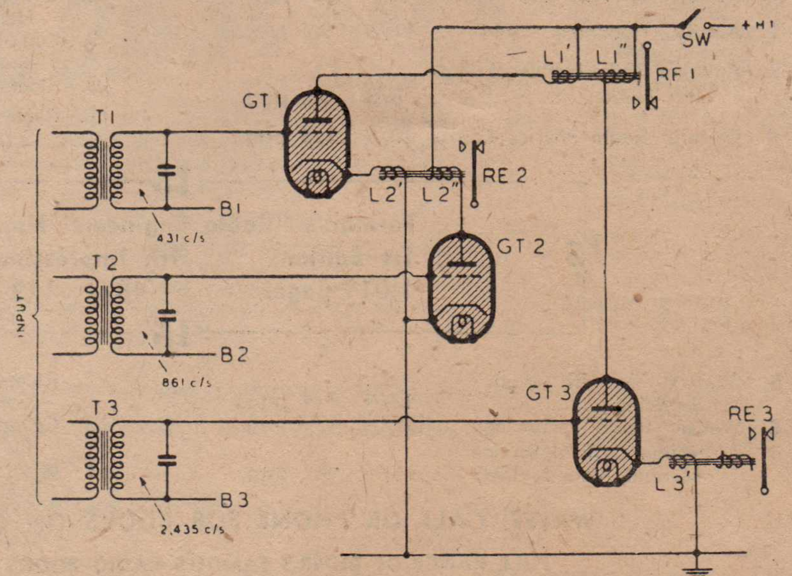
One of the most remarkable of these devices is an automatic telephone exchange system, developed in the laboratories of the Western Electric Company. The frequency composition of the words "one," "two," "three," etc., is utilised to generate the energising impulses for a uniselector or other type of telephone relay system, so that the dialing action is entirely replaced by the use of spoken words. This system obviously lends itself to all sorts of experiments on the "robot" line, as the switch contacts thus operated could be associated with electric devices other than telephones.

To explain the action of these devices it will be necessary to make a short reference to the composition of speech sounds as explored by the research work of Sir Richard Paget in England and I. Crandall, Sacia and others in the United States. It has been shown, that a vowel sound consists of a group of frequencies, bearing no simple harmonic relationship one to the other and being characteristic for the vowel itself, while a single additional frequency, varying with different individuals accounts for the variations in voice pitch. The characteristic frequency group, as the majority of authors agree, contains, as a rule, two frequencies only, though a third frequency occurs, according to Crandall, in the American pronunciation of "er" as in part. The following table gives some of the characteristic vowel frequencies according to Paget.

	English		American	
	f1	f2	f1	f2
a (talk) ..	558	886	645	1,024
oo (pool) .	383	724	431	861
e (teem) ..	332	2,434	431	2,435
o (tone) ..	430	790	724	1,218
a (father) .	790	1,254	861	1,149

A detailed list of English and American vowel components (for which the reader is referred to Paget, "Human Speech," Kegan Paul, 1930) shows that the separation between adjacent frequencies is 5 to 7 per cent. throughout the vowel scale. Thus selective separation of these components by tuned LC circuits does not offer in itself too great difficulties. To type a vowel sound on a speech-operated typewriter it is necessary to apply that sound to a suitable microphone or other sound sensitive device, single out one of the characteristic frequencies appearing in the output of the device and guide the currents or voltages thus obtained, by means of a set of reactive elements, to the controlled section of the apparatus. This consists, in Dudley's system of a set of small electromagnets, each associated with one of the tuned circuits and actuating levers of the typing mechanism. The magnets are fed with impulses of unidirectional currents, obtained from small metal rectifiers which are situated between the resonant circuits and the windings of the magnets. Valve rectifiers to ensure a sufficiency of energising current for the electromagnets and an automatic gain control to eliminate amplitude differences in the sound input as a controlling factor, will, as a rule, also be in-

(Continued on next page)



Basic circuit of speech analyzer used in a voice-controlled lift.

TYPEWRITER

(Continued)

corporated in the device.

The use of consonants for voice actuation is a mort difficult proposition. The elements entering the frequency make-up of a consonant sound are very numerous and it appears, that the frequencies themselves are of less importance than is their rate of change in time. While it is quite possible to "tune in" to frequencies contained in vowel sounds, it is a more difficult task to provide a circuit responsive to the time derivatives of varying frequencies, irrespective of their initial and final values. Further, no definite statement can be made even as to the value of $\frac{df}{dt}$ for a given consonant sound, as this value also depends on the nature of the vowel sound preceding the consonant. "L" in "eel" is characterised by a drop of frequency from 2,298 to 1,722, while in "all" a rise from 912 to 1,366 takes place (Paget). Consonant sounds cannot thus be handled by simple LC arrangements and more complex circuits have to be designed to deal with consonants and vowel-consonant combinations. Much work remains to be done in this direction.

Lift Control

The final stage of a circuit for lift-control as used by the author on a passenger lift in London is shown in the figure. The lift, which has been put at the author's disposal for the purpose of the experiments by Marryat and Scott, was of the usual "call button" controlled type, the buttons operating floor relays, which, in conjunction with other, automatic arrangements determine the movements of the car.

Both vowel components contained in the words "two" (for calling the lift to the second floor) and "three" for the third floor respectively are utilised. The final relays (RE1, RE2, etc.) are, accordingly, of such construction, that they do not close their contactors unless both of their coils (L1'L1" and L2', L2" respectively) are energised. The circuit shown is, in principle, the same as was used in the experiments in London, though, as can be seen, it represents an adaptation for American accent and its action is as follows.

Suppose that the word "two" which, it will be recalled, has component frequencies, 431 and 861 in its frequency make-up, is spoken into the microphone, circuits marked 431 and 861 being resonant to these frequencies will build up and apply alternating potentials to the gas-filled discharge tubes GT1 and GT2. Points B1, B2 and B3 are connected to a source of bias supplying the necessary negative potential for cut-off, in the usual manner. The positive peaks of the potentials obtained from the resonant circuits overcome part of the standing negative bias applied to the grids, and tubes GT1 and GT2 strike. These two tubes pass current, the former through winding L1′ and L2′ of relays RE1 and RE2, and the latter through winding L2″ of RE2. Only relay RE2 has current in both its windings and therefore only this relay operates. RE2 is wired in parallel with the call button switch for the second floor and will therefore actuate the floor relay system in such a way as to bring the car to rest at floor two.

