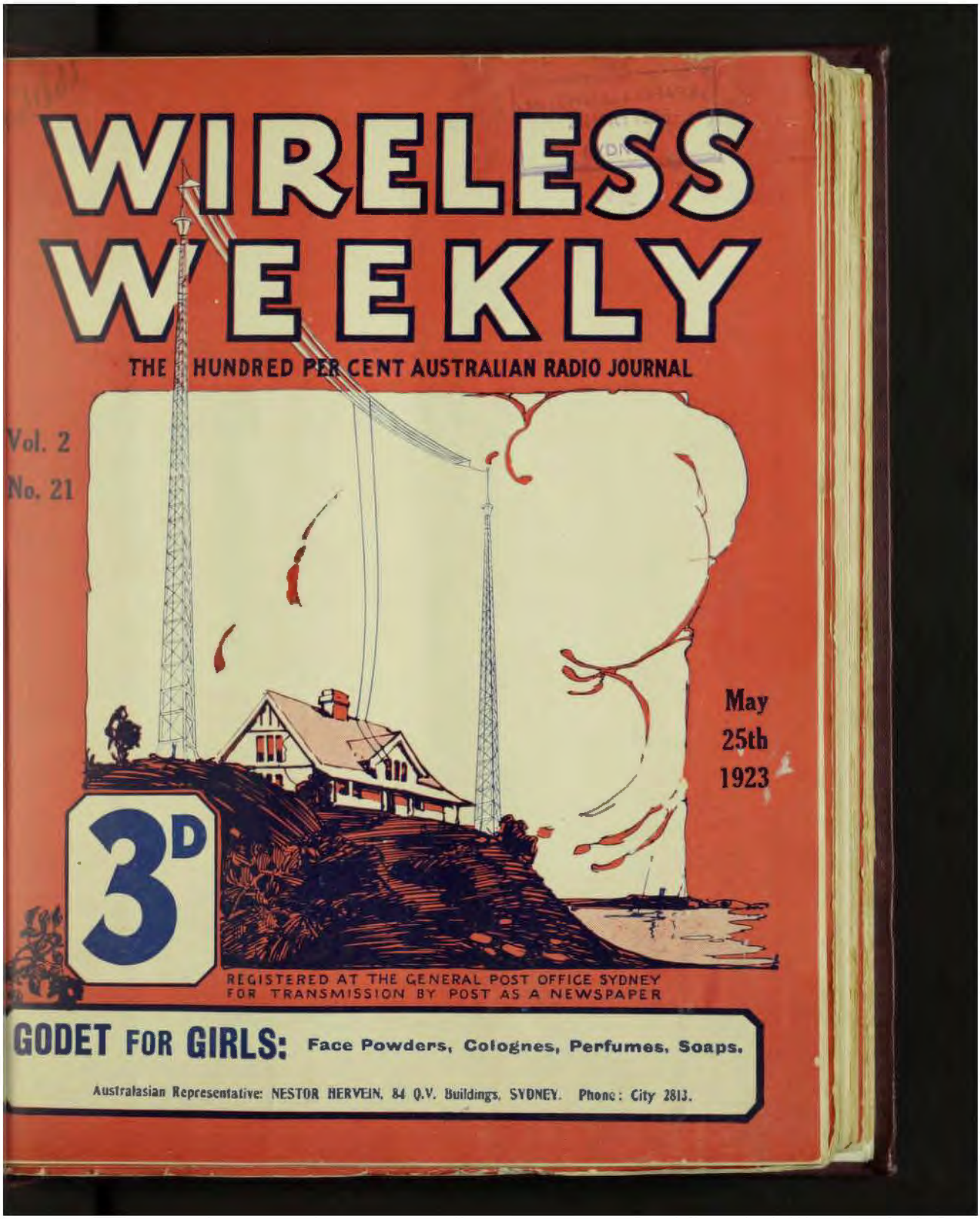
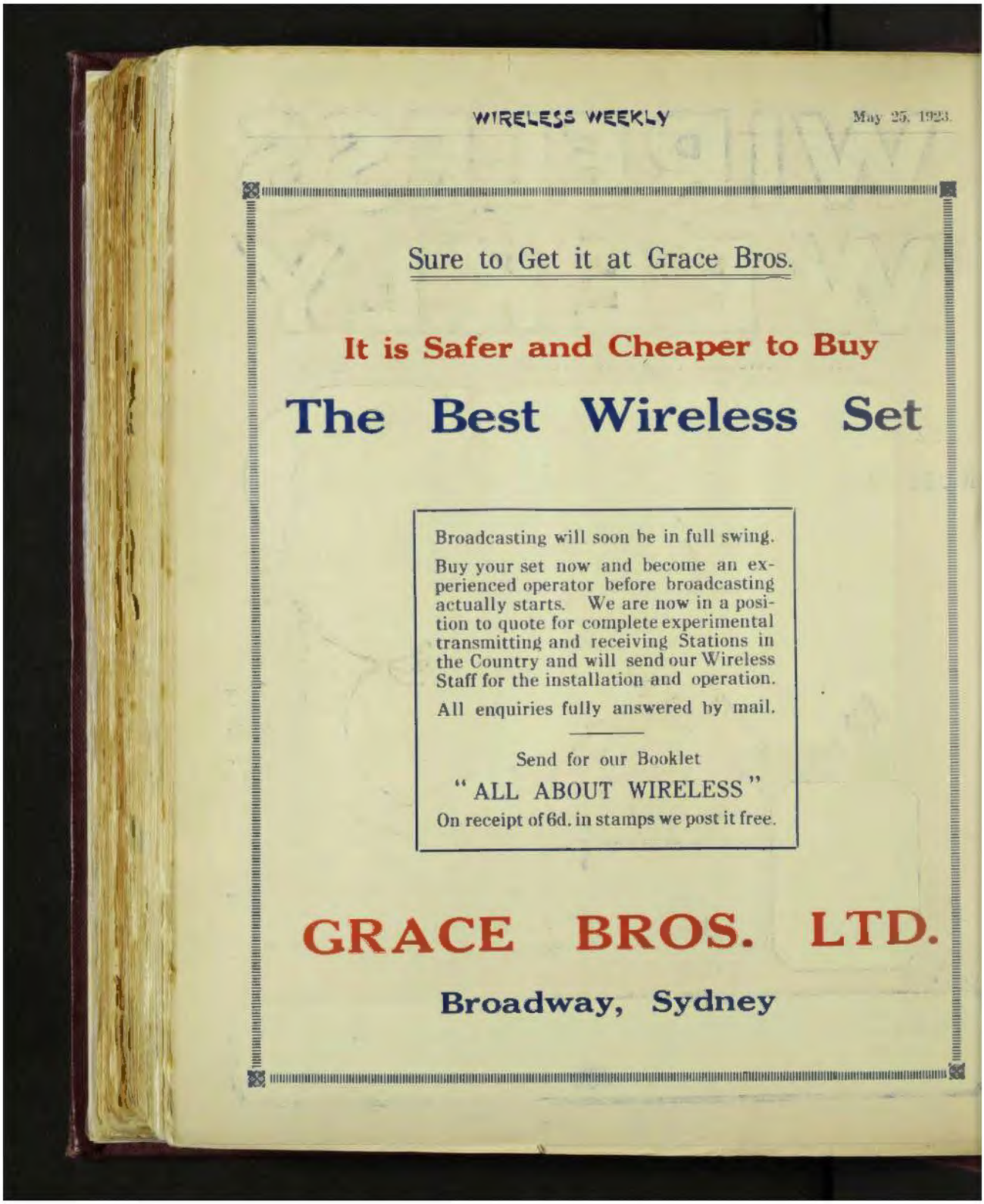
