THE AUSTRALASIAN

Radio World

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Resistances 15

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★ Design for a receiver to use either t.r.f. or superhet

★ Explanation of square wave technique for audio testing

★ Shortwave Notes and reports on reception conditions

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EDITORIAL

Great interest will be aroused by the announcement in this issue that John Straede is to organise an amplifier contest of his own. Mr. Straede must fully appreciate the problems associated with such an undertaking, but is not deterred. He is buzzing around in his little car in search of advice about the many difficulties which may arise, hoping to nip them in the bud. In order to avoid disputes about the judging it is intended to have the decision reached by the audience as well as by competent judges who are not connected with the radio trade or with prize donors.

Six major factors are to be taken into consideration in the judging: (1) volume; (2) freedom from distortion; (3) fidelity; (4) portability and flexibility; (5) accessibility and reliability; (6) cost of building.

It is hoped to run a linearity curve for each amplifier submitted, also a frequency response curve, and to measure power output at actual grid current point.

Every amplifier enthusiast will agree that the objects aimed at by Mr. Straede are indeed worthy, but many will have doubts about the ability of any single human being to handle the detail work involved in conducting such a contest with a representative entry of from fifty to a hundred amplifiers.

To Mr. Straede we extend our best wishes for success to his ambitious proposal, but we hope that he will not be unhappy if, in spite of all precautions, the contest fails to settle the many debatable points about amplifier design and performance.

AN ALTERNATE DESIGN

A set which can be operated either as a superhet or as t.r.f.

WHEN designing a radio, various items must be considered—the components, the circuit, and most important of all, if a privately owned or a commercial unit—the cost. The ordinary 4/5 valve superhet, that was the best seller in A.C. sets, is really all the average man needs in the way of a radio. He is not looking for super selectivity or super quality reproduction, or does he require something that has an output of 20 watts, in fact, if he has an ordinary 4/5 superhet, it is rarely, if ever, used at its greatest volume. He usually is content to listen to 3 or 4 stations at the most and occasionally may switch over to short waves.

By

JOHN BRISTOE

Radio Manager,

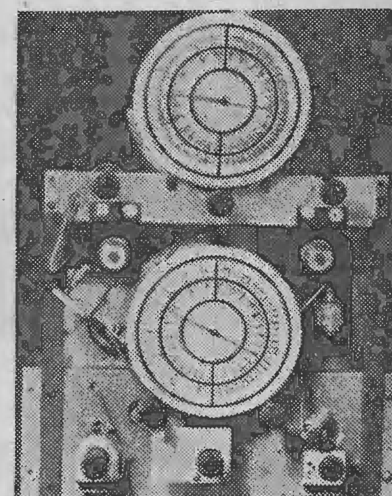
Denhams (M'bro.) Pty. Ltd.,

Tone Desirable

I have found from experience that very few people are able to tune into short wave or distant broadcast stations satisfactorily. They usually fluke it, and go to work next day proudly announcing that they had London or America on their radio last night and reception was better than the local station. However, next time, the short wave is tried the luck is not so good and the local station resorted to, and short wave forgotten. So, on the average, the ordinary little superhet with reasonable volume, tone and selectivity, is all that is required. However, it cannot stay at that; something better is necessary for those requiring really first class tonal quality or for those interested in DX work, whose hobby is getting distant stations.

Obtaining Parts

It is my object in this article to describe such a set. This task is rendered more difficult by the fact that in this country, even before the war, it was not always easy to buy first-class material for this work. For instance, to my knowledge, no standard gang condenser was available larger than the 3-gang and no coils other than the ordinary types, and so on. This lack being caused by the small demand and ever changing types of valves, etc. The war has further restricted parts buying and made these ordinary parts harder to get than before. Many people now find themselves in a position to own a really first-class radio, who could not afford it previously, and are doing as I did, rebuilding their old jobs to a new design. Most radio



fans have a few old sets about the place, and odd parts, and what is lacking can generally be supplied by the second-hand radio shops. Now here is a description of the set and what can be expected of it.

Two R.F. Stages

It is a powerful dual-wave set, with 2 r.f. stages, variable selectivity and a really good quality audio amplifier. There are many other

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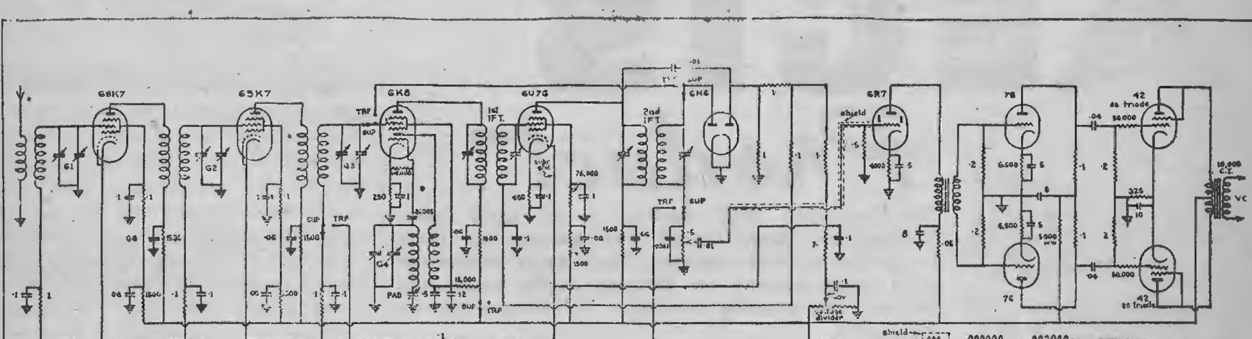

ALTERNATE SET

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features, but this is the main outline. It can be converted to a straight t.r.f. set by merely turning a switch. These features alone give practically everything that even the most fastidious person is likely to require in a radio. It is well to note that the cost of this set was not taken into consideration as I had all the parts lying about in my workshop. The set is now in regular use and results are very pleasing. It is important to use a good speaker on this set as one of the ordinary cheap jobs would spoil the effect. A Rola G12 is good, or if you happen to have a Magnavox S12 special high-fidelity speaker you have the ideal speaker for the job.

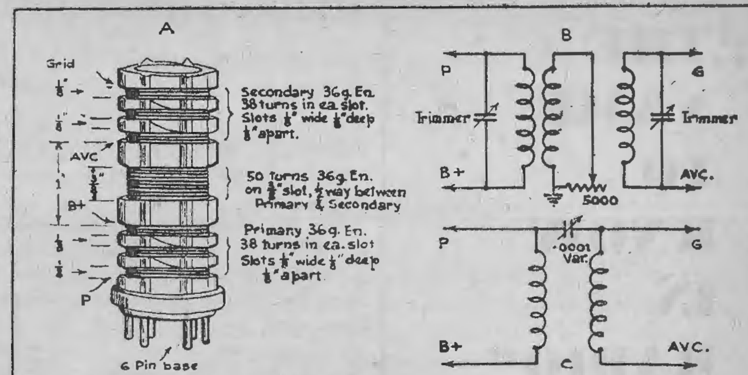
The Detector

In the design of this set I worked on the r.f. section first, then the a.f. and tone controls. Actually, the hardest section was left until last —the detector or demodulator. Although many people do not worry a great deal about this section in designing a set, it is a very important part as it is absolutely useless to design an amplifier for low distortion quality output if you are introducing a lot of distortion in the detector. The good amplifier would then make a good job of amplifying the distorted signals from the detector. So the snags arose as to what type of detector to use. I considered the possibilities of using leaky grid, anode bend or diode detector, and a few other ways really variations of these systems. It was decided that for signal handling capabilities the diode detector was most suitable as A.V.C. was essential in the set, preferably delayed A.V.C., but the problem was still not solved as to what type of diode detector was the best to use. The diode detector was good in most of the systems generally used, provided that the iput voltage is high and that A.C. shunting is reduced to a minimum. However, there are various snags in most of the systems especially if it desirable to use delayed A.V.C. as usually a certain amount of harmonic distortion is introduced.

Eventually I came to the conclusion that a triple diode system was the only answer to the problem. This system eleminates the troublesome effects that arise in delayed A.V.C. with diode circuits. Unfortunately, no valves are, or ever were, available in this country, to my knowledge, with 3 diodes, so it seemed that two valves had to be used for the detector stage. I notice that triple diode valves are available in England. Fortunately, I had a 6H6 duo diode which was a help, in order to avoid the use of a second valve, I used the suppressor grid of the i.f. amplifier as the third diode. Unusual, but it has been done, and is quite satisfactory. The valves used were rather a varied lot, but I happen to have a number to choose from and used what, in my opinion, were the best ones for the job. The 6SK7's in the r.f. stages are not commonly used in this country and can be satisfactorily replaced by 6K7G or 6U7G. As for the rest of them, I would suggest sticking to the types shown in the original and certainly would not suggest any attempt at substitutes in the detector and audio sections, except that the 42's could be 6F6G's. If it is desirable to have a greater output, two more 42's or 6F6G's could be put in parallel with each of the output valves. However, unless it is to be used in a very large public building or outside, you will have all the output required.

An Unusual Choice

Probably some of you will wonder why the 42's were used as the output valves. Well, not for the usual reason that other types were not available as in my spare parts I have a pair of 2A3's, 6A3's, 45's, 50's. All of these were tried thoroughly under various working conditions, but I found that for all-round tonal quality the 42's used as they are shown in the circuit give me better reproduction than any of the others. If anyone can let me hear or show me the circuit of anything better I should certainly like to compare them, but, believe me, it will certainly have to be good, as the reproduction from this set is absolutely marvellous. It gives almost a third dimensional effect. However, enough said about the performance. If you have the gear to build the job exactly as it is shown in the circuit, well, give it a trial. I am willing to wager that you will back up what I have said about it. But, be fair to the designer, either build it as it is shown or leave it alone. Don't try substitute methods or gear unless it is stated that substitutes can be used in the section in question. At last the dream of a real quality set was in sight, and now to work to **put all the sections together.**



CONSTRUCTION DETAILS FOR PLUG-IN TYPE 460 KC. I.F. TRANSFORMER
A.—PLUG-IN COIL. B.—SELECTIVITY IS VARIED BY MEANS OF 5000Ω POT. ACROSS 50 TURN CENTRE WINDING C.—ALTERNATIVE METHOD.

Diode Circuit

It will be noticed that the diodes on the 6R7 are not used at all. These could have been used in conjunction with the detector circuit but it is essential that 4 volts only be on the cathode or grid of the valve used as the third diode. Also as I used the amplifier section on a different chassis it would have introduced long leads.

Layout Tricky

As the wiring between the switch for the t.r.f. and superhet to the diode and grid must be very short, the layout for the set is a bit tricky, as it is necessary for the second detector to be very close to the converter and yet to avoid any chance of interaction between the r.f. and sections, so be careful with the layout. It is really important, and so is the shielding. Just forget all the other sets you built or have seen with the usual chassis and minimum of shielding throughout. Make this a real job. The best way is to work on a box system. In other words make each stage from the aerial to the audio and power pack in a separate shielded compartment with all metal shields effectively earthed.

The audio transformer can be any good make, preferably a Ferranti. If you have a good push-pull type all the better. It can be connected as a push-pull transformer then. Due to the shortage of one, I used the Ferranti as shown in the circuit. At the time this set was built I had no spare intermediates or could I buy any, so I decided to make them—full description of how to do this is shown later. The gang condenser was an old 4-gang that was on the Radiola chassis used. The band spread condenser was an old 4-gang Stromberg Carlson, actually a dual two-gang used originally in a set with separate gangs for shortwave and broadcast. The front two-gangs were normal E type, the back two had only a few plates, so I took all the plates out of each gang except two—one moving, one fixed, and coupled it in parallel with the main tuning gang and it made an excellent band spread. A separate dial was used and I mounted this above the main tuning dial and coupled it to the dial with a mecanno chain. This could also be done with a belt drive. The steel belts used on the very early model Atwater Kent or R.C.A. Radiolas would be ideal. These should be easily obtained from a radio dealer, who has any of these old timers lying around. The chassis should not present any great difficulty. I actually used 3 old chassis, one for the r.f. and i.f. sections, the other the audio amplifier and the third for the power pack. Make sure the

(Continued on next page)

ALTERNATE SET

(Continued)

chassis used for the power pack is substantial, as with the transformers and chokes mounted it makes a heavy job. The connecting leads from the chassis to chassis should be of heavy wire for any filament voltage. Preferably the type that is used for wiring motor cars, not the type used on spark plugs, but that used on head lamps. It is much heavier than the ordinary hook up wire.

The Sections

The first section contains the aerial coils, No. 1 gang, the first r.f. valve, and the first section of the wave change switch and the trimmers for this stage, and all the resistors and condensers.

The second section—No. 1, r.f. coils, No. 2 gang, second r.f. valve, second section of switch deck, the trimmers, condensers and resistors associated with this section.

The third section—No. 3 gang, second R.F. coils, third section of wave change switch and associated condensers and resistors, trimmers and the switch for the t.r.f. to super, shielded from the other components.

The fourth section contains the oscillator coils, trimmers, converter valve, fourth section of switch, and all associated resistors and condensors, etc.

The fifth section contains the first i.f. transformer with resistors and condensors, and i.f. valve.

The sixth section contain the second i.f. transformer, 6H6 valve, volume control, resistors, condensors, etc.

The seventh section contains the first audio with components, and 6R7.

The eighth section has the two 76's with audio transformer and components. Each valve to be shielded from the other, also components used on it.

The ninth section contains the two of four output valves, these to be shielded from each other, but plenty of ventilation allowed.

The tenth section contains the power pack to be built as one unit with the transformer, chokes, valves, etc., shielded from each other, but allow plenty of ventilation.

Do your shielding well and you will not be sorry.

I shall be pleased if builders of this set will write and give me their opinion of its performance when they have had time to try it out thoroughly.

Readers requiring additional information, please address your letters to the Radio Manager, Box 145.

Construction of I.F.T.S

The intermediate transformers for this set presented a problem, as I had no way of obtaining one with the required windings, so decided the only thing to do was make them. Although this may seem difficult it actually is fairly easy, and although our Australian manufacturers make quite a good article, I think these are just as good. Also, it is a very simple matter to incorporate variable selectivity at a very low cost. The cans used for the originals were old Radiokes coil cans, but if none of these are available, small cans such as contain cocoa, etc., can be used quite effectively. For simplicity in mounting I used $1\frac{1}{4}$" plug in coil formers ribbed type. These can be plugged into ordinary valve sockets and the trimmers can be mounted across the socket underneath the chassis.