How It Works

The action of the circuit on reception of the sound input "three," is similar, RE3 being then the actuated relay. The further winding L3′ shown in the cathode circuit of tube GT3 may be used in conjunction with similar arrangements to those just described to call the lift to the fifth floor in response to the word five, frequency 861 being also a component of the vowel sound "i". Switch SW is common to all anode circuits and is momentarily opened and closed whenever the car is in motion, so as to put the gas-filled discharge tubes out of action and then enable them to receive further calls. This switch may be operated by a ramp mounted externally on the side of the lift car, in much the same way as are the shaft direction switches of electric lifts.

The actual input frequencies to the windings of T1, T2 and T3 are not necessarily identical with those picked up by the microphone. It is a better idea to convert the input frequencies in such a way as to increase their separation

$$\frac{f1 - f2}{f1}, \text{ otherwise}$$

noises generated by the presence and activities of the speaker may cause serious interference. (Laughter and coughs are sources of the worst complications, the latter invariably causing the lift to proceed to the ground floor!) A suitable conversion is described by the function F = Af — B which, as simple calculation shows, will increase the separation of adjacent frequencies f1 and f2 from

$$\frac{f1 - f2}{f1} \text{ to } \frac{F1 - F2}{F1} = \frac{f1 - f2}{f1 - B/A}$$

which is greater than $\frac{f1 - f2}{f1}$.

A distorting valve generating the Ath harmonic of its grid input and a frequency changer in conjunction with a local oscillator of a frequency output B is then needed to obtain the conversion referred to.

TELECHROME

(Continued from page 17)

(The blue-green and orange-red images forming a stereoscopic pair and being viewed through colour glasses.)

New Form of Scanning

In the present form of scanning all the lines in successive frames are of the same colour, the colour hanging with each successive frame.

In the new form of scanning now being developed successive lines are of different colour and the number of lines is made a non-multiple of the number of colours, so that every line of the complete colour picture has successfully shown each of the primary colours.

The object of this is to reduce colour flicker. Where frame by frame colour alteration is used flicker becomes prominent in any large area of a single colour; for example, if the picture is showing a large blue area, this blue appears in the blue frame only. While the red and green frames are appearing it is not shown, so that the frequency of the repetition is reduced and flicker accentuated. With line by line colour alteration each colour appears in every frame.

This form of scanning does not lend itself to the revolving disc system.

—"Practical Wireless (Eng.)

WAR-TIME RECEIVERS IN ENGLAND

Interesting Details of Trading Control

THE annual peacetime output of the English radio industry was in the neighbourhood of 1,250,000 sets, but few have been made since the war, and up to the end of 1943 the numbers being made did not provide for the replacement demands.

The wartime civilian receivers intended for members of the public without means of listening, and not for those who already have a set in working order, are, as from July 1st, controlled by The Wireless Receiving Sets (Control of Supply) Order, 1944, which relates to the sale, hire purchase and renting of wireless sets marked with the words "Wartime Civilian Receiver." The substance of the Order is as follows:

The sets may not be sold at prices in excess of those shown below:

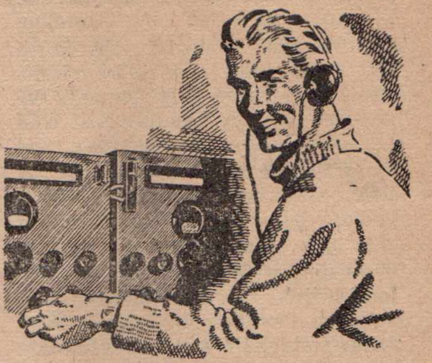
	A.C. Mains Set			Battery Set (exclusive of battery and accumulator)		
	£	s.	d.	£	s.	d.
To wholesalers	5	13	4	5	2	0
To retailers ..	6	13	4	6	0	0
To retail customers (price including Purchase Tax) .. A.C. Mains	12	3	4	10	19	0

These prices must include delivery charges, but in the case of sales to wholesalers and retailers, are subject to a cash discount of not less than 2½ per cent. where payment is made by the end of the calendar month following that in which the sets are despatched. Hire purchase and similar agreements for which a maximum service charge is fixed under the second schedule of the Order must provide for an initial payment of not less than £2, and must be for a term of not less than six nor more than 24 calendar months. The first instalment must not become payable until delivery of the set, and the service charge must not exceed 20 per cent. of the balance of the maximum cash sale price, exclusive of purchase tax, after deducting the initial payment. If the agreement is for a period of 18 months or less, or the final instalment is tendered before the due date, the service charge must be adjusted, if necessary by a refund so as not to exceed the appropriate percentage shown below:

Period between date of agreement and date of accrual or payment of last instalment	Percentage
Not exceeding 12 months	12½
Exceeding 12 months, but not exceeding 18 months	15

No adjustment, however, need be made if the customer at any time after delivery of the set becomes more than one month in arrear in payment of the instalments due. Battery sets may not be rented. Renting agreements for A.C. mains sets must provide terms not less favourable to the customer than the following;

The customer must be at liberty to terminate the agreement at any time on giving one month's notice or paying one month's rent in lieu thereof. The trader must not terminate the agreement before the end of six years unless the customer fails to pay the monthly rent when it becomes due or to observe reasonable conditions as to the use and care of the set.



The trader must maintain the set in proper working order at his own expense, and the customer must give him all reasonable facilities for this purpose.

Any deposit required from the customer must not exceed £2, and must not be forfeited to the trader if the customer pays the monthly rent for 30 consecutive months and returns the set at the end of the agreement in good condition (fair wear and tear excepted).

The monthly rent must not exceed:

	s.	d.
for any of the 1st 30 mths.	13	6
for any of the next 42 mths.	7	6
for any month thereafter	5	0

and the total amount paid or payable by the customer (including any deposit which has been forfeited or remains liable to forfeiture for non-payment of rent) must not at any time exceed

for the first 30 months ..	£16
for the next 42 months ..	12

By the terms of the Musical Instruments and Wireless Order, 1944, it is unlawful for any person to remove the words "Wartime Civilian Receiver" from any set on which they have been marked, or to mark those words on any set except by licence of the Board of Trade.