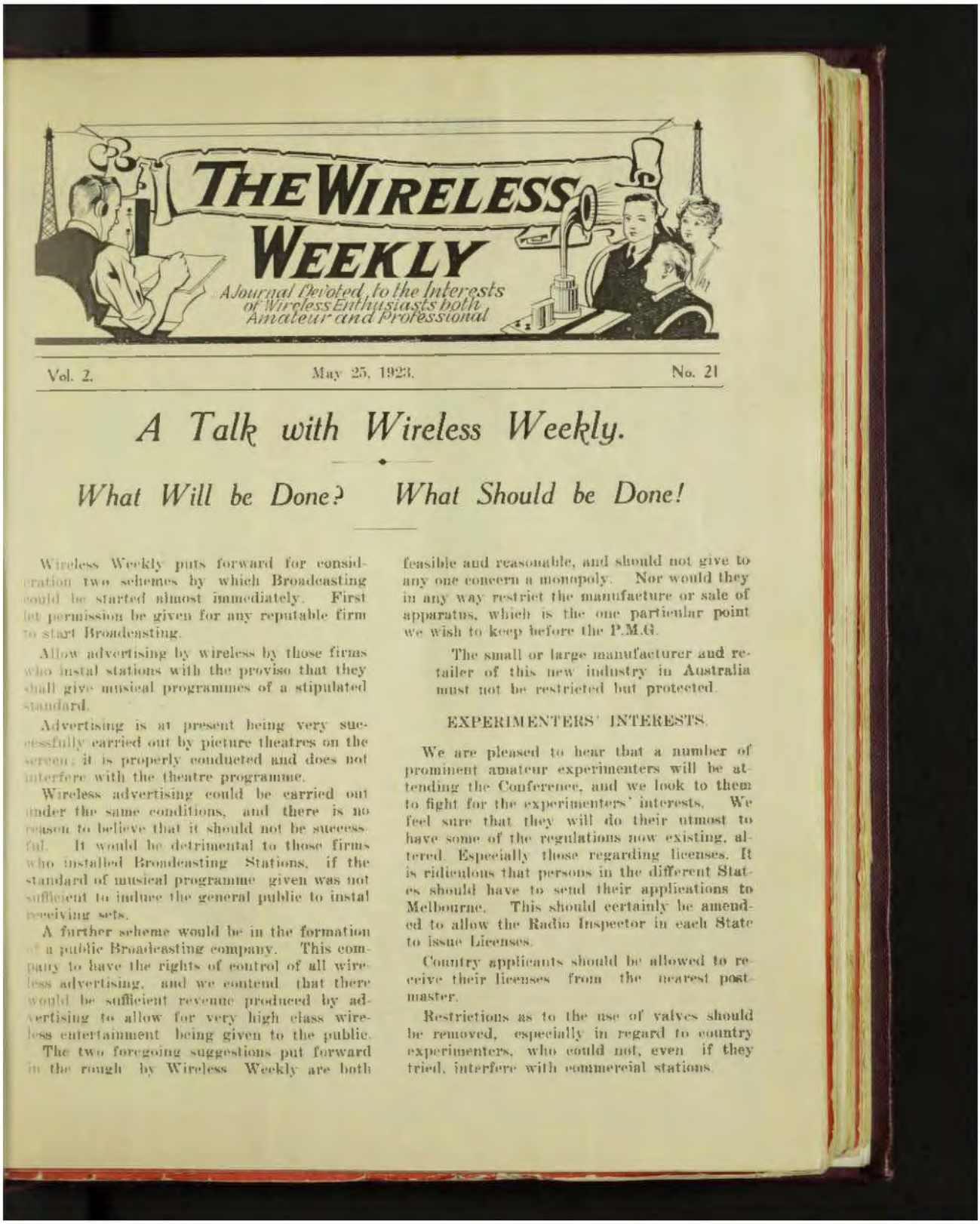