Construction

First of all obtain the formers. The types used were Marquis brand. These formers are $2\frac{1}{2}$" long, that is the former proper. Standing on its legs on a flat surface, the unit is 4" high. The diamater from rib to rib is $1\frac{1}{4}$" outside. Measure it and put a mark in the centre Then measure $\frac{1}{2}$ and inch each side of this mark and file two slots into all the ribs about $\frac{1}{8}$" wide and $\frac{1}{16}$" deep. This will be almost down to the main former. Then measure $\frac{1}{8}$" from these slots and do likewise, and after these do another, working towards the end of the former all the time, of course. This now means you have a former with 6 (six) slots cut into each of the ribs, or two sets of three, one set 1" away from the other set. The slots are to take the primary and secondary windings, of course. The easiest way to cut these slots is to use a file 1/8" wide, either a small square one or a flat file 1/8" thick, and provided you take care to make your measurements accurate and make a careful neat job of the filing the finished article can look and perform like a good professional unit. The diagrams show how to wind the coils. Now the unit is finished and ready to mount unless you decide to incorporate variable selectivity. There are a number of ways this can be done, but I have chosen two only which in my opinion are the simplest. First type variable selectivity by means of a variable condensor connected between the primary and secondary, on the plate and grid ends. By adjusting this condensor you automatically vary the coupling between the plate and grid or plate and diode as the case may be, and thus you have a simple, but very effective form of variable selectivity which is an advantage on any superhet that is designed for quality reproduction. Quite a number of people have the idea that the actual tonal quality of a receiver depends on the audio amplifier only. This is a bad mistake as the detector i.f. and r.f sections have quite a lot to do with it, If super selectivity is wanted, you cannot have super quality reproduction at the same time, but by incorporating variable selectivity, it is possible to have either at will provided the set is properly designed. The second system is entirely different and consists of a third coil wound between the primary and secondary winding. The inductance of this is varied by means of a variable resistor across it. By test a 5,000 potentiometer did the job quite well. The trimmers used across the primary and secondary windings require a capacity of about .00025. These can be obtained from old burn-out intermediates.

ANOTHER AMPLIFIER CONTEST

John Straede, well-known Melbourne radioman, has announced that he is organising an amplifier contest in conjunction with "Radio Times," the Melbourne broadcasting weekly. The contest is open to amateurs and radio servicemen.

Already a fine prize list is asslred, support having been promised by Homecrafts, Hartleys, Repco, Warburton Franki, Collins Radio and other Melbourne firms.

Having followed previous amplifier contests intently, Mr. Straede has drawn up elaborate rules to govern the contest and the judging. If space permits, these will be published in full in next month's issue. Intending competitors should not wait for these, however, but should get in touch immediately with Mr. Straede at 7 Adeline Street, Preston. 'Phone: JU1814.

SQUARE WAVE TESTING

Some details of the latest method of checking audio amplifiers

By

CHARLES MUTTON

1 Plow Street, Thornbury, Vic.

UP to the present time in Australia most testing in audio work has been carried out with the beat frequency oscillator and cathode ray oscilloscope plus a means of measuring input and output voltages. While there is nothing wrong with this method, it can be said that at least it lacks speed. To plot a frequency curve of an amplifier in actual production is to say the least a bottleneck. To-day the prime requisite in production is speed, and the general trend in America seems to be toward using the technique of square wave analysis in connection with audio work. In fact, in video frequency amplifiers as used in television, square wave testing is the only satisfactory means of measuring their performance.

Generating the Wave

The square wave in itself is not hard to produce, but requires a fair amount of practical use and comparison work in order to be able to interpret results. It will probably have been noticed by many of our more advanced readers and servicemen who are fortunate enough to possess a C.R.O. and a B.F.O. that by overloading a voltage amplifier or power output stage severely the usual sinusoidal wave shape takes on a decided rectangular shape on the C.R.O. screen. Due to the sloping sides of the waveshape it is not a true square wave but closely approaches it.

Rich In Harmonics

When it is realised that a distorted waveshape contains, or is extremely rich in harmonics, one is well on the way to understanding the theory behind square wave testing.

With the B.F.O. method of testing the prime requisite is that the output waveform of the B.F.O. be absolutely free from distortion and in the better class jobs filters are included to guard against unwanted harmonics. However, in the case of the square wave it has been shown by many investigators that a square wave pulse contains all frequencies, fundamentals plus a terrific number of harmonics. Therefore it will be readily seen that any apparatus which will successfully pass a square wave at one particular frequency will be certain to give a good performance over a wide range with regard to a sinusoidal wave. Thus it become possible to see at one glance just how good the frequency response will be by being able to interpret the square wave output pattern on the C.R.O. screen.

Methods of Producing Square Waves

One method of producing a square wave is to clip portions of a sine wave in a series of stages so that only waveshape with substantially vertical sides is left. The basic circuit using diode clippers is shown at fig. (1) with its resulting output voltage. This circuit works in the following manner. The two diodes are biased in such a way that the output voltage increases with input voltage in the normal manner until the impressed voltage is equal to the biassing voltage. At this instant current commences to flow in one of the

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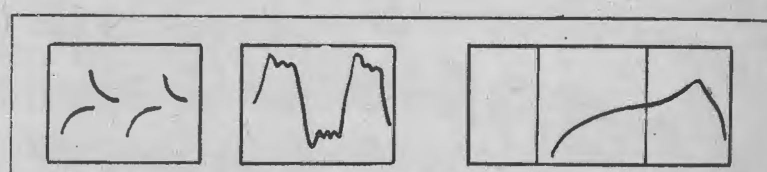
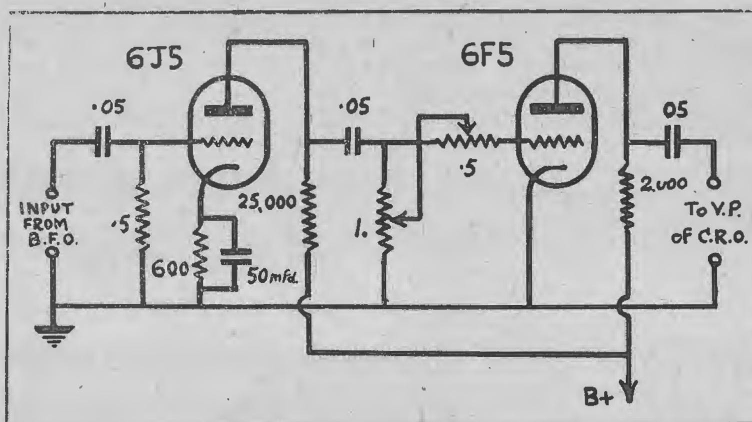


Examples of square wave patterns produced by audio amplifiers having frequency responses as shown alongside. Incidentally this example also gives an indication of improvements in audio transformers over a period of fifteen years.

SQUARE WAVES

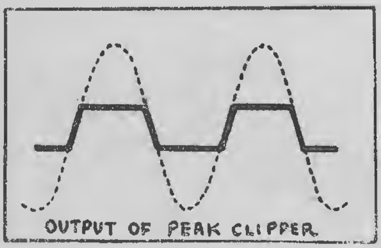
(Continued)

diodes and the RI drop in the series resistor prevents a rise of output voltage. The output waveform of this set up can be amplified and applied to another diode stage in order to make the voltage changes more abrupt. This is done until the wave shape assumes a true rectangular formation. A simple way to obtain the same results is to work an ordinary voltage amplifier on zero bias and then put an extremely large input to the grid which will result in the flow of grid current, which will produce a square wave output or near enough to it. One commercial audio oscillator uses this scheme and to bring this about, merely shorts out the bias resistor in one of the buffer amplifiers and then overloads the tube as just explained. For those interested a simple circuit which will produce a square wave for normal testing purposes is shown herein. Its action is as follows: The output of any audio variable frequency oscillator is applied to the input of the 6J5 from here it is subsequently amplified in the tube until the amplitude of oscillations is large in comparison to the normal grid bias on the 6F5 tube. During the positive cycle the grip voltage reaches a maximum positive value of 2 to 5 volts, depending on the adjustment of the .5 and 1 megohm potentiometers. The plate current is at a maximum at the same time. The input voltage, however, continues to rise, the increase being absorbed across the .05 coupling condenser (which charge is



Simple circuit which will produce square waves for normal testing purposes. An even simpler method is to use a valve without bias as the first amplifier.

negative) and the .5 potentiometer. When the signal reverses the plate current cuts off at some small value of grid voltage as a result of the high negative charge across the .05 coupling condenser. This cut-off value is reached early in the cycle. The plate current thus remains at cut-off for a longer time than at its maximum value. Pulses of un-



equal sizes will thus be produced, but the inequality can be partially compensated for by adjusting the two potentiometers or by using a follow-up tube after the waveform distorter. This does not represent the ultimate in square-wave design but will be adequate for most experimental purposes.

A comparison test has been suggested by W. R. Hewlett of the Hewlett-Packard Co. in America, for testing audio amplifiers. The procedure is to apply a square wave simultaneously to an amplifier or network under test, and an ampli-

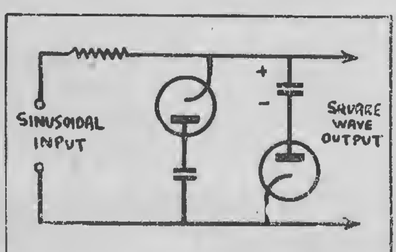


Figure 1, showing method of using diode clippers to provide square waves.

fier or network that is the standard of comparison. The output of one provides the horizontal deflection and the other the vertical deflection in a C.R.O. If the two systems are identical the resulting pattern will be a straight line, but if the characteristics differ for any one of the frequency components contained in the square wave, something other than a straight line will result.

As a guide some curves and output waveforms are given here which were contained in a paper on the subject of square wave testing of audio transformers produced by the General Radio Co. Comparing the square wave output waveform against the respective frequency curves tells the story. In conclusion one feels that square wave testing is here to stay and will no doubt be adopted by many firms in their post-war plans.

MONEY IN TELEVISION

Approximately twenty-five million dollars has been invested in American television research, according to the Vice-President of the Philco Corporation.

"Probably never before has the product of a great new industry been so completely planned and so highly developed before it was offered to the public as has television," he said recently.

AESTHETICS OF REPRODUCTION

Some further notes and advice

THE following notes are intended to deal with most of the points arising from the article under the above title which was published in our December issue, having been reprinted from the English "Wireless World." It is hoped that the information given will avoid the necessity of letters having to be written and answered on technical matters.

The Choke

A number of readers require information on the 3-henry air-cored choke. Fig. 1 gives a simplified version of the original design suitable for amateur construction. The coil former is an assembly of five 3½in. diameter laminated bakelite discs ⅛in. thick, spaced by four 1½in. diameter discs ¼in. thick. These latter could be hardwood, ebonite or the like. The whole is held together by a 2BA stud and nuts, and large washers should be used against the outside cheeks to support them. The former is then wound full with 40 SWG enamelled wire. Taps are conveniently brought out at the end of each section. It will be appreciated that the first slot should be filled, then the second, and so on.

As A Unit

A suitable control unit external to the cabinet is indicated in Fig. 2. The components shown are mounted on a small metal panel, and the back of the panel and the components are enclosed in a moderately substantial screening box. The various leads connecting the controls to the radiogram are of good-quality single-way screened flexible wire, the screening braiding being bonded at each end, and used as the earth return. The leads can be up to about 6ft. long without noticeably impairing the performance of the complete instrument. Such an external control box is very convenient, and well worth the trouble of making carefully. The components are numbered to agree with the numbers on the complete circuit diagram which appeared in the August issue.

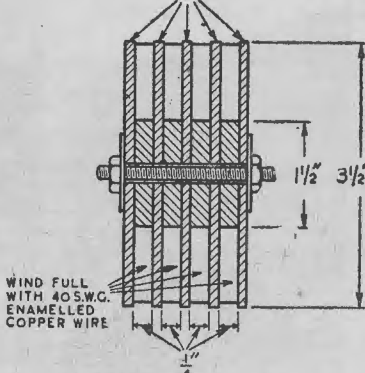


Fig. 1. Constructional details of a 3H choke, suitable for amateur construction, which can be relied upon to give good results in the circuit described in the original article.

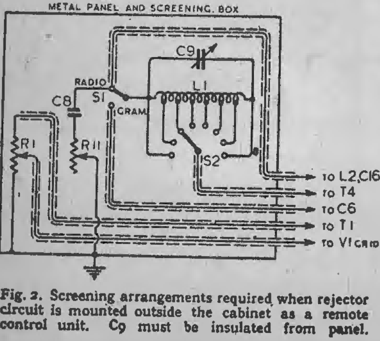


Fig. 2. Screening arrangements required when rejector circuit is mounted outside the cabinet as a remote control unit. C9 must be insulated from panel.

At this point it might be as well to clear up one or two obvious errors or omissions which found their way into the original article. In the circuit a blocking condenser should be inserted between the "Radio" contact of S1 and the junction of L2 and C16 to keep DC out of the coupling transformer primary and to preserve the correct DC cathode load in the detector stage. In my set this condenser has a value of 0.5 uF. The current rating of the 5-volt heater winding for the rectifiers should be 4 amps., not 2 amps., as stated in the list of component values.

I am sorry that I cannot undertake to offer critical comments on readers' equipment. Such requests do really miss the point of my contribution, which was to express a point of view on musical reproduction. My argument was that "high fidelity" was not enough, and I gave a slightly philosophical thesis on the artistic reproduction of music. In the course of my argument I pointed out that the basis was equipment capable of reproducing all frequencies equally between 32 and 10,000 cycles per second, and purely as a matter of convenience to my readers I gave a description of an instrument which I had designed myself as a basis for my experiments. My contribution is not a "constructional article," and the description of my own radiogram is not an essential part of my thesis. In these difficult times I just have no idea where the various special bits and pieces can be obtained. To get my own instrument completed I had to exercise all the guile I could muster, and I can only recommend my readers to do likewise.