—"Practical Wireless"

SOUTH AFRICAN BROADCASTING

What is believed to be the only FM transmitter in use in the British Commonwealth is being operated experimentally by the South African Broadcasting Corporation. This fact is learned from the annual report of the Corporation, which stresses the need for making immediate provision for the establishment of a television service in the Union after the war.

The MONTH'S LOGGINGS

ALL TIMES ARE EASTERN AUSTRALIAN STANDARD TIME

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

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

OCEANIA

Fiji

VPD-2, Suva 6.13mc, 48.94m
Heard at 6.30 pm, good sig. (Miss Sanderson).

New Caledonia

FK8AA, Noumea 6.208mc, 48.39m
Heard nightly, 7-8 pm (Miss Sanderson)

New Zealand

ZLT-7, Wellington 6.71mc, 44.68m
Heard nightly (Miss Sanderson).

AFRICA

Algeria

AFHQ, Algiers 9.60mc, 31.22m
Heard in relay with U.S. stations at 8 am with news at good level. 'Cross Section" followed (Gillett).

AFHQ, Algiers 9.535mc, 31.46m
Also heard at 8 am in parallel with 31.22 m. (Gillett).

Belgian Congo

RNB, Leopoldville 15.17mc, 19.78m
Closed at 11 pm after presenting AFRS programme (Gillett).

RNB, Leopoldville 11.64mc, 25.76m
Best of the RNBs. Relays WLWK at 6.30 am (Gaden).

RNB, Leopoldville 9.78mc, 30.66m
Heard from 3.45-5.15 pm (Miss Sanderson, Dr. Gaden).

French Equatorial

FZI, Brazzaville, ... 15.59mc, 19.25m
Some very good reception, especially 10.15 news (Gaden). Heard closing at 10.45 pm after giving a programme from the Armed Forces (Gillett).

FZI, Brazzaville 11.97mc, 25.06m
Heard well when opening at 2 am (Gillett).

FZI, Brazzaville 11.687mc, 25.67m
Opens at 2 am with good sig. (Gillett).

Madagascar

Radio Antananarivo 6.14mc, 48.86m
Antananarivo appears to be using 48.86 m. regularly now. On a number of occasions have found them on this spot until closing at 2 am (Gillett).

CR7BE, Lourenco Marques, 9.86mc, 30.42m
Logged with wonderful volume around 6.15 am with great musical programme.

GREAT BRITAIN

GRN 6.195mc, 48.43m
Heard at 6 pm with news at dictation speed (Cushen).

INDIA

ZOJ, Colombo 15.275mc, 19.64m
Heard with Delhi relay till 2.30 pm—takes own programme till 3 pm—then with Delhi till sign off with "Auld Lang Syne" at 3.25 pm (Cushen).

SEAC, Colombo 11.81mc, 25.40m
Roars in lately at night (Pepin).

CENTRAL AMERICA

Panama

HP5G, Panama 11.78mc, 25.47m
Ern Suffolk and myself have identified this one. Heard at fair level around 7 am with a variety of programmes—Latin-American music, Sports commentaries and Spanish language talks (Gillett). Heard fairly well before breakfast (Gaden).

KP5A, Panama 11.696mc, 25.65m
One of my favourites; heard fairly well before breakfast (Gaden).

SOUTH AMERICA

Brazil

PRL-8, Rio de Janiero 11.72mc, 25.60m
This is by far the best South American I have ever heard (Gaden). (Schedule: 5.30-6.15 am; 7.10 am-12.42 pm. English daily except Mondays.—L.J.K.)

Dutch Guiana

PZX-5, Paramaribo 15.395mc, 19.48m
Good some nights, but not heard any English. Erratic as to skeds (Gaden). (See "New Stations"). Good level when closing with Dutch National Anthem (Gillett).

Ecuador

HCJB, Quito 12.445mc, 24.08m
Heard from early evening at great strength.—L.J.K.

HCJB, Quito 9.958mc, 30.12m
Heard regularly each evening from 8.45-10.15. Signal very good (Miss Sanderson).

U.S.A.

San Francisco unless otherwise mentioned.

KWIX, ... 17.76mc, 16.89m
Splendid signal till closing at 5.58 am (Gaden).

KWID, ... 17.76mc, 16.89m
Very good on opening at 6 am (Gaden).

KROJ 17.76mc, 16.89m
Heard daily opening at 11 am (Pepin).

KGEI, ... 15.13mc, 19.83m
Heard closing at 8.30 pm (Miss Sanderson). (Thought I heard KGEI the other morning around 11 in parallel with KGEX (19.57 m.).—L.J.K.

KGEX, ... 7.25mc, 41.38m
Very good signal nightly (Miss Sanderson). (Since Miss Sanderson's report left Melbourne, I find KGEX has voices behind, especially in early part of transmission. I often hear, G for George, R for Robert, etc.—any one any ideas?—L.J.K.)

KROJ, ... 6.10mc, 49.15m
Strong signal at night ruined by hum (Cushen, Edel, Perkins, Miss Sanderson).

Other than 'Frisco stations

(Items with an asterisk (*) are carried over from December issue)

WLWL, C'nnati 15.23mc, 19.67m
Signs at 5.45 am; re-opens at 6 am (Cushen).

***WNRX,** New York 14.55mc, 20.61m
At 12.30 am, "This is Columbia Broadcasting Station, New York." Then on in French, and at 12.45, Italian (Edel).

***WNRI,** New York 13.05mc, 22.98m
Good at 9 pm (Matthews).

WLWL, C'nnati 13.022.5mc, 23.03m
Heard at 6 am (Cushen). (Note: Call at 6.45 am is WLWL.—L.J.K.)

WLWK, C'nnati 11-71mc, 25.62m
Sched. 5.30-7 am (Cushen).