THE WIRELESS WEEKLY

A Journal Devoted to the Interests of Wireless Enthusiasts both Amateur and Professional

Vol. 2. May 25, 1923. No. 21

A Talk with Wireless Weekly.

What Will be Done? What Should be Done!

Wireless Weekly puts forward for consideration two schemes by which Broadcasting could be started almost immediately. First let permission be given for any reputable firm to start Broadcasting.

Allow advertising by wireless by those firms who instal stations with the proviso that they shall give musical programmes of a stipulated standard.

Advertising is at present being very successfully carried out by picture theatres on the screen; it is properly conducted and does not interfere with the theatre programme.

Wireless advertising could be carried out under the same conditions, and there is no reason to believe that it should not be successful. It would be detrimental to those firms who installed Broadcasting Stations, if the standard of musical programme given was not sufficient to induce the general public to instal receiving sets.

A further scheme would be in the formation of a public Broadcasting company. This company to have the rights of control of all wireless advertising, and we contend that there would be sufficient revenue produced by advertising to allow for very high class wireless entertainment being given to the public.

The two foregoing suggestions put forward in the rough by Wireless Weekly are both feasible and reasonable, and should not give to any one concern a monopoly. Nor would they in any way restrict the manufacture or sale of apparatus, which is the one particular point we wish to keep before the P.M.G.

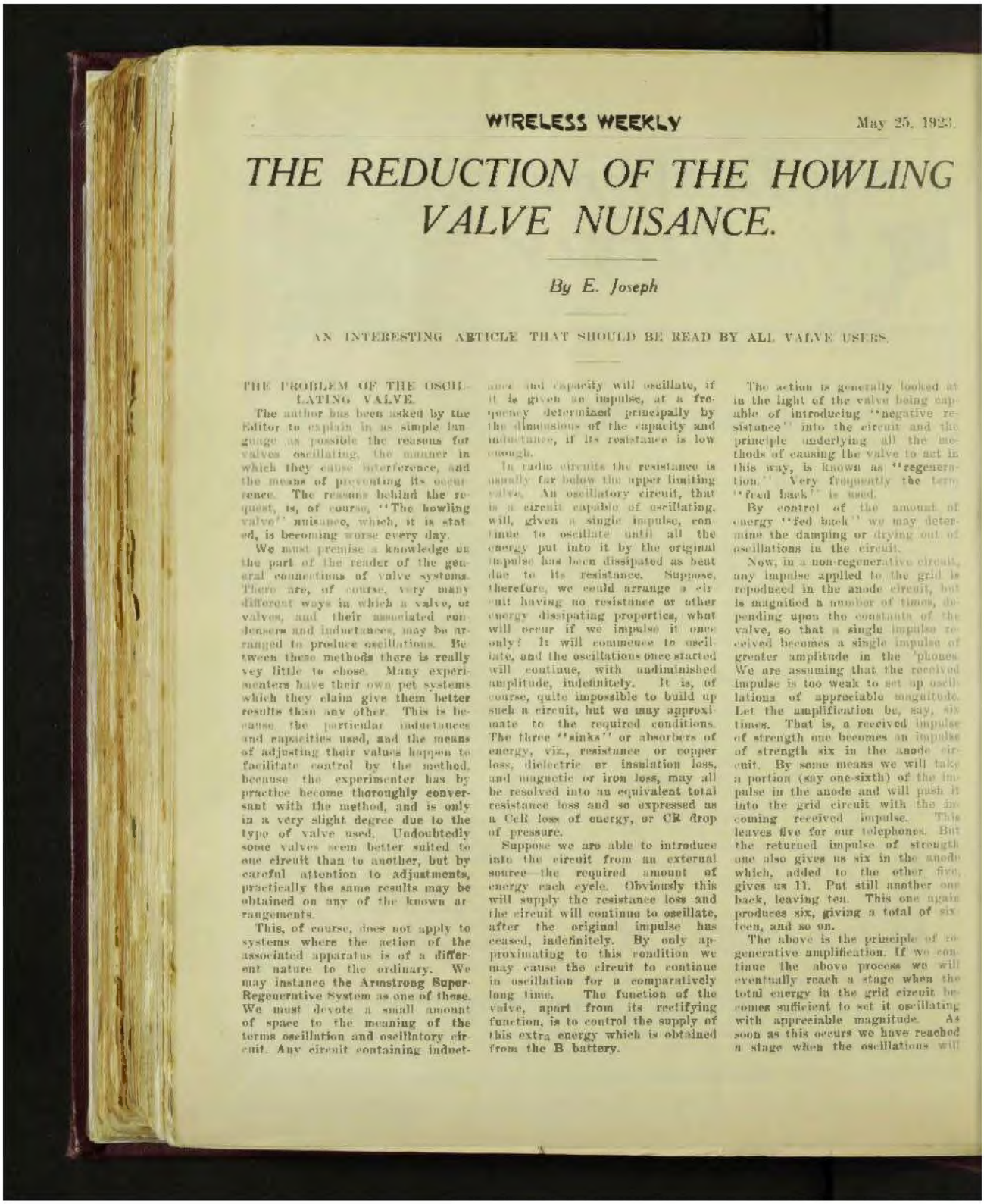
> The small or large manufacturer and retailer of this new industry in Australia must not be restricted but protected.