Selecting Records

Choosing records is not quite such a pig-in-a-poke as it used to be, provided certain points are borne in mind. Nearly all the records of American orchestras are poor recordings in varying degrees. This, apparently, is due to the fact that American radiograms are all bottom and no top, so the records are all top and no bottom. Unfortunately, this cannot be remedied by cutting top and boosting bass, for the top is so distorted and scratchy as to be painful. "Attack" is poor, and the piano sounds like a cross between a harpsichord and a banjo. On the other hand, new English recordings are good and sometimes superb. H.M.V. records numbered C3000 and upwards, and Columbia DX1000 and upwards are generally a safe buy, and no doubt certain Decca records are equally good, but I have not tried them on my own machine. The British Council H.M.V. records are all good, and

(Continued on page 26)

FILING YOUR RESISTANCES

■ There must be many radio enthusiasts, who, like myself, spend much of their spare time pottering around in the workshop, making new pieces of equipment or effecting improvements to their sets.

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

ONE often decides to try out a new circuit or modification, following which it becomes necessary to procure extra component parts. It is generally found when searching through the junk box that most of the bits and pieces required are available in some form or other, but there are always one or two things missing which often, these days, are difficult to purchase and involve a waste of time walking from one shop to another looking for them.

Such is the case with resistors. No matter what one wants to do, a certain number of these is sure to be required. I recently became tired of finding that the necessary resistors to effect a few minor alterations were not readily available. Here is the way the difficulty was overcome; if you are not already using the system yourself, it is passed on for what it is worth.

Saving Money

New carbon and wire wound resistors cost a lot of money these days if purchased in any quantity, and to buy a hundred or so of miscellaneous types to ensure having in stock any odd value required, eats a hole in one's pocket. Therefore, why not make a habit of procuring all the odd secondhand resistors possible? Quite a few radio shops in Melbourne have junk boxes full of secondhand and broken components on their counters and generally there are a few resistors in each of these. Other shops are willing to sell cheaply, a dozen or so secondhand resistors, which they normally throw away, provided you are willing to take the responsibility if they turn out to be faulty.

Choose Carefully

It is suggested that, if you are continually doing experimental radio work, procure as many of these as possible until you have at least four or five dozen miscellaneous types. When purchasing them, it is of course necessary to inspect each one closely and make sure that carbon types have not been severely overheated, that the connecting leads are not loose, and that no viable break appears in any wire-wound types under consideration.

Testing

Assuming your first batch of these components has been obtained, it becomes necessary to test them for resistance, continuity and general utility. It is most likely that some will be intermittent, or noisy and therefore careful examination must be made to ensure these are destroyed, so that they will not be later incorporated in a piece of equipment where they may cause endless trouble.

Points to Watch

Each resistor should be tested as follows: Firstly, examine it closely for obvious electrical and mechanical defects. Make sure the leads are not loose and that in general appearance it looks satisfactory. Then check the actual resistance of each one separately with the ohmmeter section of a multimeter. Tap the unit occasionally while it is being tested and see that the meter needle does not flicker, showing an internal intermittent break. Some resistances will register a steady reading in ohms on the meter and then will gradually alter in value, as indicated by creeping of the meter indicator. These, of course, are useless and should be

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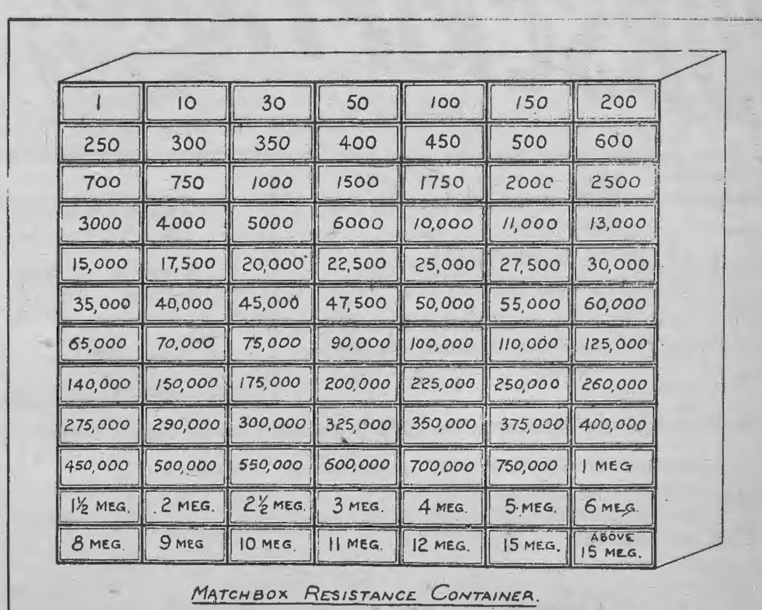


Match boxes are used to build this filing cabinet for resistances.

RESISTANCES

(Continued)

disposed of immediately.

Practically all carbon resistors increase in value with age and use; therefore, it will be found that in many cases, the true value of the unit will not correspond with its colour markings. Although in the average practical application, it does not matter very much if a resistance is greater or less by 20 per cent. of the rating specified in the circuit, it is definitely desirable to know as accurately as possible, the correct resistance value. To do this, it is necessary to measure all units separately and then put them away in some type of box having a separate compartment for each value.

A Filing Cabinet

An admirable container of this description can be made from empty match boxes, glued together with strips of paper between each layer (to strengthen the assembly), so as to form a miniature chest of drawers. Each box has marked on its end the value of the resistors which it is to contain.

When building one of these containers, about eighty match boxes are required. One third of these can be labelled with the range of resistance values generally readily available, such as 10,000, 25,000, 50,000, 100,000 ohms, etc. The balance are used to house units which are either special or which differ slightly in actual value from the standard sizes. For example, if one is testing ten resistors, all supposed to be 50,000 ohms, it will probably be found that their actual values vary from 45,000 to 65,000 ohms. It therefore pays to have boxes side by side, marked 45,000, 50,000, 55,000, 60,000 and 65,000 ohms, so that the ten units concerned can be separated and kept in these groups. Reference to the diagram in the text will indicate the values found most suitable by the writer to cover the range of available types.

Each match box compartment will easily hold five or six one-watt carbon resistors or ten to twelve of the ½ watt type. About three of each of the commercial type of small wire wound units will also fit in any one compartment.

When checking the values of resistors with a commercial multimeter, do not expect the readings obtained to be too accurate. If, on the average, they are within plus of minus 5 per cent, the instrument is quite a good one. The main thing is that any such meter will indicate accurately which is the larger of two resistors with the same colour coding—they will seldom be found exactly equal.

Disregard Coding

When the value of a resistor is determined, it is put into the matchbox compartment bearing the closest number to that of the measured value, whether its colour coding corresponds to that value or not. It is astonishing the number of resistances housed in the assembly which differ considerably in rating from that specified by their colour markings.

By adopting this procedure, one knows that when a resistance is taken from one of the compartments at a later date, it is within a few per cent, at the most, of the value written on the box, and that it is larger than the units in the box before it and smaller than those in the box after it. This is most important when building many types of test equipment, such as in cases where a resistance network with a meter in it must be such that the meter gives a certain reading under specific conditions. If a resistance is chosen for part of this network and found to be just too small, then one of those in the next compartment to that which the original unit came from, will probably be satisfactory.

A Tested Scheme

The procedure outlined above is excellent in practice, as it cuts in half the time wasted looking for specific resistance values in a pile of unknowns at the bottom of a junk box, as well as making available a fairly complete and cheap stock of good resistors when specific selection is required.

Some readers may say that using second hand resistors in new equip-

(Continued on page 34)

MAKE YOUR OWN SELENIUM CELL

The first of a series of articles on applied electronics

IN the past twelve months it has become most noticeable in overseas technical literature that manufacturers who advertise therein, are striking a new note, the whole trend and text of the advertisements show a marked tendency to push electronics to the fore. In pre-war days the main text of advertisements seemed to be radio receivers, public address systems, and component parts. Then war broke out, and manufacturers were forced to take on a more sombre attitude, and we found in almost every case prominent firms saying, "Due to increased war production and a speeding up of the war effort we find it no longer possible to keep up civilian supplies, but we have not forgotten our friends, etc., etc." Many will doubtless wonder why at this stage the subject of electronics crops up so frequently.

Industry Conscious

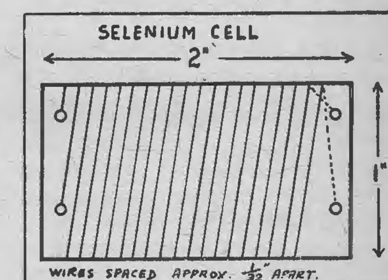
Firstly Australia is primarily a primary producing country and a young one, so that industries have more or less taken second place, but since war broke out Australia has become industry conscious and has accelerated the growth of industry enormously. As a result of this enormous growth the science of electronics has also received a tremendous boost. This fact must then be brought home to the radioman to-day that the radio trade in post-war period will be obliged to extend its activities much further afield than the mere manufacture of receivers for entertainment, electrical appliances test equipment, etc. Food factories are going to need ph meters for measuring the ph content of food for public consumption, engineering firms will require electronic micrometers involving the use of the cathode ray oscilloscope for extremely accurate measurements, such things as photometers, spectrophotometers, densitometers, all connected with photography, will find many uses. Just these few items mentioned have not yet been really manufactured here in Australia, and have mainly been imported. What a rich field for the progressive radio service man, experimenter, etc. Having now put the case for electronics forward, it is intended that, circumstances permitting (and the editor) to start an electronic section in this journal, which will start off with the fundamentals of electronics and progress as time goes on to the more complicated side of industrial electronics.

Importance of the Vacuum Tube

Of outstanding importance in all phases of electronic engineering is the vacuum tube in all its different guises, the cathode ray tube, thyratrons or gaseous triodes voltage regulators and photo electric cells; these four form the fundamental basis of all electronic work. The first named, of course, playing the most prominent part. As it is proposed to discuss each in turn it would perhaps serve as an introduction to take phato-electric cells first, as they are probably the easiest to understand..

Photoelectric Cells

The photoelectric cell performs the function of converting light in its various forms into usuable electrical energy. The cell performs this function with a minimum of time lag and as a result, will repond faithfully to light variations up to reasonably high frequencies. In the ordinary triode, pentode, vacuum tube we are all aware that upon the heater or filament being heated electrons are liberated. In the photocell precisely the same thing happens but it is brought about in a different manner. Instead of a given voltage being applied to the filament, a ray of light is directed on to the cathode of the cell which by reason of a coating of light sensitive material gives off electrons. The number of electrons given off is dependent on the amount of light to the cell, the material on the cathode and the colour of the light. The plate in a photocell performs the same function as the plate in any ordinary vacuum tube, i.e., the amount of plate voltage will, to a large degree, determine the current or number of electrons drawn from the cathode and is supplied in the usual manner with a positive potential large in comparison with that at the cathode. However there is a physical difference in a photocell plate and that is, it takes the form of a ring or some type of mesh, in order that the light beam will not be impeded on its way to the cathode.



Constructional details of a simple but effective photo-electric cell.

The Lumen

It might be advisable at this juncture when we are discussing light to give the definition of the "lumen" which is used to express light as a quantity. "The lumen is the amount of light that would be received by unit area from a light source of one candlepower placed at the centre of a sphere of unit radius, assuming, of course, uniform radiation in all directions.

One of the earliest photocells was termed the Potassium Cell, and was so named due to the deposit of potassium which was deposited by distillation on one side of an evacuated bulb. The potassium performed the function of the cathode. The plate was formed by a metal ring. The main disadvantage of this early cell was its extremely poor emission qualities, limited to about two

(Continued on next page)

SELENIUM CELL

(Continued)

microamps per lumen of light. However, in certain applications, this type of cell has the advantage in that the cathode emission is proportional to the light on the cathode.

There are two main types of photocells in use to-day and these are divided into firstly, high vacuum and secondly the barrier layer, or self-generating type.

The first type is similar to the description just given for the Potassium cell, except that improvements have been made in the various chemicals, usually the alkali metals, used for the cathode material. As stated previously the current with this type of cell is quite small, hence they are mostly used in conjunction with an amplifying system, in order to boost the current to sizable proportions required for control purposes These types of cells always require an external potential be applied to them for operation.

Self Generating Type

A self-generating type of photocell is different in construction from the high vacuum type just discussed, and usually in simple form consists of a metal plate on which is deposited a semi conducting surface, typical examples being copper, cuprosis oxide selenium and iron. For example in the well-known Westinghouse metal rectifier we have a copper oxide surface separated by an alternate series of lead washers. In the Westinghouse photocell the surface which is exposed to the light source is composed of copper oxide, one connection goes to this surface and other to the copper underneath. On being exposed to a light source, a flow of current starts from the oxide to the copper. This takes place without any application of external potentials and under such conditions the output from the cell is something like 120 micro-amps per lumen. This type of cell, however, suffers the disadvantage that the internal resistance is extremely low.

Selenium Cells

Departing from the two types of commonly used photo cells, it might be just as well to touch lightly on a chemical substance called sele. nium A selenium cell differs from the usual photo electric principles, but merely changes its resistance with light. However, in general, selenium cells are cheaper than photo-cells, and by means of a ray of light can control simple circuits such as burglar and fire alarms, trick advertising stunts, door bells, etc.

The main disadvantage with the selenium cell is the fact that its response to light is not instantaneous and hence suffers from what is known as a time lag. In fact, it has been shown in early experiments with this type of cell, that even when completely cut off from light action, a steady current passing through it does not attain a steady value. This is due to the fact that the selenium cell is rather unstable in its internal resistance properties due to temperature effects and also polarisation.

When subjected to light the current curve of a selenium cell rises rapidly at first, then at a slower rate and takes a short period to attain maximum output.

A second disadvantage is that when subjected to light for long periods, the current in the selenium cell drops off badly. However, the selenium cell is probably the ideal thing for the home experimenter as they can be made quite easily and economically, two factors which gives it many attractions for the man who likes to "make his own."