***WJQ,** New York 10.10mc, 29.97m
Heard at 6.30am (Young, Gillett, Cushen). (This Press Wireless Station situated in Hicksville, N.Y., was away back in 1942 one of the best signals on the air. They ceased operations about February, 1943. I sent them a report very early in the piece and for want of fuller particulars, not knowing at that time the owners, I simply addressed my letter to Short-Wave Radio Station, WJQ, New York City, N.Y. It was returned "Unknown." Such is fame.—L.J.K.

WBOS, Boston 9.89mc, 30.31m
Heard well at 5 am with prog. from AFRS (Cushen). This is the call in early morning with all English prog. Good at 6.30 am (Gillett).

WNRA, New York 9.855mc, 30.44m
Heard closing at 11 pm (Cushen).

WLWR, C'nnati 9.75mc, 30.77m
Heard from 1-6 am (Cushen, Gillett).

WRUW, Boston 9.70mc, 30.93m
Very fair with special prog. at 11 pm (Cushen).

***WGEX,** New York 9.55mc, 31.41m
"X" appears to be the call on this frequency at 7 am—quite a good signal (Gaden). (Yes, 9.55 mc is reserved for "X", schedule being 7-11 am; the call on 9.53 mc 31.48 m is "O" or "A" according to schedule.—L.J.K.)

***WLWR,** Boston 7.832mc, 38.30m
Good at 8.30 am (Matthews).

***WOOW,** New York 7.82mc, 38.36m
Good at 10.30 am (Matthews).

WRUL, Boston 7.805mc, 38.44m
Very good in special prog at 11 pm (Cushen).

WNRI, New York 7.56mc, 39.66m
This is call, now, at 7 am (Gillett). (Was previously WNRX.—L.J.K.).

WGEO, New York 7.25mc, 41.38m
One of the best Yanks at 5 pm (Cushen)

WNRX, New York 6.10mc, 49.10m
News at 7 am (Gillett).

U.S.S.R.

Moscow unless otherwise mentioned

15.33mc, 19.31m—see "New Stations".

12.26mc, 24.47m—Calls BBC at 10.30 pm (Cushen).

15.75mc, 19.05m—Seems to be the best for English programme, nightly from 9 o'clock; news at 9.40—L.J.K.

RW-15, Radio Frunze 5.93mc, 50.54m
Heard well at 10 pm (Edel, Young).

——, **8.94mc, 33.54m**—Heard at 9 pm (Edel, Young).

——, **9.48mc, 31.65m**—Heard fairly well around 4.30 pm (Young).

(Continued from page 29)

Items with an asterisk (*) are carried over from December issue.

Canada

***CBFX,** Montreal 9.63mc, 31.15m
Good at 10 pm (Matthews, Young). (Delhi back on this frequency mars reception here.—L.J.K.)

France

Radio Paris 15.355mc, 19.53m
See "New Stations".

Radio Francais 15.24mc, 19.69m
Have heard male and female announcers on the old Paris wave-length, at good strength (Gillett, Young).

Radio Paris 15.095mc, 19.87m
See "New Stations".

Radio Paris 9.56mc, 31.38m
Reported by Mr. Young and Dr. Gaden as heard around 3.30 pm. Mr. Edel found them signing off at 11.34 pm. (This is one of the wave lengths in p/l with 19.87 m.—L.J.K.)

Radio Paris 7.245mc, 41.44m
See "New Stations"

Iraq

***Radio Baghdad** 7.095mc, 42.32m
Good in English at 2.30 am (Matthews).

Jerusalem

***British Mediterranean** 11.72mc, 25.60m
Has been heard with news in English at 10.45 pm. Very good signal (Gillett).

***British Mediterranean** 9.67mc, 31.03m
In p/l with 25.60 but not as strong (Gillett). (Same position here, Rex.—L.J.K.)

Mexico

XEWW, Mexico City 9.50mc, 31.58m
Good at midnight (Edel).

Middle East

JCJC, location unknown 7.22mc, 41.55m
Received verification letter stating 7.84 mc withdrawn last June. Also mentioned location must remain secret (Cushen).

WVLC, Leyte 18.60mc, 16.14m
Good at 8.45 am (Gaden, Ferguson, Gillett).

WVLC, Leyte 17.74mc, 16.91m
Good at 9 am (Matthews).

WVLC, Leyte 14.85mc, 20.20m
Heard around 11.45 pm (Gaden, Ferguson).

WVLC, Leyte 7.795mc, 38.44m
Heard about 8.30 pm (Gillett). Good at 10 pm (Gaden, Matthews). Heard closing with RCA at 10.54 pm (Cushen, Pepin).

***WVLC,** Leyte 9.302mc, 32.25m
Is very strong at 11.15 pm with commentary for the U.S.A. (Gaden, Matthews, Gillett).

SWITZERLAND

Berne

HER- 12.965mc, 23.14m
Very poor signal on Tues. and Sats. owing to morse.—L.J.K.

HER- 11.775mc, 25.48m
News in English daily except Sats. at 7.20 am; news in nat. lang. daily 7.30 and 8 am.—L.J.K.

HEI-5 .... 11.715mc, 25.61m
One of the best signals on the air from 6-7.30 pm on Tues. and Sats. Eng. Tues. nat. lang. Sats.—L.J.K. Heard at 2.10 am in French. Call "Ici la Suisse" (Gillett).

HEO-4, ... 10.338mc, 29.02m
News in nat. lang. daily at 5.45 am.—L.J.K.

HEK-3 .... 7.38mc, 40.65m
News in nat. lang. daily at 11.30 am.—L.J.K.

HET-3, ... 7.36mc, 40.78m
Good strength when closing at 1.50 am (Matthews).

HEI-2 .... 6.345mc, 47.28m
News in English daily at 7.20 am; nat. lang. 7.30 and 8 am.—L.J.K. Heard in afternoon at 2 o'clock (Young).

HER-3 .... 6.165mc, 48.66m
News in nat. lang. daily at 11.30 am—L.J.K. Good signal at 1.45 pm (Young).

Sweden

***SBT,** Stockholm 15.15mc, 19.81m
Fair to good at 9 pm (Matthews)

***SBO,** Stockholm 11.705mc, 25.63m
Good at 1.30 am (Matthews). Heard at 5 am (Gillett).

***SBU,** Stockholm 9.535mc, 31.46m
Opens with bells on Sundays at 8 pm; signs off at M/N (Cushen).

Syria

***FXE,** Beirut 8.035mc, 37.34m
Good signal on closing at 7.15 am with "Marseillaise" (Gillett). Good with news in English at 1 am (Matthews).