EXPERIMENTERS' INTERESTS.

We are pleased to hear that a number of prominent amateur experimenters will be attending the Conference, and we look to them to fight for the experimenters' interests. We feel sure that they will do their utmost to have some of the regulations now existing, altered. Especially those regarding licenses. It is ridiculous that persons in the different States should have to send their applications to Melbourne. This should certainly be amended to allow the Radio Inspector in each State to issue Licenses.

Country applicants should be allowed to receive their licenses from the nearest postmaster.

Restrictions as to the use of valves should be removed, especially in regard to country experimenters, who could not, even if they tried, interfere with commercial stations.



THE REDUCTION OF THE HOWLING VALVE NUISANCE.

By E. Joseph

AN INTERESTING ARTICLE THAT SHOULD BE READ BY ALL VALVE USERS.

THE PROBLEM OF THE OSCILLATING VALVE.

The author has been asked by the Editor to explain in as simple language as possible the reasons for valves oscillating, the manner in which they cause interference, and the means of preventing its occurrence. The reasons behind the request, is, of course, "The howling valve" nuisance, which, it is stated, is becoming worse every day.

We must premise a knowledge on the part of the reader of the general connections of valve systems. There are, of course, very many different ways in which a valve, or valves, and their associated condensers and inductances, may be arranged to produce oscillations. Between these methods there is really very little to chose. Many experimenters have their own pet systems which they claim give them better results than any other. This is because the particular inductances and capacities used, and the means of adjusting their values happen to facilitate control by the method, because the experimenter has by practice become thoroughly conversant with the method, and is only in a very slight degree due to the type of valve used. Undoubtedly some valves seem better suited to one circuit than to another, but by careful attention to adjustments, practically the same results may be obtained on any of the known arrangements.

This, of course, does not apply to systems where the action of the associated apparatus is of a different nature to the ordinary. We may instance the Armstrong Super-Regenerative System as one of these. We must devote a small amount of space to the meaning of the terms oscillation and oscillatory circuit. Any circuit containing inductance and capacity will oscillate, if it is given an impulse, at a frequency determined principally by the dimensions of the capacity and inductance, if its resistance is low enough.

In radio circuits the resistance is usually far below the upper limiting value. An oscillatory circuit, that is a circuit capable of oscillating, will, given a single impulse, continue to oscillate until all the energy put into it by the original impulse has been dissipated as heat due to its resistance. Suppose, therefore, we could arrange a circuit having no resistance or other energy dissipating properties, what will occur if we impulse it once only? It will commence to oscillate, and the oscillations once started will continue, with undiminished amplitude, indefinitely. It is, of course, quite impossible to build up such a circuit, but we may approximate to the required conditions. The three "sinks" or absorbers of energy, viz., resistance or copper loss, dielectric or insulation loss, and magnetic or iron loss, may all be resolved into an equivalent total resistance loss and so expressed as a C^2R loss of energy, or CR drop of pressure.

Suppose we are able to introduce into the circuit from an external source the required amount of energy each cycle. Obviously this will supply the resistance loss and the circuit will continue to oscillate, after the original impulse has ceased, indefinitely. By only approximating to this condition we may cause the circuit to continue in oscillation for a comparatively long time. The function of the valve, apart from its rectifying function, is to control the supply of this extra energy which is obtained from the B battery.

The action is generally looked at in the light of the valve being capable of introducing "negative resistance" into the circuit and the principle underlying all the methods of causing the valve to act in this way, is known as "regeneration." Very frequently the term "feed back" is used.

By control of the amount of energy "fed back" we may determine the damping or drying out of oscillations in the circuit.

Now, in a non-regenerative circuit, any impulse applied to the grid is reproduced in the anode circuit, but is magnified a number of times, depending upon the constants of the valve, so that a single impulse received becomes a single impulse of greater amplitude in the 'phones. We are assuming that the received impulse is too weak to set up oscillations of appreciable magnitude. Let the amplification be, say, six times. That is, a received impulse of strength one becomes an impulse of strength six in the anode circuit. By some means we will take a portion (say one-sixth) of the impulse in the anode and will push it into the grid circuit with the incoming received impulse. This leaves five for our telephones. But the returned impulse of strength one also gives us six in the anode which, added to the other five, gives us 11. Put still another one back, leaving ten. This one again produces six, giving a total of sixteen, and so on.

The above is the principle of regenerative amplification. If we continue the above process we will eventually reach a stage when the total energy in the grid circuit becomes sufficient to set it oscillating with appreciable magnitude. As soon as this occurs we have reached a stage when the oscillations will

persist for as long as the return of energy from the anode alone is continued, and the valve system is in a state of self and persistent oscillation.

If the returned energy is barely sufficient we may reach a stage when the addition of received energy is required before the system will oscillate. This state has no doubt frequently been noticed by the experimenter. He is listening to telephony, speech coming in clear and undistorted, a near-by or powerful spark station starts transmission, and immediately not only is the latter heard "behind" the telephony, but it makes the latter "mushy." This is due to the fact that the addition of the energy from the spark station has been able to set the system into a state of oscillation. The mushiness usually ceases as soon as the spark station stops transmitting, but sometimes, when anode pressures too high are being used, the effect continues. The spark energy has had a "trigger" effect, and the mushiness can only be removed by a reduction in the amount of energy fed back.