Constructional Details of the Selenium Cell

The first requisite in making a selenium cell is the chemical itself, i.e., selenium. The selenium for our purpose is usually sold in stick form, somewhat similar to a stick of solder and may be purchased from wholesale manufacturing chemists or firms like H. B. Selby & Co., of 393 Swanston St., Melbourne. The cell is constructed on a small sheet of mica, the size being immaterial, usually 2in. by 1in. A small quantity of copper or German silver wire will be required about 30 s.w.g. Philips type 4003 audio transformers, one of the old timers, had the secondary wound with German silver wire, many experimenters will have one with a burnt out primary, and thus can pull the transformer down. The German silver wire is not, however, essential, and as copper wire is far easier to obtain it would be just as well to stick to copper. By glancing at fig. 1 the method of construction can be seen, and somewhat resembles a mica card type of non-inductive resistance, the two wires terminating in two holes in the mica for connections to external circuits. The selenium now has to be heated to approximately 220° C. at which temperature it will spread readily on to the mica. By placing the cell on a small sheet of copper, on putting this copper on the gas flame, the heat will be distributed evenly. A guide to temperature will be the condition of the selenium when melted sufficiently. If the temperature is excessive small bubbles will appear on the surface of the selenium, if two low the selenium will exhibit a greyish tinge.

Applying the Coating

Apply the selenium as evenly as possible over the mica and make the layer three to four thousandths of an inch thick.

After applying the selenium remove the cell from the copper and allow it to cool slowly. When this is done replace the cell on the plate again and bring to a heat just below melting point, allow the cell to cool slowly again and repeat the same procedure two or three times. This procedure, known as annealing, is a most important one to assure success. This article serves merely as an introduction to the simple types of cells, in a coming issue of this journal we will deal with some practical experiments which will help towards a better understanding of P.E. cells and their application.

(Watch for the next issue of this series in an early issue.)

A SHORT COURSE IN RADIO

THE ELECTRON THEORY

■ The phenomena of electricity and radio may be accounted for by the electron theory; so to begin, we will learn something about this theory.

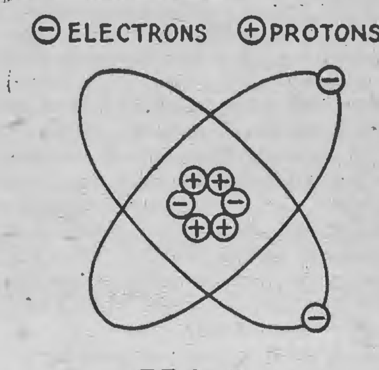


FIG. 1

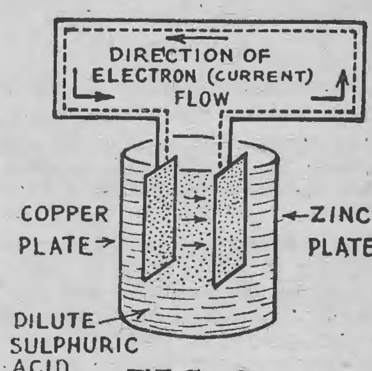


FIG. 2

THERE are 92 different elements which in one form or another compose all matter; aluminium, hydrogen and sodium are three of these elements, which may exist in a free state, or chemical unions with other elements, these unions are called "compounds."

If a piece of iron, for example, could be magnified many billions of times it would not appear as a solid but as millions of separate units separated by fairly large spaces, these units are called molecules. A molecule is the smallest part of a substance that can exist in a free state and yet retain the properties of the substance.

Molecules, it is believed are in continual state of agitation, as the substance is warmed so this agitation will increase, and when cooled decrease.

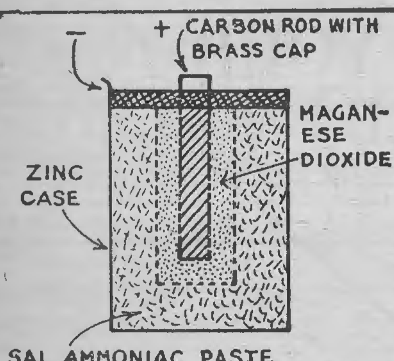


FIG. 3

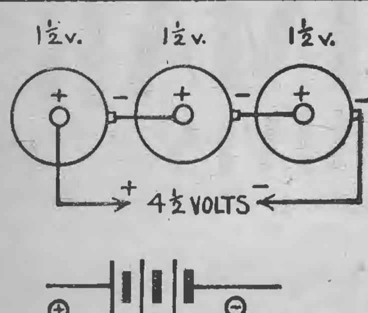


FIG. 4

Molecules

Molecules are comprised of smaller units called "atoms". Except in the case when a molecule is composed of a single atom, an atom is not capable of independent existance for any length of time. The atom is an assembly of even more diminutive things—minute particles of negative and positive electricity.

The core, or "nucleus" of the atom consists of a positive charge of electricity which may be made up purely of protons (+) or a combination of protons and electrons (—), however in a neutral atom the resultant charge is always positive. For an example we will examine a helium atom, Fig. 1; it can be seen that the nucleus consists of four protons and two electrons so the resulting charge will be positive, to neutralise this positive charge the atom is provided with two planetary electrons.

Conductors and Insulators

As we all know some substances will conduct an electric current freely while others tend to oppose it. If we grasp the rubber insulated portion of two wires connected to the "mains" we can hold them all day without any discomfort as there will be no current flow through our body; if we now feel reckless enough to touch the two copper conductors we will either finish up in a coffin or with the knowledge that copper conducts electricity. Now if we connect up a piece of this rubber insulated wire to a few thousand volts and would like to be thrown across the room without any idea of jumping on our part just bring the hand slowly towards this wire, even the "insulated" part, and when there is still a couple of inches of air still separating it from the wire and the so-called "insulation" a nice big spark will jump out to the finger, we will then be thinking of things far removed from insulators and conductors as we lie in the corner of the room. From these

FUNDAMENTALS -- Part 1 -- Starting Now

experiments we learn that a conductor will offer little opposition to an electric current, and an insulator is an insulator until a sufficiently high electrical pressure is reached; actually even at low electrical pressures an "insulator" will still conduct a very small part of the current. A conductor, no matter how good (silver is the best) will still offer a small opposition to the flow of an electric current, so that there is no definite line of demarcation between conductors and insulators.

Ions

If a suitable force is applied to an atom it will be made to lose an orbital electron so that the atom will not be neutral but will have a greater positive than negative charge, this unbalanced atom is called a "positive ion" and will exert a strong attraction to any electrons that may come in its field of influence, and thinks nothing of stealing an electron from its neighbour if it gets half a chance.

When a neutral atom is forced to receive an extra electron it will possess an excess negative charge and is called a "negative ion." This atom is as pleased to lose this excess electron as the positive ion is to regain one, so it looks as if atoms have one object in life, that is to remain normal. It is unusual for an atom to gain or lose more than one electron at a time.

Electrical Generation

The statement that "electricity is generated" is very confusing, for it is no more generated than a water pump generates water; the pump causes water already in existence to flow through a circuit of pipes, and an electrical generator causes electrons already in existence to flow through a circuit of conductors.

It should be evident that if we could get a bundle of negative ions in one position and a bundle of positive ions in another, join them with a suitable conductor the ions would exert their respective influences and a "conduction current" would flow.

It is as well to point out at this stage that an electron flow is from negative to positive while the current flow is regarded as being from positive to negative. This difference can be blamed on our scientific forefathers.

Primary Cells

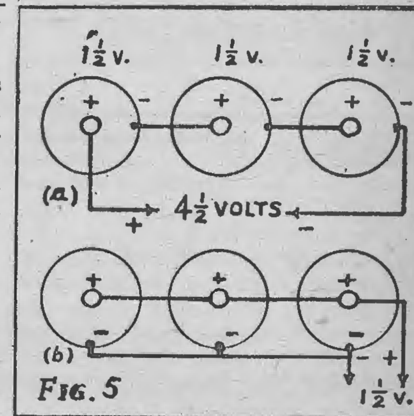
If a plate of zinc and another of copper are immersed in a dilute solution of sulphuric acid, what is known as a primary cell is formed. When the two plates are joined with an electrical conductor a current will flow through it. Fig. 2.

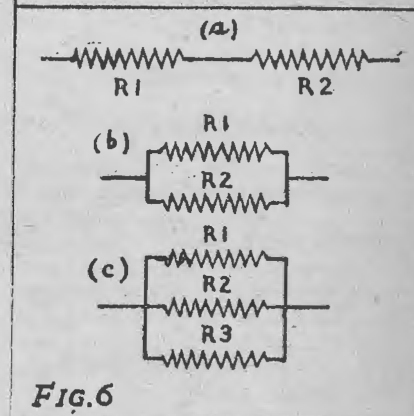
The acid attacks the copper, robbing its atoms of some of their electrons which then pass over to the zinc plate; a lot of the copper atoms will be positive ions having a deficit of electrons, while some of the zinc atoms having an excess of electrons will be negative ions, so, as before, a conduction current will flow through the conductor.

A secondary cell, or accumulator as it is more commonly known, has a different operation in which the chemical action is rather complicated and beyond the scope of this book. It consists of two lead plates immersed in a dilute solution of sulphuric acid. Before it is possible for a cell of this type to generate an electric current, it first must be charged with an electric current; actually in the charging process the cell converts electrical energy into chemical energy and when discharging converts the chemical energy back into electrical energy. When a single accumulator is charged its voltage is 2, which it retains until it is almost completely discharged. In applications where heavy current flows are required an accumulator is usually much more suitable than a dry cell.

Dry Cell.

A dry cell is not really dry—if it were it would not work, as the moisture contained in the active paste within the cell is essential to its





Above, figure 5, showing two methods of battery connections. Below—figure 10 showing (a) resistances in series, (b) and (c) resistances in parallel.

operation. This is why all dry batteries should be kept in a cool place in order to obtain the longest service from them.

Figure 3 shows the internal construction of a dry cell. The outer case is of zinc, which forms the negative pole. Next comes a lining of the active material, which is generally a paste of sal-ammoniac and plaster-of-paris or gelatine.

The Positive Pole

In the centre of the cell is a rod of carbon (the positive pole) and this is separated from the sal-ammoniac by a layer of manganese dioxide, which prevents a chemical action taking place that would im-

Continued on next page)

ELECTRONS

(Continued)

pede the efficient working of the cell.

When fresh, the voltage of a cell of this type is a little over 1½ volts. By connecting two such cells so that the positive terminal of one is joined to the negative terminal of the other, the voltage between the two free terminals will be double that of a single cell. With three cells so connected, the voltage would be three times that of one and so on. This is illustrated in Fig. 4, which also shows the theoretical symbol used in radio diagrams to represent a battery of any kind. The short heavy stroke denotes the negative terminal and the thin long one the positive. Cells connected in this manner are said to be series connected.

Parallel Connection

Another way in which cells may be connected is in parallel, Fig. 5 (b), it can be seen that the positive terminals are all connected together, an dthe negative terminals connected in a similar manner. The advantage of this connection is that in certain circumstances two cells so connected will give more than double the life of a single cell. No matter how many cells are parallel connected the resulting voltage will be no more than that of a single cell.

High tension or "B" batteries are made up from dozens of these small cells linked in series. A 45-volt H.T. battery consists of 30 such cells.

Conduction Current.

Use has been made of the term "conduction current" and this is the type of current that flows through a conductor when it is connected to the terminals of a generator.

As copper is the most commonly used of all the conductors it will be used as an example. A copper atom is provided with 29 orbital electrons, nearly all of which are held firmly in place by the attraction of the nucleus, but there is one electron when moving through its orbit passes much further from the influence of the nucleus. These "free" or "mobile" electrons are readily interchangeable and wander from one atom to another in a haphazard fashion.

When this piece of copper is connected across a generator these "free" electrons come under the influence of the applied voltage and move in a regular direction from the negative terminal to the positive and will continue to pass around the circuit while a deficit of electrons exist at the positive connection and a surplus at the negative.

The units of measurements are:—

Electricity . . . . Coloumbs.
Electric current
Coulombs per sec. Amperes.
Potential difference . . . . Volts.
Resistance . . . . Ohms.

Coulombs.

A coulomb is a measure of quantity of electricity and is denoted by the sign Q and is equal to 6.29×10^{18} electrons (nearly 10 million, million, million).

Potential Difference.

Potential difference is the result of the difference in the number of electrons between the two points in question. It is not necessary for one body to be positive and the other negative. If one body is 50 units positive and the other 100 units positive, the first will be 50 units negative to the second, so it can be seen that it is the algebraic potential difference between the two bodies that is the deciding factor.

Electromotive force, abbreviated as E.M.F. is the expression that is used to donate the pressure due to potential difference and is expressed in units called "volts."

Electric Current.

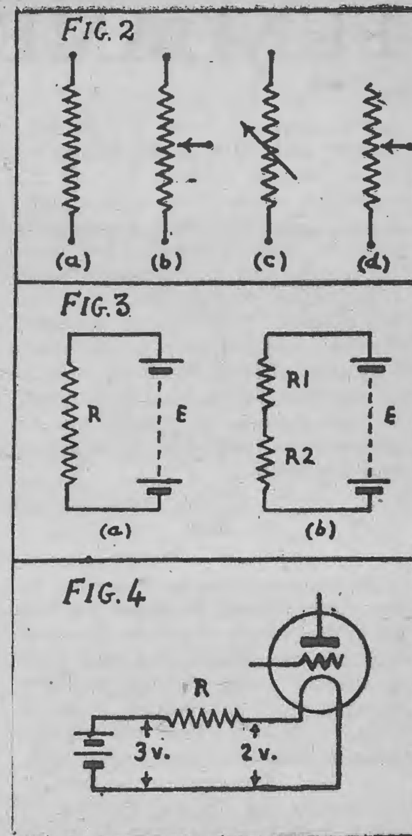
The manner in which an electric current passes through a conductor was explained under "Conduction Current."

The rate of flow of electricity is stated in "amperes," usually abbreviated to amp., and is the flow of one coulomb per second.

Current is donated by the letter I.

Resistance.

It was shown earlier that some substances offer little opposition to the flow of an electric current; copper, silver, etc., owing to their



Top, figure 6, showing symbols for resistances and variable resistances. Centre—figure 7, showing resistance connected across the output of a battery. Bottom—figure 9, which shows how a resistor can be applied to a filament circuit to apply two volts to the filament from a 3 volt battery.

free electrons and that others offer great opposition to the passage of an electric current; rubber, wood, glass, etc.; in which all the electrons are held firmly in their atoms by the attraction of the nucleus.

A length of a certain substance, of fixed cross sectional area, has a certain resistance, and if this length is doubled so will the resistance be doubled. For a fixed length of wire and doubling the cross sectional area the resistance will be halved.

The Circuit Symbol

A zig-zag line is used to depict all kinds of resistances, there being minor variations to differentiate between various types.