Turkey

***TAP,** Ankara .... 9.465 mc, 31.70m
Now using English on Mondays, Tuesdays and Fridays at 6.30 am. On Mondays put over a Post Bag Series when listeners' letters are acknowledged. I heard announcer say there were three transmitters at Ankara, viz., TAR, TAP and TAQ, but that an order had been placed for three more.—L.J.K.
When listening to No. 9 of Post Bag Series on Xmas Day announcer said the success of the series was such that they were considering making it 30 minutes and in the daytime (our night time) using TAQ also.—L.J.K.

Vatican City

***HVJ,** 17.445mc, 17.20m
Heard around 12.15 am (Young).

West Indies

Cuba

COCY, Havana 11.737mc, 25.56m
Heard giving call in English at 6.30 am—Spanish language follows. Fair signal (Gillett).

***COCX,** Havana 9.27mc, 32.36m
Great signal at 8 am (Matthews).

Haiti

HH3W, Port-au-Prince 10.13mc, 29.62m
"Congratulations on logging HH3W—heard same myself this week"—Wally Young). Thanks, Walter.—L.J.K. "Your old friend HH3W too noisy for me." (Gaden).

NEW STATIONS

PZX-5, Paramaribo, 15.395 mc, 19.48 m: Well, here is a sitting shot for those South American hunters to add Dutch Guiana to their log, and what is more at an hour that is somewhat unique for that part of the globe. PZX-5 is heard at quite good strength from around 8.30-9.23 pm . . . I say around advisedly, as the schedule varies, but they can be counted on to be "on the air" most nights at 9 o'clock and the Dutch National Anthem signifies their closing, which is anytime from 9.23 to 9.30. It was the playing of the anthem that attracted the attention of Roy Hallett. He rang me up mentioning the approximate wavelength and time that he had heard it and I called to mind a note from Wally Young that had arrived that morning advising me of Paramaribo. So we will credit Young-Hallett with first honours. Since then other ether-combers, Leo Edel, Dr. Gaden and Rex Gillett, have written in about it.

Radio Paris, 15.355 mc, 19.53 m: "Ici Paris Radio Diffusion Francais" is the call heard at 9 pm. A weak signal, plus very annoying morse spoilt what may be quite a good station reported by Mr. Edel. Cannot announce schedule as it has not been heard, if given, but some nights are still there at 1 or 1.30 am.

Radio Paris, 15.095 mc, 19.87 m: Here is a real "honey" of a signal, comparable with the 19 metre band BBC's at this hour, 10-11.30 pm. This item which has been re-written should have appeared in the December issue of "A.R.W." but with a good deal more "copy" was squeezed out owing to pressure on space. Rex Gillett wrote me the last week in November telling me he had heard a station at 10.45 pm on 19.87 metres announcing as "Ici Radio Diffusion Francais". All attempts this end failed to find it and apparently they jumped to 19.53 metres. But now they are back again on 19.87 metres with programme directed to French Indo-China; for this information I must thank Mr. Edel. After opening at 10 o'clock with "Marseillaise" a male and female announcer talk till 10.45 when bright cabaret type music continues till 11.15. Then the Annamite language is employed till close down at at 11.30 by "Marseillaise". Signal right through is R 9 Q 5 and according to announcement are on additional wavelengths of 31.19, 31.38 and 31.58 m. I found them with a weak signal on 31.58 metres, say R 5 Q 3, but not a sound on the others, although a few weeks ago Paris **was** heard on 31.38 metres at that time.

Radio Paris, 7.245 mc, 41.44 m: Rex Gillett advises he heard Paris a few weeks ago at 5 am with male and female announcers, but when Delhi opens they are overpowered. This is an old Vichy frequency and will be well worth watching.

Moscow, 15.53 mc, 19.31 m: Another frequency for the U.S.S.R. whose transmitters are already legion. This one could very easily be passed over as the signal at 9.40 is very weak. Following the Soviet Anthem an English programme is heard.

XGOY, Chungking, 6.165 mc, 48.66 m: Another station with the fidgets of the old time South American frequency jumpers has been located here. Opens at 10 pm with news headlines followed by Chinese programme. News in English for 10-15 minutes is given at M/N. Mr. Edel and I found this one, one night when having a "session" at his home.

KCBA, 'Frisco, 11.14 mc, 26.92 m
KCBF, 'Frisco, 9.75 mc, 30.77 m

These two are bracketed because they are twin-like in their habits. First heard at 1.30 am by Mr. Edel, who 'phoned me (with considerable thoughtfulness) after breakfast about his catch. I have since kept a watchful eye on them and so far can go on record with: Heard closing with very faint signal at 4 pm. Re-open at 4.30 and stay in parallel with KWV, KRCA and KWID (9.57 mc) until 5.45 pm, when KWID drops them. At 7 o'clock KCBA and KCBF close, returning at 7.30 with KWV when they pick up KRCA and talk in Japanese for the rest of the evening. After midnight musical programme is heard till 1 or 1.30 am (I think KWV drops them at 9 o'clock and closes). According to their frequent announcements are operated by Columbia Broadcasting System. Signal is quite o.k. in late afternoon but at night morse is a little troublesome. KCBF seems the stronger at all times.

KNBA, 'Frisco, 15.15 mc, 19.81 m.
KNBC, 'Frisco, 13.05 mc, 22.98 m.

Running over the bands during the holidays I came across these two new outlets of the National Broadcasting Corporation, heard in parallel with KGEX, 15.33 mc, 19.57 m, 7 am-3 pm. Signal from 11 am on KNBA is good, but KNBC is only fair.—L.J.K.

ZNR, Aden, 6.75 mc, 44.38 m: Mr. Edel during an all night sitting came across this new one. Programme in Arabic, but at 2 and 3 am announce in English that they are transmitting on 24.76 and 44.38 metres.—Nice catch, Leo.—L.J.K.