It might be suggested that if the valve is oscillating at a wave-length exactly agreeing with that of the telephony carrier wave, no distortions or mushiness should occur. Unfortunately this is not so. The wave-length of a radio telephone transmitter may be considered as a variable, its upper and lower limits being found thus. Upper limit of frequency equals carrier frequency plus audio frequency. Lower limit equals carrier frequency, minus audio frequency.

So that a narrow band of wave-lengths is covered. It therefore follows that an oscillating valve cannot reproduce telephony satisfactorily. There is, of course, a pardonable desire on the part of the experimenter to obtain maximum results, so that he tries to adjust his circuits to the point where the maximum of feed back, without excess, occurs. The least shade of excess causes a "dummy" effect, and very slightly more makes the reproduction "musky." The remedy is clearly to so arrange the circuits that full and complete control over the amount of feed back is obtained.

The above deals with the facts as they affect the individual listener. There are, however, other effects which, as they interfere with other listeners, may, except in the case of very selfish experimentors—of whom it is trusted and believed there are only a few—be considered as of more importance.

Your set is working satisfactorily, perfect reproduction of sound is being obtained, you are enjoying one of the Galli Curci or Paderewski records so kindly lent to Mr. Maclurcan for these occasions. Suddenly a horrible whistling, screeching noise replaces the music. How is this? What has happened? You go all over your adjustments without being able to improve things; meanwhile the discord is varying in pitch and volume, is spasmodically appearing and disappearing (this is not quite the correct term, but it will serve).

Some other experimenter not very far away has by accident, or design, set his valve oscillating, and is radiating a little energy at a wave-length not far removed from the carrier wave-length you are listening on. Your set does not tune sufficiently sharply to prevent it responding to these pseudo signals. They are picked up and cause beats of an audio frequency with the carrier wave. Really, the interfering set is acting as a separate heterodyne to you.

If more than one set interferes at the same time, very complex heterodyning effects are produced, and you complain of "howling valves." This, although your own set is not oscillating at all.

The remedy is to arrange your set to give you the sharpest possible tuning, so that you may pick up as little energy as possible from the interfering set. This implies, of course, loose coupling and unfortunately means weakening signals. You are doing everything in your power to strengthen them, and indeed for comfortable reception one cannot afford to allow any available energy to slip past. The per-

missible power of the transmitters is too low for that.

The real remedy lies with the offender himself rather than with the offended.

(To be Continued)

The Principles and Construction of an Electrolytic Rectifier.

By KENNETH M. SWEENEY.

In most localities, except in the immediate vicinity of power stations, alternating current is supplied to the homes that are equipped for electricity. The reason for this is because of the greater ease and economy of transporting alternating current over direct current. Power can be transferred over the long stretches at a high potential and low current strength, and then reduced by means of transformers to the correct voltage for district and individual use. You can readily see that this procedure allows the use of a smaller guage wire, thus lowering the expense of the distributing system.

Alternating current is far from being a disadvantage to the work of the experimenter. It can be used the same as direct current for lighting lamps, and can also be used for running motors. If you possess alternating current you can rig up a "spark" radio transmitter, capable of covering great distances, at a small outlay. You can also, by its use, investigate the fascinating realm of high frequency currents, and perform all the spectacular stunts that are usually left to the laboratory, or to the wizard of the stage.

However, alternating current (or more simply, A. C.), cannot be used in places where a steady unidirectional current is required, such as for charging storage batteries, or for electro-plating. But still we have a method of overcoming this difficulty by means of what we call a rectifier. This piece of apparatus so changes the current that it becomes in effect a pulsating direct current.

There are five types of rectifiers in common use; the commutator, the magnetic vibrator, the mercury arc, the vacuum tube, and the electrolytic. For small storage battery charging purposes the magnetic vibrator, the electrolytic and the vacuum tube type are the most convenient. Of them all, the electrolytic is the easiest and simplest to construct at home. For those who can afford to buy them, the other two types are to be recommended, as they are efficient, compact and little bother. However, for those who care to make a rectifier of the electrolytic type, the following principles of operation, and the details of construction of a de luxe model, are given.

Let us bring to our minds the experiment that illustrates the electrolytic decomposition of water. There are two electrodes used; one at which the current enters the solution, called the anode, and the other at which the current leaves, or the cathode. When a cell or a battery is connected to the proper terminals, the water is found to split into its component parts —hydrogen and oxygen. Hydrogen is given off from the cathode, and oxygen from the anode. As water is composed of two parts hydrogen to one part oxygen, its decomposition can be used as a positive indication of polarity. This is particularly useful to know when working with storage batteries. If the ends of the two leads that come from a storage, or any other kind of a battery, are immersed in a receptacle of water that has been slightly salted or acidulated (this to lower the resistance), the lead from which the most gas, or the greatest number of bubbles, is given off, is the negative.

Now, aluminium has the outstanding property of readily combining with oxygen, forming oxide of aluminium. Almost instantly a piece is cut, it is coated with a thin coating of oxide. However, this is so very thin that it is practically transparent to the human eye. But its presence is unmistakably proved when soldering or welding is attempted, as it renders these operations next to impossible.

Advantage is taken of this property of aluminium, in the electrolytic, or Nodon, rectifier. One electrode or plate is made of this metal, and the other of some chemically inactive substance such as platinum, carbon, iron, or lead. Lead has some advantages over the others mentioned, and is therefore gener-

ally used. These electrodes are immersed in a solution of aluminium phosphate in water.