Fig 6 (a) shows the way an ordinary fixed resistance is represented, while the symbol for a potentiometer, which is a special kind of variable resistance is illustrated in figure 6 (b). An ordinary type of variable resistance such as a rheostat is indicated in Fig. 6 (c). An alternative way of indicating a variable resistance is to use the potentiometer symbol, but omitting the connection at one end as shown in Fig. 6 (d).

The circuit shown in Fig. 7 (a) can be seen a resistance connected across the terminals of a battery of voltage E.

Carbon Resistors

What is known as a carbon resistor is composed of powdered carbon mixed with an insulating cement and then baked into a rod. The ratio of the ingredients depends on the resistance and wattage rating required.

Another type consists of a rod of insulating material which is "metallized" or sprayed with a very thin layer of metal ,the thickness of the layer will decide the resistance.

Wire wound resistors consist of resistance wire such as nichrome wound on an insulated former of suitable size. This type is used when large currents are to be passed.

Ohm's Law.

The law connecting voltage resistance and current is known as ohm's law, named after Professor Ohm, a noted early electrical pioneer. It is a very simple law, but a sound working knowledge of its applications is essential to anybody studying radio.

Stated simply, ohm's law says that the current in amps. is equal to the electromotive force (pressure in volts) divided by the resistance in ohms. It is usually expressed in the form $I = E/R$, where I stands for current in amps., E for electromotive force in volts, and R for resistance in ohms.

The law may be also expressed as $R = E/I$ ohms and $E = IR$ volts, enabling any one of the three quantities to be found when the other two are known.

Figure 8 will be found useful for working out ohm's law problems. To use it, cover up with a finger the letter representing the unknown, and the way to deal with the other two quantities will be revealed.

Thus by covering up E, I R are left together and should be multiplied as shown to obtain the result. If I is covered, it is obvious that E should be divided by R.

Returning to Fig. 7 (a), if the resistance R, which will be taken as representing the entire resistance in the circuit, has a value of 500 ohms, and the voltage of the battery is 100 volts the current flowing through the resistance may be now calculated by the use of ohm's law. From the formula $I = E/R$, we obtain $I = 100/500$ amps. $= 1/5$ or .2 amps.

Ohm's law is particularly useful in radio for working out the voltages which are developed across resistances. In fig. 7 (b) is shown a battery E of 100 volts, across which are connected two separate resistances, R_1 and R_2, which we will assume have values of 600 and 400 ohm respectively.

Calculating Voltages

The current flowing through both resistances will be the same and will be equal to $100/600 + 400 = .1$ amps. Now to find the voltage drop across each resistance, all that is necessary is to multiply the resistance in question by this current, thus there is a voltage drop of 60 across R_1 and 40 across R_2, so the total drop is equal to the battery voltage.

It is often necessary to reduce voltage available to a value required. For example, if the filament of a 2-volt valve is to be supplied from a 3-volt battery a resistance has to be inserted that will drop the applied voltage by one as shown in fig. 9. If the filament current is .1 amp., then from the formula $R = E/I$ we find that $R = 1/.1 = 10$ ohms.

Some Common Prefixes.

In radio, it often happens that in one calculation one unit is being considered in thousands and even millions, while the same problem may involve only a one-millionth part of another unit. To overcome this apparent difficulty in the tremendous range of quantities, prefixes are used.

To reduce the unit to a smaller dimension we have:—

Milli = one thousandth.
Micro = one millionth.

Thus one milliampere is one

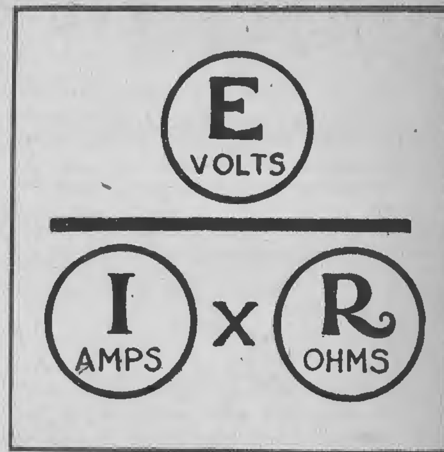


Figure 8. If you can keep a picture of this in mind you will always be able to work out Ohm's Law.

thousandth of an amp., so to convert the latter to the former it should be multiplied by 1000. For example .03 amps. equals 30 milliamps. Similarly .02 volt equals 20 millivolts.

To increase the unit to a larger dimension we have:—

Kilo, means 1000.

Mego (or mega) means 1,000,000. Thus, one megohm is one million ohms, and 500 kilocycles equals 500,000 cycles.

Resistances in Series and Parallel.

Fig. 10 (a) shows two resistors connected in series and when two or more resistors are connected in series the total resistance of the circuit is equal to the sum of the separate resistances. For an example let R_1 have a resistance of 600 ohms and R_2, 400 ohms, so the total resistance will be 1000 ohms.

Figures 10 (b) and (c) shows two and three resistances paralleled respectively. If in 10 (b) the values of the resistances are the same as that shown in the previous example then the effective resistance of the circuit is given by the formula:—

$$I/R = I/R_1 + 1/R_2, \text{ etc.}$$

Thus $I/R = 1/600 + .1400$
$= 2 + 3/1200$
$1/24$ OR $= 1$
$R = 240$ ohms

The same formula may be extended to calculate the resistance

(Continued on next page)

ELECTRONS

(Continued)

of any number of resistors paralleled. For example, if four resistors of 120, 40, 60, and 30 ohms are connected in parallel then the resultant resistance is given by:—

$$
\begin{aligned}
I/R &= I/R_1 + I/R_2 + I/R_3 + I/R_4 \text{ etc.} \\
&= 1/120 + 1/40 + 1/60 + 1/30 \\
&= 1+3+2+4/120 \\
1/12R &= 1 \\
R &= 12 \text{ ohms.}
\end{aligned}
$$

In the first example, where there is only two resistances to be considered the calculation could be simplified by using the following formula which is derived from the other formula:—

$$R = \frac{R_1 \times R_2}{R_1 + R_2}$$

It should be kept in mind that when two or more resistors are connected in parallel the effective value of the resistance is always less than the lowest resistance of the combination.

Shunt Resistances

As we have said before when a voltage is applied to two or more resistors connected in parallel it will divide itself among the paths provided by the resistances, with respect to one of these resistance the others may be said to "shunt" it.

Referring again to figure 10 (b), R_2 may be said to shunt R_1; while in 10(c) R_2 and R_3 may be said to shunt R_1; R_2 and R_3 would be called the shunt resistors.

(The second article of this new series dealing with the fundamentals of radio theory and practice will appear in next month's issue. Make sure of your copy by placing an order with your bookstall—NOW.)

RADIO TO THE RESCUE

Radio amateurs in Belgium aided in the accomplishment of a notable feat in communications by the Belgian underground. Last December the Belgian government-in-exile sent into their homeland a three-man military commission whose assignment was to set up transmitters through the underground to maintain communications with London. Of the eight transmitters dropped by parachute, only one fell into German hands.

* * *

When fire destroyed the administration building and all telephone lines at the Douglas Aircraft Company at Chicago on July 17th, production in the plant continued without delay through the use of handie-talkies for emergency communications. Supplied by the Signal Corps, the handie-talkies were strategically located throughout the rambling plant and eight stations were placed in operation, ranging in distances from less than 100 feet to over a mile.

VOLTAGE DOUBLING

Handy circuit suggestions for high-voltage power supplies

THERE are many occasions which crop up in the course of radio experimenting which require much higher voltages than can be obtained from standard transformers. For instance most cathode ray tubes, with the exception of the very small types, require anything from 1200 up to 3000 volts D.C. on the tube elements. This is especially true

By

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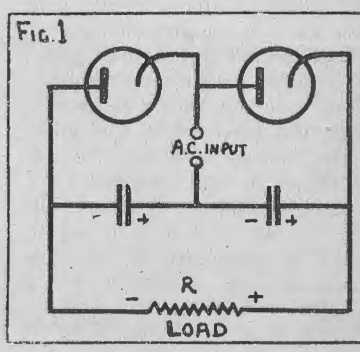
for those types which have the intensifier on the extremity of the bulb. For cases like this, bulky and expensive transformers are neither necessary or desirable in view of the fact that cathode ray equipment does not draw much more than a mill or so H.T. current, and so we find voltage doubler systems used extensively in this application.

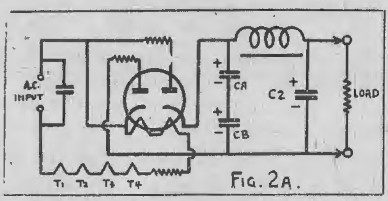
Transformerless Sets

However to the average man connected with radio, the voltage doubler is seen in the more familiar guise of the transformerless set, or, as it is more commonly known in this country, the AC-DC receiver. In connection with this type of receiver I can't remember yet meeting the serviceman who had a good word to say for them. This, I think, would be due no doubt to the large percentage of both valve and condenser failures and frequent service calls. A large number of these failures could be minimised and their recurrence reduced in number, if the theory and application of voltage doubling received more attention by the technician.

Work For Condensers

Fundamentally, and reducing the voltage doubler to its most simple form, as shown in fig. 1, we see that we simply have two half-wave rtctifier units connected in series and in such a manner as to cause the output voltages to be additive. In general the condensers used in voltage doublers are much higher in capacity than used in normal types of filter circuits. An erroneous impression held by many is that the tube is responsible for the voltage doubling. This is not the case, the condensers perform this



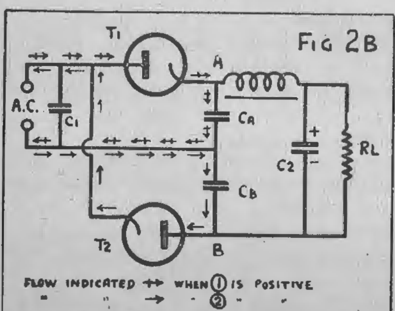


function and as such they do the most important job in this type of circuit.

Types of Voltage Doubler Circuits

The two main types of voltage doublers may be classified into (1) half wave; (2) full wave.

The ripple frequency of the latter is twice that of the former across the filter input, or more simply said. The ripple frequency across the filter circuit in the half-wave circuit is 50 cycles and that for the full-wave is 100 cycles. In order to explain the action of the circuit refer to fig. 2 wherein will be seen the full-wave or balanced type of voltage doubler, utilizing one of the dual half-wave rectifier tubes such as the 25Z5 which possesses two independent cathodes. The resistors in series with either plate are peak current limiting resistors and should at all times be included as they definitely help a great deal against rectifier break down when switching off and on suddenly, they generally vary in value from 50 to 250 ohms. By leaving out the usual series filament dropping resistor and the rectifier filament circuit we have reduced the diagram to the essentials required for the explanation of the circuit operation, as shown at 2A.



Mode of Operation

When the line voltage at point (1) is positive, the current flows through rectifier (1) in the direction shown by the arrows and hence condenser CA is charged, thus making point A positive with re-

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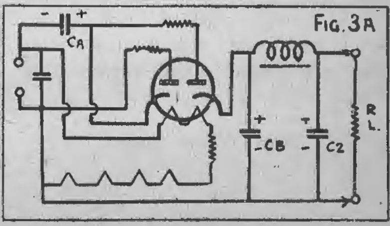


DOUBLING

(Continued)

spect to point O. Rectifier 2 is not conducting because its plate is negative. However, a complete reversal takes place when the A.C. line reverses polarity, and the charging current flows in the direction shown and condenser CB becomes negatively charged with respect to point O. Thus one condenser discharges through the load while the other is in the process of being charged. It is desirable and generally the case that condenser CA and CB should be approximately equal in capacity, if otherwise is the case then a state of unbalance exists across the two condensers will be evidenced by a hum component of line frequency being heard in the output of the receiver.

Used as a voltage doubler the 25Z5 tube is rated at a maximum DC load current of 75mA, which should cater for most receivers up to about 6 tubes, however, larger current drain is permissable for larger receivers by paralleling two tubes.

Safety Precautions

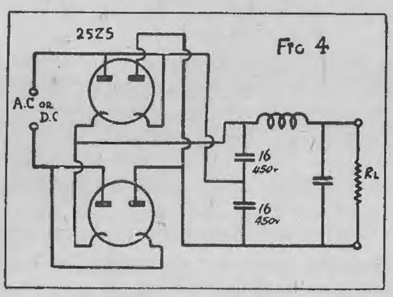
In many Australian receivers of the AC-DC type one side of the mains is connected to the chassis proper and under certain conditions can become dangerous, it is always preferable to use a common earth bus which is insulated from the chassis with a good quality condenser.

From the performance angle as regards hum trouble, unless particular attention is paid to the sequence of the heater wiring, modulation or tunable hum is apt to cause trouble. The usual method being to have the second detector as the first tube in the string starting from earth potential, thence through the converter tube. IF tube, power output stage, rectifier filament and then the series dropping resistance to the AC line. The reason for this precaution being that heater to cathode voltage in the critical tubes which may cause hum, are kept within reasonable limiits.

Half Wave Type

The half wave type made its appearance somewhat earlier than the type just discussed and is slightly different in its operation, in fact it could be more correctly termed a voltage multiplier circuit rather than the voltage doubler. Looking at fig. 3 it can be seen that one side of the power line can be hooked directly to the negative side of the filter output and is better than the full wave type in this respect that it overcomes the high voltage difference between heater and cathode of the high gain tubes at the ground end of heater string.

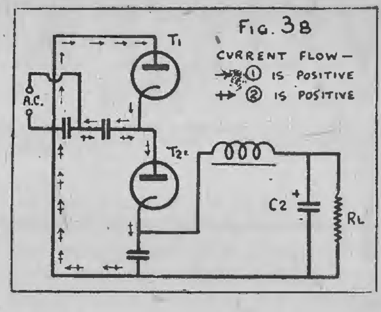
As in the former case, take point (1) to be positive with respect to point (2) and trace the current flow as shown by the arrows through the rectifier tube 1. In the first half cycle condenser CA assumes a



charge equal to the voltage of the line. In the the next half cycle point 2 now swings positive with respect to point 1, the charge on CA will now add its potential to that of the line and current now flows through rectifier tube 2, and at the same time charges condenser CB to a potential equal to that of the charge in CA plus the line peak. This would result in a charge on CB equal to twice the line peak potential but it must now be remembered that as soon as tube 2 starts to conduct condenser CB discharges through the load. As far as the type of electrolytic used is concerned as the actual polarity of CA never reverses the polarised or normal electrolytic condenser can be used in this position.