KRHO, Honolulu, 6.12 mc, 49.02 m: This Hawaiian who made his debut first week in January comes in at terrific strength from 6 p.m. till closing at 2 am. Programme is "For the enlightenment and entertainment of the peoples in Japan, China, Formosa, Manchuria and Korea. This programme can also be heard on 1,000 kilocycles in the medium wave band." Programme is mostly in Eastern language, but there are frequent announcements in English. An harmonic of this very strong station will be heard on 12.24 mc.—L.J.K.

KRHO, Honolulu, 17.80 mc, 16.85 m: Just after ringing Ted Whiting to tell him of KRHO on 6.12 mc, he rang me to say he heard them on 17.80 mc. I found them there on Sunday, 7th inst., from 11.30 till closing at noon. Announcer said, "This has been a special broadcast by KRHO, A Voice of America broadcasting from Honolulu, Hawaii, transmitting on 17.8 mc in the 16 metre band. Our programme is heard in regular transmission from 5 pm till 1 am, Japan time, 0800-1600 G.M.T. on 6.12 mc in the 49 metre band." To-day, 8th inst., I could not find them on 16 metre band, but signal yesterday was R 8 Q 4.—L.J.K.

CHANGE OF FREQUENCY

KRCA, 'Frisco, has moved from 9.49 mc to 6.19 mc, 48.47 metres. Opens at 6.30 pm in parallel with KES-2, 8.93 m. 33.58 metres, and is heard much more clearly than when on 9.49 mc. KRCA is also heard on 15.13 mc, 19.83 m, opening at 9 am.—L.J.K.

ALL-WAVE ALL-WORLD DX CLUB

APPLICATION FOR MEMBERSHIP

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

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

Name..

Address..

(Please print both plainly) ....

....

My set is a..

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

(Signed)..

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

Shortwave Review

CONDUCTED BY
L. J. KEAST

NOTES FROM MY DIARY

NEW YEAR RESOLUTION

I am introducing a new column in this issue under the title "SAYS WHO?" and would like to know from members if it appeals. It will afford members an opportunity of expression and become a sort of debating column until such time as doubtful stations are definitely tabbed. I find members often hear stations that they hesitate to put under any particular country, and this is understandable with the great number of relays that are taking place. For instance RNB, Leopoldville, is often heard in AFRS programmes—remember the confusion when they were heard some months ago relaying the BBC at 2.30 p.m. Well it is to ventilate this type of query as well as to provide an opportunity for listeners to say their piece in addition to the short, sharp, snappy loggings they send in which will still go in the classified column.

UMBRIAGO

I was delighted to hear through KROJ, 17.76 mc, on December 16, that an American destroyer had picked up the entire crew of the Super-Fortress that did not return to Saipan from the Nagoya Mission. But I had to smile when we were told the giant bomber was named Umbriago. Listeners to the Armed Forces Radio Service will remember Umbriago is the imaginary pal of Jimmy Snozzle Durante in the series "Comedy Caravan."

ERRATA

Under the paragraph The Ever Bending Beam, KROJ was shown as 9.89 m.c., 30.31 metres. This should read: 6.10 m.c., 49.15 m., 6-11 p.m. South Pacific.

RADIO QUIZ

Seems to be some doubt as to what is the correct frequency for the new Columbia Broadcasting System stations KCBA and KCBF. On one thing we all agree, that is, the frequencies are 9.75 m.c. and 11.14 m.c. But who belongs to which?

I listened again to-day, 8th inst., and am hoping Mr. Printer will be able to squeeze this in. I tuned to 9.75 m.c. and at 4.30 p.m. heard announcement: "This is The Voice of America, stations KCBA and KCBF operated by Columbia Broadcasting System, transmitting on 9.75 m.c. and 11.14 m.c., in the 30 and 26 metre band, as authorised by the F.C.C."

Well, it looks as though the position is the reverse of the paragraph elsewhere in this issue.

Both stations go into parallel with KWV till closing at 7 p.m. Re-open at 7.30 p.m. with same announcement at at 4.30. Both close at 2 a.m.

CHANGES ON THE AIR

Effective 1700 G.M.T. or 10 a.m., 10th January P.W.T. (that is 3 a.m. Thursday, 11th Jan., Sydney). The Voice of America will be heard over the following frequencies:

Directed to **The Philippines.** — 7.25, 15.21, 6.12, 7.46 and 13.05 m.c.

Directed to **China.**—9.57, 7.23, 15.29, 6.06, 17.80 and 11.14 m.c.

Directed to **Japan.**—9.55, 9.57, 9.70, 13.05, 11.14 and 6.12 m.c.

Directed to **Indonesia, Burma, Thailand, Indo-China and S.W. Pacific.**—7.23, 13.05 and 9.70 m.c.

In most cases News in English will be heard ON the HOUR, every hour.

WHAT! NO SUGAR?

As from last October, Home Town News heard over the 'Frisco stations has been known as "Sugar Report." The title was evidently determined by the fact that a sweet young thing, introduced as "Your Sugar" gave the names of musical items that punctuated the news supplied by the Armed Forces Radio Service, read by an army officer. Well, whether it is a New Year resolution or what have you, I do not know, but Sugar has gone and the old monnicker is being used again. I will certainly not subscribe to the idea that Sugar has run out, notwithstanding the fact that we were presented with a new Sugar each week.

By the way, there is a possibility that Domestic News from the States may from January 10th be increased to 30 minutes and be read at dictation speed. With the happy knack the Yanks have of finding unusual items of news, I am sure this would be welcomed.

SAYS WHO? . . .

"Noumea very kindly sent me a verie. I believe lots of the lads in the past have reported them without result. Verie was a letter."—Dr. Gaden.

(Yes, Dr. Gaden, a lot of the lads, including yours truly, have written without receiving an acknowledgment. Several of the letters, like mine, had Reply-Coupons enclosed. I think Roy Hallett received a photo of the lassie who used to announce from FK8AA.—L.J.K.

•

"Service Digest" is now heard on WEDNESDAYS at 11.15 a.m. over KROJ 17.76 m.c., 16.89 m.—L.J.K.

•

The opening march used by CFRX, Toronto, 6.07 m.c., 49.42 m. is "Bond of Freedom" according to a reply received by Dr. Gaden in answer to his enquiry.