If a potential is applied to this electrolytic cell in such a way that the lead plate is made the anode, a current will flow readily from the lead to the aluminium, hindered only by the resistance of the electrolytic. But if a potential is applied with a reverse polarity, so that the aluminium is the anode, the oxygen will so affect this metal that a tough skin of oxide will be formed that completely covers the plate. This oxide is a non-conductor, and hence the current is shut off.

When placed in an A. C. circuit, the effect of such a cell can readily be imagined. During one-half of an alternation the current would be allowed to flow, but during the other half the current would almost completely be shut off. The resultant current flowing through the circuit would be intermittent, and in single direction—in the direction of lead to aluminium. The direct current in relation to the alternating current is shown by Fig. 1. It is to be observed that only one-half of the alternating current cycle is made use of, that the direct current is intermittent. By using a number of cells with the proper connections, both halves of the alternations can be made use of, and a current having an outline similar to that represented by the second curve in the same figure can be obtained.

Passing from theory, let us look at the practical side of the question. The amount of current that a rectifier will pass is limited, on account of the heating of the liquid. Five amperes is the maximum that can be passed continuously through one of the size to be described. Another disadvantage is the waste of power due to the high voltage of the supply and the necessary series resistance. Regardless of these faults, however, a rectifier of this type will be useful about the home and laboratory, wherever an alternating current is available, and a direct current of low amperage is wanted. It would be ideal for charging storage batteries of 60 ampere-hour capacity, or less, and for experimental work.

Four jars are necessary. These may be of glass, metal, or glazed earthenware. It is evident that the greater the exposed surface, the greater will be the cooling facilities, so bear this in mind when making your selection. Procure jars that are as large as convenient. A good size is about five inches in diameter and six inches deep. If you use metal you should cover the interior surface with several coats of pitch or asphaltum varnish. A dull black paint of pigment applied

Continued on Page 7, Col. 2

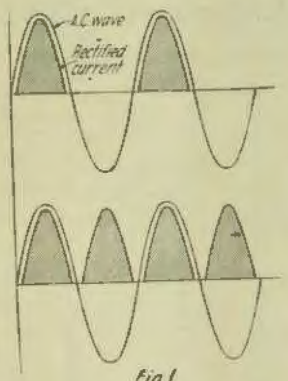


Fig 1

Fig. 2

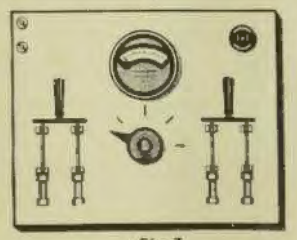


Fig. 3

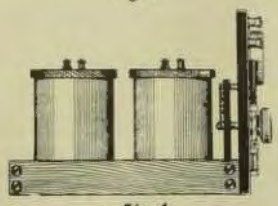


Fig. 4

2/6 will be paid for the best "BIT" of wireless humour sent in each week. Articles sent in will become the property of Wireless Weekly Newspaper. 2/6 will be paid for each humorous drawing accepted.

MAKE YOUR OWN

Measurement Charts.

For Determining the Capacity of a Condenser.

Both the engineer and the amateur have cause to make or to use condensers of a certain fixed capacity in testing out new radio circuit. Sometimes they have a number of fixed condensers of unknown capacity on hand, says Raoul J. Hoffman, A.M.E.

The condenser is an electrical device which has two or more conducting sheets that are separated by some insulating material (a non-conductor of electricity) in order to store up electrostatic energy. The capacity of such condenser, which is usually measured in microfarads (mfd.) depends entirely upon the active area of the plates or sheets of conducting material, the distance separating them, and the kind of material (dielectric or insulator) which is used to separate them.

The formula for the capacity of a condenser follows:—

$$C = \frac{AK}{T} .0000002248$$

where

A = the area of the plates in square inches

K = the dielectric constant of the insulating material (given below)

T = the thickness of the insulating material, in inches

and

C = the capacity of the condenser in mfds.

The dielectric constants for various materials are:

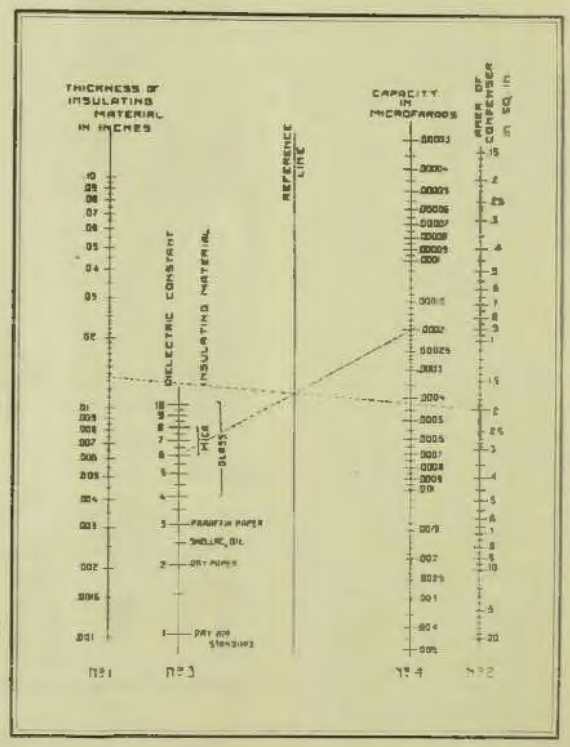
Material, Constant (K.): Air (standard), 1; Paper, 1.5-2; Paper (paraffin), 3; Shellac, 2.5-3.5; Oil, 2.5; Mica, 6-8; Glass, 4-10.