Polarity Reverser

It is commonly known that when it is desired to operate a universal receiver on DC mains that the receiver will only operate one way. Fig. 4 shows an interesting diversion of the voltage doubler. This circuit will give a fixed polarity at



the output regardless of the input polarity. All full wave rectifiers are not polarity reversers, only the bridge rectifier performs this function. With this circuit a universal receiver becomes truly universal in that it works on AC and will operate when connected either way on DC mains.

XXXXXXXXXXXXXXXXXXXXXXXXXX

THE PROMISE OF POST-WAR

Some mighty interesting developments can be expected as soon as the war clears up. A clue to a possibility is found in a recently-released American specification of a new type of valve which operates with a normal plate supply of 5 volts high tension.

XXXXXXXXXXXXXXXXXXXXXXXXXX

AESTHETICS

(Continued from page 14)

Dr. Sargent and the Liverpool Philharmonic Orchestra, and Bârbirolli with the Halle Orchestra on Columbia have mastered the art of making records. I can specially recommend Dohnanyi's "Variations on a Nursery Tune" (Col. DX1148-1150), and Ireland's "London Overture" (Col. DX1155-1156). The fill-up on the latter work is Johann Strauss' Radetzky March," which has the most amazing bass drum recording I have ever heard. An extraordinarily impressive record, and a certain favourite if you want to show that your speaker is "the real thing," and you don't suffer from "boom."

[These remarks about recordings are published as an item of interest, but it should be noted that the Author was an Eglishman and the recordings mentioned are English discs.—Editor.]

THE MILLER EFFECT

What it means to the amplifier design

IT appears that, although most radio amateurs have heard of Miller Effect, few take it into consideration when building equipment for themselves. With so many amplifier enthusiasts about, it is proposed to show how important this factor is in regard to radio receiver design, particularly in connection with high frequency response in audio amplifiers.

By

J. G. DU FAUR

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

Miller Effect determines the input admittance to a valve when it is used as an amplifier. It can be described as the effect which makes the input impedance to an amplifying tube with a plate load impedance, different to the input loading of that valve if no plate load exists.

Inter-Electrode Capacity

Any pair of the electrodes in a vacuum tube form a small condenser which is known as one of its inter-electrode capacities. In the case of a simple triode, three inter-electrode capacities which are of importance in design considerations, exist, these being:—

Cgk:—Capacity between grid and cathode.

Cgp:—Capacity between grid and plate.

Cpk:—Capacity between plate and cathode.

These condensers are illustrated in Fig. 1.

Input Capacity

The input signal in amplifiers is applied between the grid and the cathode. It will, therefore, be seen that Cgk will directly shunt this signal and Cgp is also across it in series with the plate load impedance of the amplifier (RL). The inter-electrode capacities Cgk and Cgp are normally only very small condensers, but at high audio frequencies their capacity reactances become comparable with or smaller than the value of the grid leak resistance (Rg) and the plate load impedance of the previous stage in parallel, and under these circumstances, attenuation of high frequency signals occurs. This is because the inter-electrode capacities have reactances of many megohms at low audio frequencies, but at higher frequencies such as say, 10,000 cycles per second, their reactances are small enough to considerably change the plate load impedance of the previous stage (if a high value of load resistance is used), thus reducing amplification at these frequencies.

Typical Example

In a typical amplifier, if an A.C. signal of one volt is applied between the grid and cathode and the amplification of the stage is 100, the plate will vary in voltage during each cycle between plus and minus 100 volts. Owing to the high difference in A.C. voltage (produced by the amplification of the stage) between the plate and grid of the tube, relatively large A.C. currents tend to flow between these elements. This assumes, of course, that external impedance exists in the tube plate circuit across which the high voltages are developed. If no such plate load is present, the plate must

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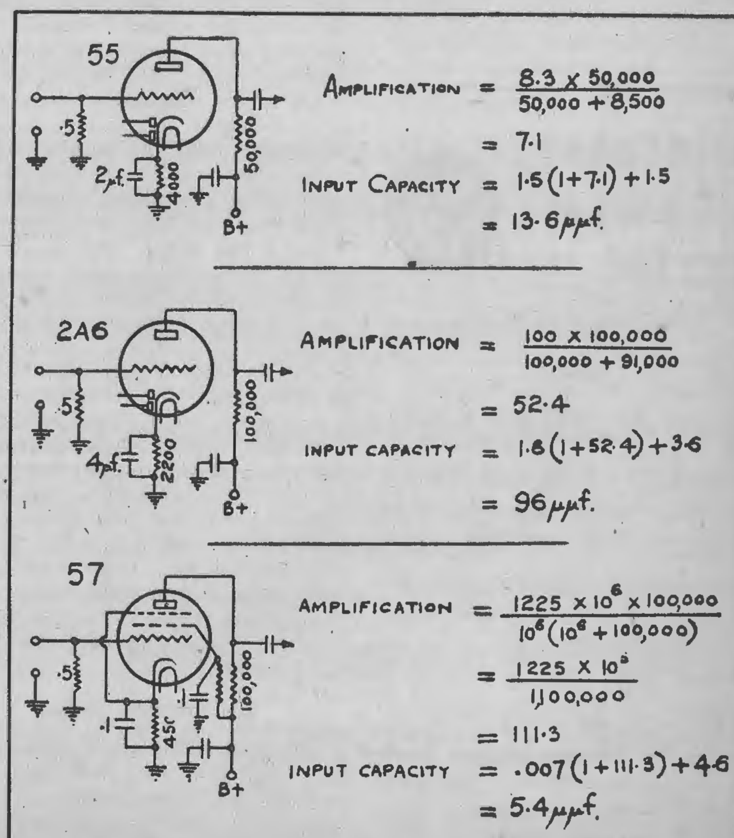

FIG. 2.

MILLER EFFECT

(Continued)

be at earth potential as far as audio or radio frequencies are concerned and, therefore, only small difference of A.C. potential will exist between the plate and grid since no amplification occurs if there is no load in the plate circuit.

If the plate load is a pure resistance, the input loading on the amplifier due to tube inter-electrode capacities is purely capacitive, but if the load impedance has a reactive component, the input circuit of the tube will have a resistance as well as a capacitive component, notwithstanding the fact that the grid is normally negative with respect to the cathode and therefore attracts no electrons from it.

It is not proposed here to go into details of the tube input loading caused by inductive and capacitive loads in the plate circuit, as this is generally of no importance in resistance-coupled amplifiers. The calculations illustrated in the text are shown to indicate the extent of the capacitive input loading when the plate load impedance is a resistance.

Phase Reversal

Referring to Fig. 1 and neglecting the effect of the grid leak Rg, suppose a signal Es is applied to the amplifier. Let M represent the signal voltage gain from grid to plate. As there is a difference in phase of 180° between the applied signal Es and the output signal Ep, the audio frequency voltage on the plate will be—M.Es. (The minus sign is accounted for by the reversal in phase.) Therefore, at any instant the A.C. voltage between grid and plate is Es—(—M.Es) which equals Es + M.Es.

Since the charge on a condenser at any instant is equal to the product of the voltage between its plates and its capacity, the charge on Cgp will be Cgp (Es + M.Es). Similarly, the charge on Cgk will be Cgk.Es. Therefore, the total charge on the grid owing to these two capacities will be Cgp (Es + M.Es) + Cgk Es

= Es [Cgp (1 + M) + Cgk]

For Flat Response

As charge equals capacity multiplied by e.m.f., the capacity between the grid and other elements in a triode becomes:—Cgp (1 + M) + Cgk.

The above expression shows that when designing an amplifier for flat response up to the higher audio frequencies, not only must one take into account the tube inter-electrode capacities, but also the amplification of the stage. As is shown above, the effective input capacity of the amplifier is practically proportional to the amplification of the stage.

The uninitiated enthusiast, when building his own amplifier, often uses tubes having large amplification factors, with the one idea in mind that these will produce greater overall gain. Generally speaking, this is correct, but these valves have the disadvantage that when working into a plate load impedance, they attenuate the higher audio frequency signals owing to the large shunting capacity produced by Miller Effect.

The Pentode Screen

Pentode valves have a screen grid fitted between the plate and the control grid. This additional element is normally at earth A.C. potential (being connected to earth through a by-pass condenser) and

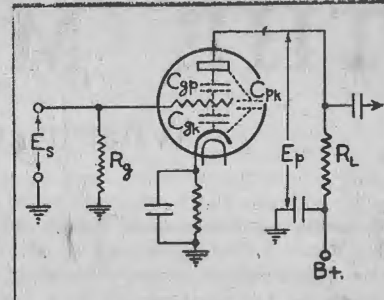

Fig 1

produces an effect which reduces to a great extent the inter-electrode capacity between plate and grid. For this reason, pentodes are useful as resistance-coupled amplifiers, because, owing to their low Cgp, Miller Effect is considerably reduced, yet high gain per stage may still be obtained.

From the above arguments, it will be obvious that high Mu triodes are not the best tubes to use in audio amplifiers, if flat overall response is required, unless some provision is made to boost the "highs" elsewhere in the circuit. However, low Mu triodes, since their amplification is relatively small, do not suffer so much from this effect; therefore, to minimise capacitive shunting in an amplifier, it is desirable to use a tube with low Cgp and Cgk, as well as low gain in the circuit in which it is to be used.

Feedback

Owing to the large effective capacity between the plate and grid of a tube caused by the Miller Effect, instability may result owing to feedback. This fault will be noticed in the form of audio oscillations and if severe, can be limited by reducing the plate load impedance, thus decreasing the Miller Effect and the amplification of the stage.

It is now proposed, for the purpose of illustration, to consider the Miller Effects in three separate single-stage amplifiers using typical valves.

The first uses the low u triode section of a 55; the second, the high u triode section of a 2A6 and the third, a 57 pentode.

Some Examples

The circuits concerned are shown in Fig. 2 and incorporate typical values of resistors. (The diodes in the 55 and 2A6 will be neglected, as they do not effect the argument.)

In order to calculate the Miller Effect in each amplifier, the stage amplification must be determined. This is attained by using one of the following equations taken from the R.C.A. "Receiving Tube Manual":

Voltage amplification = amplification factor × load resistance over load resistance + plate resistance; or transconductance in microohms × plate resistance × load resistance over 1,000,000 ×

After studying Fig 2 and its asso-
(plate resistance + load resistance).
ciated caluculations, it will be seen that the actual input capacitances of the tubes in the circuits shown are:—

55	13.6 uuf.
2A6	96 uuf.
57	5.4 uuf.

Note that the high u triode 2A6 has nearly 18 times the input loading of the 57, while the low u 55 has only about twice that of the 57, yet by far the greatest stage amplification is obtained with the pentode. It is pointed out that the calculation for input capacity in the case of the 57 in Fig. 2 is not strictly correct, since the interelectrode capacities between the control grid and screen grid, and between control grid and supressor grid have not been taken into consideration. These capacities are, however, for practical purposes, small enough to be neglected and as both the screen and the supressor are normally at earth A.C. potential, the abovementioned capacities are not increased in practice by the amplification of the stage.

It should be noted that the calculations in Fig. 2 apply only to the circuits shown and not merely to the valve types used. If different load resistances are used in these
be different in each case.
circuits, the input loading will also

For example, if the load resistance of the 57 is reduced to 50,000 ohms, the input loading capacitance will also be reduced considerably; however, it is obvious that it can never become lower than 4.607 uuf, which is the sum of Cgk and Cgp.

With reference to high frequency response in amplifiers, the additional input capacity caused in each amplifier stage by Miller Effect is always in parallel with the grid leak resistance of the tube concerned and the plate load resistance of the previous tube and therefore, as long as the resultant impedance of these two resistances is comparable with the capacitive reactance of the input loading due to Miller Effect, the latter will not considerably effect the high frequency response. However, with high gain triodes, if Rg and RL are kept low enough to make Miller Effect negligible, the amplifier as a whole will have such a low amplification that it will be unsatisfactory and may also suffer from distortion.

Shortwave Review

CONDUCTED BY L. J. KEAST

NOTES FROM MY DIARY

Several have written to me mentioning KMBC and KMBA. I have heard the calls of the stations in queston several times both before and since receiving the letters referred to, and still think the calls are KNBC and KNBA.

I do not know what method is employed in fixing of call-signs, but doubtless a similar procedure to that used in naming of race-horses is adpoted—some association with the dam and sire—in this case its location and owner—therefore, whilst I may be wrong, I still give the calls as KNBC and KNBA—K the prefix for California—NB for National Broadcasting Company and maybe the Federal Communications Commission suggest the last letter.

THE FUN OF DX-ING

There is no doubt DX-ing springs many surprises. One spends a great number of hours teasing and cajoling a station to stay tuned long enough to get some idea who he is, at the same time hoping and praying he will gather a little more strength to fight the noise or morse or both, but it seems worthwhile and there is a delightful feeling when he is landed and a definite tab placed on him. Oh yes! many a big fellow gets away, but maybe he will be hooked to-morrow.

But it is aggravating when, after entering him in the Long Book, you find on returning the next day or so he has changed his call-sign. This is all the more annoying when you have gone into print with your discovery and you know it will be a month before the correction can appear. Well, that's just what happened on January 11th, the 'Frisco stations seemed to do a kind of Jig-Saw dance. The only comforting thought is a much more improved and enlarged service for the Armed Forces has resulted. Elsewhere in this issue, if space permits, will be found a fairly comprehensive lay-out of the services referred to. I have purposely compiled them in hourly routine so listeners can select a station according to the time that suits.

CHOOSE YOUR PROGRAMME

On January 15th the 'Frisco stations introduced a new idea, a list of programmes in advance. I am sure it is welcomed, enabling as it does, an opportunity to select a special item well in advance. It is to be given on 1st and 15th of the month and follows the first newscast. At the same time daily, of course, the usual programme resume for the day is given.

Several new sessions have been noticed and one that appeals to me is "Let's Go To Town," heard from 9.30 to 10 p.m. on Mondays, Wednesdays and Fridays over KROJ 6.105 m.c., or if you prefer it KGEI, 6.09 m.c. As its title suggests you are taken to an American town and what will give a thrill to the Armed Forces is the switching on to one or two of the "local" broadcast stations. When taken to Rochester (Roy Hallett, please note) we heard stations WHAM, WHEC and WSAY.