•

Recent verifications received were from XEQQ, TGWA and CR7BE. The card from XEQQ, Mexico City, was an attractive postcard depicting a native Mexican in colour. TGWA's card was the usual one showing the country's national bird, the Quetzal, and they also sent a 72 page booklet about Guatemala. CR7BE, Lourenco Marques, sent their usual card verifying my report of last April. (Gillett).

•

I was very pleased to receive a report from W. H. Pepin, of Perth, logged during his brief leave from the military.

I was very pleased to receive a letter from Private W. H. Pepin, of Maylands, W.A., who during his

(Continued on next page)

brief leave found time to "run over the dial." Mr. Pepin before joining the Army was a regular contributor to these pages. He says, "Well, I hope some day in the near future conditions will be back to normal." I am sure we all subscribe to that thought.—L.J.K.

•

Sent out over 700 messages picked up here from our men interned in enemy country and heard over Tokyo, Singapore, Shanghai, etc., this year.—Cushen, Invercargill, N.Z.

•

WCBN, N.Y., 16.83 m.; WGEO, N.Y., 19.57 m; WCBX, N.Y., 19.64 m. and WRUS, Boston, 19.83 m. all good at 10 p.m. (Matthews).

•

Lindsay Walker, of Perth, who writes the broadcast band notes for the W.A. Short Wave League has been selected for a Commonwealth Engineering Cadetship and will be in Melbourne for 14 months, to do field work. He will return to Perth in February, 1946, to complete his University course in Engineering. —"The Broadcaster."

(Congratulations! Lindsay did not confine his Radio dialing to the broadcast band and often sent in a long and informative report to these pages.—L.J.K.)

•

Mr. Rex Gillett reports hearing Egypt on 7.22 m.c., 41.55 m., from 12.30-6 a.m.

•

Dr. Gaden says he heard WLWR on 18.16 m.c., 16.52 m. at good strength in a.m. He does not mention exact time but it must be before 7, as at that time I can hear "nuttings".—L.J.K.

•

A new Indian has been heard on 15.22 m.c. at 1.30 p.m.—Cushen.

•

A good opportunity to try the selectivity of your set is to tune to GWR, 15.30 m.c., 19.61 m. (schedule is 8-9.15 p.m.) say about 9 p.m. Stay tuned and watch them quietly withdraw at 9.15. A whisper away you will find GSP on 15.31 m.c., 19.60 m., has commenced business and will continue till 10 p.m.—L.J.K.

•

Wally Young writes: "Have heard a muffled voice on approximately 24.52 metres at night." I am wondering if he has been listening to the elusive TFJ, Reykjavik. Only thing against this is they were, when heard a couple of years ago, only audible in the afternoon and then for a brief 15 minutes.

•

Probably the first of the BBC transmitters to show up near midday is GSD, 25.53 metres, who in the last quarter hour of their 7.15 a.m.-12.15 p.m. transmission to South America can be heard at quite good strength.—L.J.K.

•

Radio Maroc was recently logged on a few occasions on approximately 36.65 metres at 6 a.m. French language and a classical concert were presented.—Gillett.

•

Saipan heard with a call that sounded like NPLA or NBL-8 on 7.35 m.c., 40.82 m., after the first recent Tokyo raid.—Cushen.

•

Heard BBC in French until 7 a.m., then German using "V for Victory" (. . . —) interval signal and announcement, "Hier ist Englant" repeated three times. Approx. 6.04 m.c., 49.67 m.—Gillett.

(If anyone hears or knows of call-sign, please oblige.—L.J.K.)

•

Mr. Cushen writes: "ABSIE, Office of War Information, American Embassy, London, verified with a long letter from Margaret Gill, Transmitter Intelligence. They stated schedule is now 3.30-11 a.m., and that they use many BBC transmitters, in fact, all broadcasts are on BBC trans.: GRB, GSL, GWH, GRR, GRT, GWJ, GWO, GWC, GWF, GWA, GWI, GWM, GWL, GSA, GRS, and GSW."

•

ABSIE has taken into use 49.59 metres, and is at good strength at 7 a.m., the same programme being carried on 49.92 metres.—Gillett. (GSA and GRB—see above.)

XGOY heard on an announced frequency of 6.165 m.c., 48.66 m.—Gillett. (See "New Stations")

•

Re these new CBS stations. Have you noticed the way the 7.30 p.m. announcement goes? KCBA and KCBF, then the frequencies 9.75 and 11.14 m.c. in the 30 and 26 metre bands. Makes it look as if A is on 9.75 and F on 11.14.—Gaden

(Yes, see "Notes From My Diary" under Radio Quiz.)

•

Received verification card promised by JCJC. Well worth having. It is cream coloured and has a lot of detail. Operated by Forces Broadcasting Unit, Middle East Headquarters, Cairo. They also operate JCPA, 1391 k.c., JCFA, 795 k.c., JCLA, 1019 k.c. and JFPA, 950 k.c.—Cushen.

•

Leopoldville on 19.78 metres is generally poor at opening but improves, closing nicely at 11 p.m. I find no interference whilst he is on but after his Anthem finishes, Spanish can be heard. Suspect TGWA.—Gaden.

•

A good signal at 6.15 p.m. is GRN, 6.195 mc, 48.43 m., when playing Allied Expeditionary Forces programmes. Schedule is 6-8.30 p.m. and 1.30-4 a.m. AEF programmes are heard on GRJ, 7.32 m.c., 40.98 m. from 8.45 p.m.-1.15 a.m.

•

Seein's believin' says the guy from Missouri, but what about hearin'? KWV on 10.84 m.c., 27.68 m. even as late as 7.15 p.m. on January 8th, when closing said, "Our programme continues on KRCA on a frequency of 9.49 m.c." Maybe the engineers and the programme clerks are not too chummy; KRCA has been on 6.19 m.c. for last week at that hour. —L.J.K.

•

Heard a new B.B.C. frequency at 9.30 p.m. in General Forces Programme, 9.90 m.c.—Ted Whiting.

(Yes, is heard as early as 8.05 p.m., giving programme details followed by Daily Service. Very nice signal.)