To enable the radio man to determine the capacity of a condenser which is already built, or to determine the size of a condenser which he intends to build that shall have a certain predetermined capacity, which incorporates the formula given above.

To use a chart to determine the capacity of a condenser, let us consider the example:—

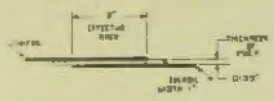
A condenser constructed as shown in Figure 2, contains two sheets of tinfoil conductor, which have an effective (overlapping) area of (2 by 1) 2 inches. The thickness of the mica insulator sheet is .0135 inch. Connecting .0135 on scale No. 1, with 2, on scale No. 2, with a ruler, and then connecting the reference point (where this line crosses the reference line) with dielectric constant for mica (about 6) on scale No. 3, we find the continuation of this line crosses the scale No. 4 at .0002 mfd., which is the capacity of the condenser.

To determine the area of a condenser which will have a certain



capacity, the process is reversed: Example:—

To construct a condenser with a capacity of .0002 mfd., using a mica dielectric of .0135 inch thickness, we proceed in the following manner:

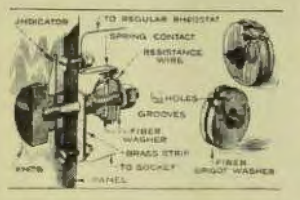


Connect, on scale No. 4, the capacity desired (.0002) with the dielectric constant (6) on scale No. 3. Now connect the point of intersection (of this line with the reference line) with the thickness of the dielectric to be used (.0135) and extend this line to scale 2, which will give the effective (overlapping) area of the plates to be used.

This chart will certainly be a time-saver for the amateur, and will give him assurance that he is getting the most out of his experimental circuits by the use of the proper sized condensers.

EASILY MADE "VERNIER" RHEOSTAT.

A "vernier" rheostat," connected in series with the regular one, will be found of advantage when regulating the filament current in the radio detector. For receiving sets not equipped with a vernier rheostat, one can readily be improvised as illustrated. The rheostat consists of a short length of resistance wire, wound once around the circumference of a fibre spigot washer, about five-eighths of an inch in diameter. Grooves are cut across the washer, as shown, so that one end of the resistance wire can be wound around the threaded spindle, and locked with a nut and washer; the other end is fastened by threading it through two one-thirty-second inch holes, drilled about one-eighth inch apart. A spring-brass contact, bolted to the panel, bears on the wire when the assembly is mounted on the panel, and connection to the spindle is made by means of a spring-brass strip, also bolted to the panel as shown. A spring is used on the spindle, between this strip and the inner binding nut on the fibre washer. A knob and indicator are mounted on the front of the panel in the usual way. This rheostat provides a variable range of resistance, the maximum value of which



is equal to that of a single turn of wire on the regular rheostat.

The Principles and Construction of an Electrolytic Rectifier

Continued from Page 5

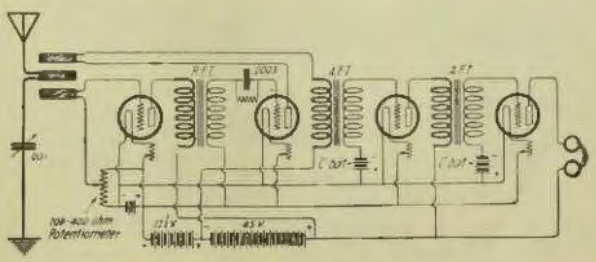
to the exterior will increase its heat radiation surprisingly.

Procure your metal sheeting, and if you intend using jars of the size mentioned, cut four strips of lead about four inches wide and six inches long, and four strips of aluminium about three inches wide and also six inches long. This metal stock should be at least one sixteenth of an inch thick. Thicker material has the good quality of giving longer service. If you intend to use jars of a size different from that mentioned, make the plates and other fittings in proportion. If your metal is very thin, the cutting can be done with a pair of tinners' shears, but the thicker metal may have to be cut with a hack saw. It is imperative that you use the purest aluminium obtainable, for otherwise the rectifier will not function properly. If you have some old lead pipe around, that is between

an inch and an inch and a half in diameter, you can use this in place of the lead sheeting. Simply cut off a six inch length, slit one side parellel to its axis, and flatter it out.

Next cut four discs of well seasoned wood, or some other insulating substance, about six inches in diameter. These discs can either be turned out on a lathe, or cut by the more laborious method of the scroll saw. Bend over one end of each of the lead and aluminium strips, about a half inch down, at an angle of 90 degrees. Fasten the strips to the discs by means of a screw and a binding post through each lug, as shown in Fig. 2. A lead and an aluminium plate goes on each disc. Space the plates about an inch and a quarter, and be sure that they are rigid. It is well to drill a hole in the centre of each cover to allow the gases to escape. Paint the exposed metal parts above the electrolyte with the asphaltum varnish to prevent corrosion.

The electrolyte to be used is a saturated solution of ammonium phosphate in as pure water as it is possible to obtain. The chemical must also be pure. To make a saturated solution, it is fairly safe to allow a pound of the phosphate to a gallon of water. Stir it until it is thoroughly dissolved, and see that no sediment remains at the bottom. A mineral oil, such as paraffin oil,



A 3 coil Circuit using 1 Radio and 2 Audio Frequency.