At the corresponding time to "Let's Go To Town" on the other days of the week, Sugar Report has been reintroduced, but on Sundays Juke Box is heard. The before-breakfast listeners can hear these programmes at 7.15 o'clock through KROJ, 15.19 m.c. Another programme I like is "Science Magazine" which comes through KROJ, 17.76 m.c. from 11.30 till noon on Fridays.

SAYS WHO?

The new B.B.C. transmitter in the 30 metre band has been variously reported as on anything from 30.22 to 30.28 metres, but I believe the frequency is 9.915 m.c. making the wave-length 30.25 metres. I am told the call-sign is GRU, this transmitter having been moved from 9.445 m.c. It takes the General Forces programme from 8-10.45 p.m. being directed to Far East, New Zealand and Pacific Area. Is heard particularly well in Sydney. —L.J.K.

●

British Mediterranean Station, Palestine, sent latest schedule:

3.30-11.45 p.m., 11.72 and 9.665 m.c.; 2.15-5.15 a.m., 9.665 and 7.215 m.c.; 5.45-8.15 a.m., 9.665 and 7.215 and 6.135 m.c. News in English at 3.30 p.m., 10.45 and 3.45, 5.15 and 7 a.m.—Cushen.

●

Airgraph from S.E.A.C. verified my report on 11.81 and 15.275 m.c. Address is. British Ministry of Information, Far Eastern Bureau, Broadcast Division, S.E.A.C., 229 Turret Road, Colombo, Ceylon.—Dr. Gaden and Arthur Cushen.

●

English by Radio comes in nicely on 31.41 metres at 9 p.m. The language that follows at 9.15 is Danish. At 9.30 America calls Norway in Norwegian and at 11.45 America calls Finland in Finnish. —L.J.K.

●

S.E.A.C., Colombo in letter verifying my report stated News is heard as follows: 1.30 p.m. on 15.27 m.c., and at 10.15 p.m. and 12.30 a.m. on 11.81 m.c.—Dr. Gaden.

●

Who is the beauty just below KKW? Hear him of a night on about about 21.75 metres.—Wally Young.

●

Another chance to test the selectivity of your set is afforded by tuning to KRCA, 6.18 m.c., and KCBF, 6.17 m.c., at 7 p.m. and at 10 p.m., XGOY, 6.165 m.c.—L.J.K.

"One of the NBC's on 13.05 m.c., is good on closing at 3 p.m. but is it KNBA or KNBC?"—Dr. Gaden.

(Think 13.05 m.c. has been dropped in favour of KNBA on 9.49 m.c., 31.61 metres, who from 1.30-3 p.m. is in parallel with KNBC on 11.89 m.c., 25.23 m.—L.J.K.)

●

"At 1.30 p.m. to-day when listening to 28.25 metres announcement was KCBF. Wouldn't it?"—Wally Young.

(You will find, now, that KES-3, 28.25 met. opens at 9 a.m. in parallel with KRCA, 15.12 m.c., 19.84 met.—L.J.K.)

●

VLG-7, Melbourne, 15.16 m.c., 19.79 met., has replaced VLG-2 (31.45 met.) in Department of Information programmes to Batavia and Shanghai, 10-11 p.m. and to Saigon and Bangkok 11 p.m.-m/n. —L.J.K.

●

CSW-6, Lisbon, verified with a very fine card my report of Oct., 1943. Schedule is 5-7.30 a.m. on 11.040 m.c., 27.17 met.—Cushen.

●

KRCA, 15.12 m.c. gives the skeds at ten past the hour but only mentions 15.29 m.c. and 15.21 m.c. in the 19 metre band. Does not even mention himself in the skeds to the Philippines, etc. In fact, the only time I have heard him mention his own name is on opening at 9 a.m. with KES-3.—Dr. Gaden.

●

A most interesting session, under the title of "American Correspondents Report" can be heard daily over KRHO, 17.8 m.c., 16.85 met., at 10.15 a.m. The same programme is repeated at 11.45 p.m. over KRHO on 6.12 m.c., 49.02 metres. —L.J.K.

●

Dr. Gaden says in reply to my query as to time he hears WLWR on 18.16 mc, 16.52 m it is about 4 or 4.30 a.m.

At 12.30 a.m. the announcer on AFHQ, Algiers, 25.24 met., says, "The programme to which you have just been listening has been retransmitted through Algiers. Please stay tuned in for further programmes from The Voice of America and B.B.C." The programme from 12.15-12.30 was the B.B.C. calling Europe.—Edel.

●

The Voice of Britain preceded by "Rule Britannia" is heard over KNBI, 6.02 m.c., 49.83 met. at 7.05 p.m.—L.J.K.

Radio Levant, 38.34 met. was heard in a religious service from 12.30 till 1 a.m. on Monday. At 1.03 o'clock they called Indo-China. —Edel.

Received nice New Year card from S/Sgt. R. K. Clack, also interesting letter and cards from Jon V. Davis, an AWDXAW member, now in England. He, with his shack mate, Harold F. Buggins, also an AWDZAW member, send 73s to all members.—L.J.K.

NEW STATIONS

Those shown with an asterisk * commenced early in January, just after our issue for that month had gone to press.

***KNBA, 'Frisco, 9.70 mc, 30.93 m:** A further frequency for the new N.B.C. station in San Francisco. Used by Armed Forces Radio Service in programmes directed to Japan and Indo-China. Schedule 7-11 pm. Signal is nice strength and surprisingly free from static since it made its debut.

***KNBI, 'Frisco, 6.06 mc, 49.50 m:** Another addition to the N.B.C. Californian team. Commenced on January 11th, directed to China from 7 pm till 12.45 am but after about a week moved to 6.02 mc. See below.

KNBI, 'Frisco, 6.02 mc, 49.83 m: First heard on January 23rd and appears to have replaced the 6.06 outlet. Opens at 7 pm and continues till 3 am, directed to China. Is in parallel with KNBF, 9.49 mc, 31.61 m.

KNBA, 'Frisco, 9.49 mc, 31.61 m: Has replaced our old friend KRCA. Heard from 4.15 till 6.45 pm, directed to China. Is in parallel with KNBC, 11.89 mc, 25.23 m.

KNBF, 'Frisco, 9.49 mc, 31.61 m.: This is the call from 7 pm till 3 am when in parallel with KNBI, 6.02 mc.

KNBC, 'Frisco, 11.89 mc, 25.23 m: Commenced business on January 19th, at 4.15 pm. Broadcasts in parallel with KNBA, 9.49 mc, till 6.45 pm. Difficult to hear till VLR-3 closes at 5.45. From then o.k.

KCBF, 'Frisco, 6.17 mc, 48.62 m: This is a new outlet for the Columbia Broadcasting System and is directed to Japan and Indo-China. Would be good signal but for morse and noise. Schedule is 7 pm till 3 am and station is in parallel with KCBA, 9.75 mc, 30.77 m. First heard 22nd January.

***KGEI, 'Frisco, 6.09 mc, 49.25 m:** A new one for the General Electric Co. and most certainly welcomed. Directed to the South West Pacific and Philippine area, it puts in a great signal from opening at 7 pm till closing at 1.45 am. Carries same programme as KWIX and KROJ. KWIX of course drops out at 8.45 and KROJ leaves KGEI at 11 pm. Immediately after reading the news at 11 o'clock, KGEI gives programme resume for the rest of the transmission.

***KRCA, 'Frisco, 7.805 mc, 38.43 m:** Here is another new outlet. Can be heard on favourable days from 1 till 3 pm.

KRHO, 'Frisco, 17.8 mc, 16.85 m: This was briefly mentioned in January issue. It is now in regular service from 9 am till 4.45 pm, and can be copied at great strength right through. Programme is directed to the People of Japan, China, Formosa, Manchuria and Korea. News is given "on the hour every hour, during hours of transmission."

AFHQ, Algiers, 11.765 mc, 25.50 met: Mr. Edel 'phoned me regarding this new Algerian. Is heard in parallel with AFHQ, 11.88 mc, 25.24 m from 12.15-1.30 am, when they relay the BBC European programme.

........, U.S.S.R., 9.185 mc, 32.66 m: Another 'phoned to me by Mr. Edel. He thinks it is situated in Far East corner of the U.S.S.R. from the dialect heard. Is fair signal from 1.45 pm till after 1 a.m.

........, Moscow, 12.10 mc, 24.79 m: A still further addition to the already numerous Russian transmitters reported by Mr. Edel. Signal is good from 8-9 pm.

........, Athens, 9.93 mc, 30.21 m: Mr. Roy Matthews reports hearing this station calling the BBC around 1.45 am. Gave talks on situation in Greece. (Nice catch, Roy.—L.J.K.)

........, 6.50 mc, 46.15 m: Mr. Edel reports hearing an U.S.S.R. station at 1 am in language that suggests to him it is situated in Azerbaijan Province. He says signal was quite good.

KNBC, Frisco, 5.24 mc, 19.69 m: Heard on 2nd February around 12.20, is in parallel with KNBA on 13.05 mc, 22.96 m.

POLSKE Radio, Lublin, 6.115 mc, 49.05 m: Here is a nice catch by Mr. Leo Edel. Heard on 31st December, at 2 a.m. when, the members of the new Polish Provisional Government were introduced. All speech was in Polish. Signal was fair but subject to the usual noise on that band at that hour. Since then apparently the same station has been heard by Mr. Rex Gillet, of Adelaide, who in "Radio Call" mentions hearing it at 5.15 am when call was Radio Lublin. Both Mr. Edel and Mr. Gillett are to be congratulated on finding this one.

CHANGES IN B.B.C. PACIFIC SERVICE COMMENCING 4th FEBRUARY

GRX 3.45-8 pm.	9.69mc	30.96m
GRV 3.45-8 pm.	12.04mc	24.92m
GRM 3.45-6.30.	7.12mc	42.13m
GWD 6.45-8 pm.	15.42mc	19.46m
GVZ 3.45-7 pm.	9.64mc	31.12m
GSN 3.45-8 pm.	11.82mc	25.38m

In the bi-monthly programme schedules given on 1st February, a new item is listed: "Pacific Diary" from 5.15-5.30 pm on Mondays, Wednesdays and Fridays, and on the corresponding time on Tuesdays, Thursdays and Saturdays, "Combat Diary". The stations, KNBA, 9.49 mc, 31.61m; KNBC, 11.89mc, 25.23m; and KROJ, 9.897 mc, 30.31m.

A very good news service and at an unusual hour can be heard over KCBF, 'Frisco, on 9.75mc, 30.77m when opening at 4.15 pm.

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.

CHANGES IN CALL-SIGN OR FREQUENCY

KWIX is call-sign for 15.29 mc, 19.62 m, when directed to China in Armed Forces Radio Service from 8 am till 1 pm.

KRCA is on 6.18 mc and 15.12 mc, and NOT 6.19 and 15.13 as previously shown.

KROJ appears to be nearer 6.105 mc and does not suffer so much from the bad heterodyne that made listening so unpleasant.

KGEX has moved from 15.13 mc to 15.21 mc, 19.72 m. From 9 am-noon is directed to Philippines-Guam area. At noon comes into parallel with KROJ, (17.76 mc, 16.86 m) retiring at 1.15 pm. Signal is generally good but often fades out by one o'clock.

KWIX is the call on 7.23 mc, 41.49 m from 5-6.45 pm, directed to China. From 7 pm to 2 am call is KWID and is directed to Malaya, Burma and Indo-China.

AFRICA

Algeria

Radio France, Algiers 12.12mc, 24.75m
Fair at 9.30 pm (Matthews).

AFHQ, Algiers 11.88mc, 25.24m
Carry U.S.A. and B.B.C. relays all evening (Edel, Matthews).

AFHQ, Algiers 11.765mc, 25.50m
See "New Stations".

Belgian Congo

RNB, Leopoldville 15.17mc, 19.78m
Very good in its last half hour with Yank transcriptions (Gaden). (Close at 11 pm.—L.J.K.).

RNB, Leopoldville 9.78mc, 30.66m
Very strong some afternoons (Gaden). Heard in p/l with 31.95 m at 2.30 am, Sig. R 8 Q 4/5 (Edel).

RNB, Leopoldville 9.39mc, 31.95m
Classical music at 2.30 am. R 576 Q 4 (Edel).

Kenya Colony

VQ7LO, Nairobi 10.73mc, 27.96m
Heard at 11.15 pm (Young).

VQ7LO, Nairobi 6.11mc, 49.07m
Very fair at 11.15 pm (Young).

GREAT BRITAIN

B.B.C., London

GVR, ... 21.675mc, 13.84m
Excellent from 7-9.30 pm (Matthews).

GSH, ... 21.47mc, 13.97m
Fair from 10 pm (Matthews).

GVO, ... 18.08mc, 16.59m
Very weak just after midnight (Edel).

GSV 17.81mc, 16.84m
Excellent al evening (Matthews).

GVQ 17.73mc, 16.92m
Very good all evening (Matthews). (Schedule: 9.30 pm-1.15 am, directed to East Africa, Near East, and Eastern Mediterranean.—L.J.K.)

........, 15.21mc, 19.72m: News in English at 1 am through programme for A.E.F. (Edel).

GRF 12.095mc, 24.80m
Very good all evening (Matthews). (Mixed up with morse over here.—L.J.K.)

GWH 11.80mc, 25.42m
Fair signal at 8.15 am (Young).

GRU 9.915mc, 30.25m
Heard well from 8 pm (Young, Fluck). Fair at 10 am (Fluck). Think new schedule for Central and South Africa is: 3-6.30 a.m.—L.J.K.)

GRY 9.60mc, 31.25m
Heard in Spanish to South America at noon—surprisingly god signal (Gaden).

GWF 9.49mc, 31.61m
Very good signal at 9.45 pm (Young) (America calls Finland in Finnish at that hour through GWF.—L.J.K.)

GRJ 7.32mc, 40.98m
Very good around 8 am (Matthews) (Present A.E.F. prog. from 1.30-4 am. —L.J.K.)

GRK 7.18mc, 41.75m
Heard well at 9.45 pm (Young).

U.S.A.

San Francisco unless otherwise mentioned

KWIX 15.29mc, 19.62m
Weakest of the 19 m. Yanks (Gaden).

KCBA 15.27mc, 19.64m
Very good signal—closes at 10.30 am (Gaden, Young).