Speedy Query Service

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

J.M. (Marrickville) enquires about meter shunts and series resistors for multi ranges.

A.—Sorry, but we haven't the space to deal with all your queries in these columns. The subject was explained in detail in our issue of November, 1939, and copies of this issue are still available from our Sydney office, price 1/- each.

* * *

D.J.C. (East Malvern) enquires about the frequency of which the oscillator tuning circuit is resonated, in a typical modern superhet.

A.—Theoretically the oscillator frequency can be higher or lower than the signal frequency, so long as the difference is equal to the intermediate frequency. In practice it is usual to have a higher frequency for the oscillator using fewer turns on the oscillator coil and the padder condenser in series with the main tuning. Both these factors help to bring up the resonant frequency of the oscillator tuning circuit to the required figure.

* * *

"Barb" (North Brighton, Vic.) sends along two circuits of shunt-fed audio transformers and asks which is preferable.

A.—There should be no difference in results. The high tension supply is (or should be) effectively by-passed to earth, so that as regards the audio component they should be considered as being at the same potential. So that no matter whether the primary returns to earth or high tension, the audio position should remain the same.

As regards direct-current there will be a big difference, noticeable mainly as regards the strain imposed on the coupling condenser in one case and the insulation of the primary winding in the other. If the primary is earthed the coupling condenser will need to stand the full peak of the initial high tension voltage, or the normal peak voltage plus the peaks of audio, whichever may be the higher. In the other case the primary to secondary or primary to core insulation will need to stand these voltages. So you can take your pick.

GREETINGS

The Editor wishes to express thanks for the many cards received from readers and regrets that he is unable to acknowledge them all individually.

H.E.F. (Collinsville, Q.) is a cattleman who is interested in two-valve superhets for short waves, but using high tension of 45 volts or less.

A.—We would have the gravest doubts about the chance of getting efficient converter operation from any type of valve when working on 45 volts. Trouble enough is encountered even when 135 volts is used. If any other readers care to let us know of their practical experience we will be pleased to pass them on, but from what we have heard in the past we have formed the opinion that the regenerative type of set would be preferable, even if capacity effects are a problem. It is easy to mount large formers on to old valve bases to make plug-in coils of the type you mention.

POLICE TELEVISION

Television, coupled with other post-war developments will be used in the not too distant future as powerful aids of police, Frank J. Wilson, Chief of the United States Secret Service, said recently in America. "Television," he said, "will lend itself particularly to the protection of the public, not only by carrying pictures of criminals at large, but in promoting public education against traffic dangers, against sports which promote juvenile deliquency and other menaces.

J.T. (Balgowlah) asks about vibrator set design.

A.—It is much easier to get quiet operation if you indirectly-heated valves, and so long as the heavier current drain is not an insuperable obstacle we would strongly recommend the 6V7G and valves of that series. Factories can and do use battery-type valves, but they have plenty of trouble with them and have to stick closely to layout and wiring of their prototype which may take six months to develop.

* * *

B.M. (Casino) enquires about back numbers.

A.—Yes, the issues listed are all available from this office at 1/— each, post free.

TRIODE VERSUS PENTODE

By Richard Crane in "Electronics", September, 1944.

It is well-known that pentode and beam power output stages have poor frequency response and appreciable distortion. These defects are manifested mainly in two ways. First the speaker tends to have "hang over," that is, the cone and the voice coil assembly tends to vibrate at its own natural period when a transient or a steep wave front signal is applied, and the amplifiers output will be far above normal when a signal is applied whose frequency is equal or close to the mechanical resonant frequency of the speaker. This does not occur in a triode because the low impedance source shunts the speaker's counter e.m.f. and effectively damps the vibration. A pentode or beam tube with enough feedback to approximate a triode's plate resistance will behave similarly. The second effect is a response which rises with increasing frequency; this happens because the primary inductance of the output transformer presents an appreciable (and, of course, varying) load to the tube throughout the audio spectrum. In a triode stage the transformer's inductive reactance is high compared to the tube's plate resistance except at the very lowest audio frequencies, and thus a fairly uniform response is obtained. As in the first case, feedback will enable a team power or pentode tube to give similar performance.

welding with a paint brush?

To solve a difficult welding problem, Eimac laboratory technicians compounded a welding alloy that could be applied with a paint brush. The alloy flows easily under an arc to complete the weld, yet subsequent heating to temperatures as high as 2900 degrees Centigrade will not destroy the weld.

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Performance of any electronic equipment is a direct reflection of the performance of its vacuum valves. Hence it is advisable for users and prospective users of electronics to look first to the vacuum valve requirements. Because Eimac makes electron vacuum valves exclusively their advice to you is unbiased and can be of great value. A note outlining your problem will bring such assistance without cost or obligation.

Alloy flows easily and weld is quickly completed under arc.

The Science Behind the Science of Electronics

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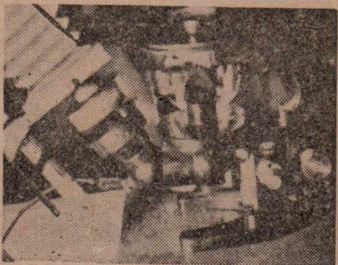
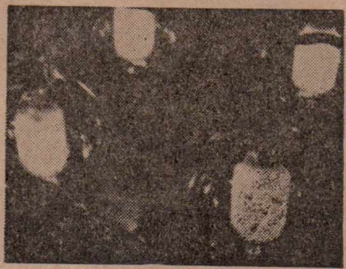


OPTICS... For studying the effects of processing.



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—H.B., Western Australia

GLUING WOOD WITH RADIO WAVES

Incredible as it may seem, an R.F. "spot-gluer" has been tested under Active Service conditions similar to those of ordinary production. Exhaustive tests have clearly demonstrated that this process can successfully be used for tacking together layers of wood veneer. This operation is necessary to mould plywood shapes, such as aircraft fuselages, wing elements, stabilizers, etc. Here is a great new application of Radio which speaks well for the future. Truly it may be said "Radio wonders will never cease."

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Printed by the Bridge Printery, 117 Reservoir St., Sydney, N.S.W., for the proprietor of the "Australasian Radio World," Elizabeth St., Sydney.