KGEX 15.21mc, 19.72m
Far and away the best of the 19 metre a.m. Yanks (Gaden).

KNBA 15.13mc, 19.81m
This appears to be the call, here (Gaden).

KGEI 15.13mc, 19.83m
Seems to be in parallel with KCBA (15.27 mc) (Gaden).

KRCA 15.12mc, 19.84m
Very good in a.m. (Gaden).

KNBC 13.05mc, 22.98m

KES-3, ... 10.62mc, 28.25m
Signs at 3 pm (Cushen). (Opens at 9 am with KRCA, 15.12mc.—L.J.K.)

KNBA 9.70mc, 30.93m
Good with news at 10 pm (Fluck).

KRCA 7.805mc, 38.43m
Heard signing at 3 pm (Cushen). (Sesion is 1-3 p.m.—L.J.K.)

KWID 6.18mc, 48.54m
Heard on this frequency every night (Matthews). Call is now KRCA. KWID is as usual on 7.23 mc, opening at 7 pm.—L.J.K.)

KRCA 6.18mc, 48.54m
Good signal at night (Gaden).

KRHO, Honolulu 6.12mc, 49.02m
Very fine at 11 pm with news (Gaden, Young, Fluck, Matthews, Edel). Have heard their harmonic on 12.24 mc also. (Young).

KROJ, ... 6.10mc, 49.15m
Very good at night (Gaden).

KGEI 6.09mc, 49.25m
Best of the 49s at night (Gaden).

KNBI 6.06mc, 49.50m
Heard at night (Gaden). (Now moved to 6.02mc.—L.J.K.)

MISCELLANEOUS

Greece

........, Athens 9.93mc, 30.21m
See "New Stations"

Italy

HVJ, Vatican City 17.445mc, 17.20m
Heard at m/n with P.O.W. messages in Italian (Edel).

HVJ, Vatican City 5.968mc, 50.20m
P.O.W. messages in Italian at 3 am (Edel).

Sweden

SBP, Stockholm 11.705mc, 25.63m
Heard well at 9.30 pm (Young).

Switzerland

HEI-5, Berne 11.715mc, 25.61m
Splendid signal at 1.25 am (Edel).

Turkey

SOUTH AMERICA

Costa Rica

TIPG, San Jose 9.617mc, 31.20m
Heard a few times after lunch but very weak. At night some good re-/sults whilst VLC-6 is having a spell. (Gaden).

Dutch Guiana

PZX-5, Paramaribo 15.395mc, 19.48m
Weak here at 9 pm (Matthews).

Ecuador

HCJB, Quito 12.44mc, 24.08m
English at 8 am (Cushen).

India

........, Kandy (Ceylon) 17.815mc, 16.84m
Calls B.B.C. around 5.30 pm (Matthews) for Correspondent's reports.

U.S.S.R.

Moscow 12.26mc, 24.47m
From 9.20-9.40 pm, News for Australia (Edel).

Moscow 12.10mc, 24.79m
See "New Stations"

Central America

Guatemala

TGWA, Guatemala City, 15.17mc, 19.78m
Very fair from 11.30 pm (Gaden).

TGWA, Guatemala City, 9.685mc, 30.96m
Appears to be on till about 4 pm. . . . Have not heard him close. Have heard him mention TGW and TGWB (Gaden).

CHINA

XGOY, Chungking 6.14mc, 48.86m
Heard from 9.45 pm in parallel with 41.96m. News at m/n (Young).

U.S.A.

Other than California

WLWL, Cincinnati 9.897mc, 30.31m
Good strength at 9.30 am (Matthews).

WCBX, New York 6.17mc, 48.62m
Heard in French at 8.30 am (Matthews).

WNRI, New York 6.10mc, 49.15m
Fair at 8.50 am (Matthews)

WRUA, Boston 6.04mc, 49.66m
Closes at 9.15 am after giving News in English (Matthews).

Here is a fairly comprehensive layout of new 'Frisco schedules:

Eastern Standard Time	Call-sign	Freq. m.c.	Wave-length	Direction.
6.15—7.45 a.m.	KWIX	11.87	25.27	S.W. Pacific Ocean Area.
6.45—7.45 a.m.	KROJ	15.19	19.75	S.W. Pacific Ocean Area.
7.15—8.45 a.m.	KGEX	11.79	25.43	S.W. Pacific—Philippines.
8.00—10.45 a.m.	KROJ	15.19	19.75	Alaska and Aleutians.
8.00—1.00 p.m.	KWIX	15.29	19.62	China.
9.00—Noon	KGEX	15.21	19.72	Philippines—Guam.
9.00—1.00 p.m.	KRCA	15.12	19.84	
9.00—3.00 p.m.	KES-3	10.62	28.25	
11.00—1.45 p.m.	KROJ	17.76	16.89	S.W. Pacific—Pacific Ocean Area.
Noon—1.15 p.m.	KGEX	15.21	19.72	S.W. Pacific—Philippines.
1.00—3.00 p.m.	KRCA	7.805	38.43	
1.30—6.45 p.m.	KNBA	9.49	31.61	Philippines—Guam.
1.30—6.45 p.m.	KNBC	11.89	25.23	
2.00—4.45 p.m.	KROJ	6.10	49.15	Alaska and Aleutians.
2.15—3.00 p.m.	KWID	9.57	31.35	S.W. Pacific—Philippines.
3.20—6.45 p.m.	KGEI	9.55	31.41	Japan and Indo-China.
4.15—6.15 p.m.	KCBA	6.17	48.62	Japan.
4.15—6.15 p.m.	KCBF	9.75	30.77	China.
4.15—6.45 p.m.	KNBA	9.49	31.61	China.
4.15—6.45 p.m.	KNBC	11.89	25.23	China.
5.00—6.45 p.m.	KROJ	9.897	30.31	S.W. Pacific Ocean Area.
5.00—6.45 p.m.	KWIX	7.23	41.49	China.
5.00—12.45 a.m.	KGEX	7.25	41.38	Philippines—Guam.
5.00—5.00 a.m.	KES-2	8.93	33.58	
5.00—2.00 a.m.	KRCA	6.18	48.54	
6.00—12.45 a.m.	KWY	7.565	39.66	Philippines—Guam.
7.00—8.45 p.m.	KWIX	9.855	30.44	S.W. Pacific Ocean Area.
7.00—11.00 p.m.	KROJ	6.105	49.15	S.W. Pacific Ocean Area.
7.00—1.45 a.m.	KGEI	6.09	49.25	S.W. Pacific and Philippines.
7.00—2.00 a.m.	KWID	7.23	41.49	Malay, Burma and Indo-China.
7.00—11.00 p.m.	KNBA	9.70	30.93	Japan and Indo-China.
7.00—12.45 a.m.	KNBX	9.49	31.61	China.
7.00—12.45 a.m.	KNBI	6.02	49.83	China.
7.00—3.00 a.m.	KCBF	9.75	30.77	Japan and Indo-China.
7.00—3.00 a.m.	KCBA	6.17	48.62	Japan and Indo-China.
9.00—11.45 p.m.	KWIX	9.57	31.35	China.
AND FROM HONOLULU,				
9 a.m.-4.45 p.m.	KRHO	17.8	16.85	To Peoples of Japan, China, Formosa, Manchuria and Korea.
5 p.m.-1.15 a.m.	KRHO	6.12	49.02	To Peoples of Japan, China, Formosa, Manchuria and Korea.

Space does not permit of list between 1.30 and 6 a.m.

SAYS WHO?

(Continued)

Arthur Cushen writes, telling me he has received verification of his reports to JCJC, Cairo, on 7.84 and 7.22 mc. Address is: Radio JCJC, Forces Broadcasting Unit, 3rd General Headquarters, Middle East Forces, Cairo. They also operate JCKW on the same frequencies but on a lower power. In addition 4 broadcast stations.

I saw the other day where JCKW was reported on approximately 7.13 m.c. Maybe this is a still further frequency.

•

Got a surprise on Thursday morning when listening to 9.89 m.c. at 6.20 a.m. Heard "Personal Album" and enjoyed it. At 6.30 fully expected to hear, "This is station KROJ, San Francisco, etc" but, no sir, the announcement was, "This is WBOS, Boston, U.S.A., in the 30 metre band." The programme continued with "Cavalcade of America." According to the book of words, KROJ is supposed to be presenting a programme for the S.W. Pacific Ocean Area from 4-6.30 a.m.—L.J.K.

•

The Crosley station on 7.805 mc, from 8.45-10.15 p.m. is WLWS. Programme is in Spanish for South America.

The Crosley Corporation now has 7 transmitters: WLWL, WLWO, WLWR, WLWK, WLWS, WLWV and WLWQ. They use 24 Antennae systems, rhombics, each carried on 4 x 135ft. masts.—"N.Z. DXTRA".

•

English By Radio.

SBP, Stockholm on 11.705 m.c., 25.63 met., is heard at great strength every night from 9 till 10 o'clock in their own language. With all the interest there is in the likely happenings of one part of Europe, English by Radio from SBP would be most welcome.—L.J.K.

Speedy Query Service

Conducted under the personal supervision of A. G. Hull

J.R. (Torbay, N.Z.) read about a material called "Durium", in connection with recording, the material being said to be a coating for flexible cardboard, and to be "as hard and smooth as a diamond." Having read the above some years ago but not having heard anything since, J.R. wonders whether the record makers bought up the patent in order to "shelve" it.

A.—We can't recall having heard of Durium, but possibly some of our readers have, in which case we would appreciate further details for publication.

From time to time new materials are boosted in newspaper articles and never heard from again. Doubtless sometimes they are so good that they are bought up and put away to avoid economic upset, but in many cases the original write-ups are founded on nothing more solid than a would-be get-rich-quick inventor's idea for attracting an investor's money. Not knowing anything about this particular case we cannot express an opinion as to which class it belongs.

* * *

R.S. (Townsville) wants a stroboscope for checking the speed of his gramophone recordings.

A.—There was a stroboscope in the issue of April, 1940, and copies of this issue are still available from this office at 1/- each, post free. By a strange coincidence, on the very same page in that issue is a set of diagrams showing how the frequency response of a crystal pick-up can be modified by using a half-meg potentiometer as a loading resistor.

* * *

J.R. (New Zealand) also enquires about light-beam pick-ups, and several other points.

A.—With any push-pull 2A3 type amplifier the current drain can be juggled about by using different bias as the 2A3 will operate with a bias of anything from 40 to 60 volts and plate current drain of from 60 to 40 milliamps per valve. With the Mystery circuit on page 15 of the November, 1944, issue the drain would be 120 milliamps as shown, but you would have to add 50 milliamps if you put an 8,000 ohm speaker field across the full high tension as well. Glad to know you liked the article. Have had similar remarks from all over; everybody agreed November issue was one of our best.

J.R. concludes with the thought that perhaps someone will design a direct-coupled speaker to avoid the input transformer.

* * *

An enthusiastic reader has an amplifier which is so powerful that if it is turned right up it will break the windows, or if it doesn't—the neighbours will!—joke sent in by J.R. (N.Z.).

* * *

D.E. (Cranbourne) asks what effect the connection of the suppressor grid has when a pentode is used as a triode.

A.—A pentode valve such as a 6J7G can be connected in several different ways to make a triode. For a low gain triode the screen and suppressor should be both tied to the plate. For a medium-gain triode the suppressor should be tied to the plate and the screen to the grid. For a high-gain triode the screen and suppressor can be both tied to the grid. It is also possible to have the suppressor tied to the cathode and the screen to the plate.

* * *

W.J.K. (Pymble) enquires about the by-passing of resistors.

A.—Even with push-pull it is sometimes advisable to by-pass the bias resistor, not in order to by-pass the audio component, but in order to avoid hum troubles which are sometimes encountered. This also applies with first and second stage audio amplifiers where the by-pass is omitted in order to get a degree of negative feedback or degeneration.

* * *

F.G. (Adelaide, S.A.) has doubts about the response of direct-coupled amplifiers.

A.—It is quite generally recognised that a correctly designed direct-coupled amplifier can be flat with half a decibel from zero to 200,000 cycles, which is far beyond the audio range at both ends.

* * *

S.N. (Fremantle) asks several questions about frequency modulation prospects.

A.—This subject was covered fully in our issue for November, 1944, but apparently you missed this issue and we doubt if there are any back numbers now available. We put up some fairly startling statements about frequency modulation, causing considerable comment, but no one has yet come forward to attempt to disprove any of the statements made.

* * *

D.A. (Northcote, Vic.) wants some advice about mixer circuits for gramophone pick-ups and microphones.

A.—Undoubtedly the best way is to feed the two inputs into the grids of two separate valves, with the plates connected in parallel. Most other schemes tend to be messy. However, in cases where there is considerable difference in the output of the pick-up and the mike, it is possible to feed the pick-up into the second stage, thereby avoiding the need for the two valves. Loading for the crystal microphone is fairly critical and wants to be on the high side, from 2 to 5 megohms with most brands.

* * *

"D.C. Fan" (New Farm, Q.) sends along a circuit of a direct-coupled amplifier which uses a neon lamp as the coupling between plate of the first valve and the grid of the outut valve, putting the grid at a higher potential than normal, but balanced off by a higher bias than normal.

A.—This is a most interesting circuit. We have seen it before somewhere, in an American book possibly, but have had no practical experience with it. Sorry you didn't tell us whether you have done any actual work on this circuit yourself, or send your full address so that we could get in touch with you.

* * *

F.D.D. (Longueville) wants to settle an argument about licensed listeners in Great Britain.

A.—According to our information there are about ten million licensed listeners in Great Britain and North Ireland.

welding with a paint brush?

Alloy flows easily and weld is quickly completed under arc.

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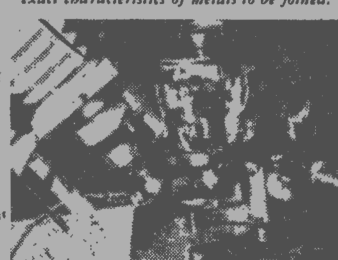

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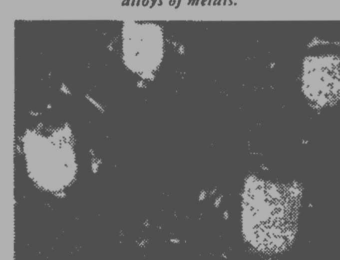

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