WIRE TABLES.

SOME VALUABLE DATA FOR EXPERIMENTERS.

S.W.G.	Diameter Bare		Diameter S.S.C.		Diameter D.C.C.		Ohms per 1,000 yards.			Comparison between diameters of—		
No.	Inches.	Mm.	Inches.	Mm.	Inches.	Mm.	Copper Wire	Manganin	Eureka.	S.W.G.	B.W.G.	B. & S.G.
14	·080	*2·032*	·086	*2·20*	·091	*2·30*	4·784	120	133·9	·080	*·083*	·0641
16	·064	*1·626*	·070	*1·80*	·075	*1·90*	7·478	186	209·1	·064	*·065*	·0508
18	·048	*1·219*	·053	*1·346*	·056	*1·42*	13·28	332	371·8	·048	*·049*	·0403
20	**·036**	***·9144***	**·040**	***1·017***	**·044**	***1·118***	**23·62**	**591**	**661·3**	**·036**	***·035***	**·0320**
22	·028	*·7112*	·032	*·812*	·036	*·915*	39·05	976	1,093	·028	*·028*	·0253
24	·022	*·5588*	·026	*·660*	·030	*·762*	63·24	1,581	1,770	·022	*·022*	·0201
26	·018	*·4572*	·022	*·559*	·026	*·660*	94·48	2,362	2,645	·018	*·018*	·0159
28	·0148	*·3759*	·019	*·483*	·023	*·585*	139·8	3,495	3,914	·0148	*·014*	·0126
30	**·0124**	***·3149***	**·017**	***·432***	**·021**	***·533***	**199·1**	**4,977**	**5,575**	**·0124**	***·012***	**·010**
32	·0108	*·2743*	·015	*·381*	·019	*·432*	262·5	6,562	7,350	·0108	*·009*	·0079
34	·0092	*·2337*	·013	*·330*			361·7	9,042	10,128	·0092	*·007*	·0063
36	·0076	*·1930*	·011	*·280*			530·0	13,250	14,840	·0076	*·004*	·005
38	·006	*·1524*	·0095	*·241*			850·3	21,257	23,808	·0060	—	·004
40	**·0048**	***·1219***	**·008**	***·203***			**1328·0**	**33,200**	**37,184**	**·0048**	—	**·0031**
42	·004	*·1016*	·007	*·177*			1913·0	48,825	53,564			
44	·0032	*·0813*					2988·0	74,700	83,664			
46	·0024	*·0610*					5313·0	132,825				
48	·0016	*·0406*						203,000				
50	**·0010**	***·0254***										

In the table particulars are given of the diameter of bare wire, and wire with single silk and double cotton covering. From the latter data, the number of turns per inch or centimetre which may be wound is readily determined. To take an example, No. 22 D.C.C. is 0·040 inches in diameter and it should be expected that $\frac{1}{0{\cdot}044} = 22$ turns of this wire will be wound in one inch. Of course a slight deduction in the number of turns should be made in the case of those who are not expert at winding coils. If the winding is to be with No. 22 S.S.C., $\frac{1}{0{\cdot}04} = 25$ turns should be wound in one inch. Wire as ordinarily purchased slightly varies in diameter measured over the insulation, but apart from this slight irregularity, with the aid of the tables it is possible for those who are not familiar with wire gauges, or who have no measuring instrument such as a micrometer to determine the gauge of wire they may have. The wire should be wound upon a small diameter rod, and the number of turns in a one-inch length counted. The covering of the wire is easily determined by inspection. If the wire has been tightly wound, and there are say 45 turns, and the wire has a single silk covering, the diameter of the covered wire is $\frac{1}{45} = {\cdot}022$ in. From the tables it is evident the wire is No. 26 S.S.C.

The resistance per 1,000 yards of copper and resistance wires given in the 8th, 9th and 10th columns are useful in that one is able to closely estimate the length of wire in a coil, and hence its resistance. As an example suppose a potentiometer is required. A potentiometer has a resistance generally of the order of 450 ohms, and No. 36 manganin or Eureka resistance wire will be used. In the case of the Eureka wire, from the tables No. 36 has a resistance of 14,840 ohms per 1,000 yards or 14·8 ohms per yard. The length required for the potentiometer is then $\frac{450}{14{\cdot}8}$ or 30·4 yards. If the rod upon which the wire is to be wound has a diameter of one inch, its circumference is 3·14 inches. The total number of turns is the total length of wire in inches divided by the circumference. Hence 30·4 yards = 1,094 inches, and the number of turns $\frac{1094}{3{\cdot}14}$ or 348 turns. The wire will wind 90 turns to the inch, and the length of the potentiometer will be nearly 4 inches.

The last columns give a comparison between the diameter of American and British wire gauges.

Wireless Willie's Weekly Warble.

Dear Experimenters,—I have decided to drop my Humorous and Competition Columns for a few weeks until I put more pages in W.W., and devote the space to Technical and Make your Own. If you have any objections to this procedure, grab a sheet of paper and a pen and let me have it.

Next week I hope to publish the full report of the Broadcasting Conference, and with that object, I am off to Melbourne, so that my readers will have the Dinkum Oil.

The new Honorary Radio Inspectors appointed for New South Wales are: Mr. C. D. Maclurcan, President N.S.W. Division of the Wireless Institute of Australia; Mr. H. A. Stowe, Councillor Wireless Institute and Councillor of Kuringai and District Radio Club, Mr. Crocker, Councillor Wireless Institute, and well known in the aether as 2BB; and Mr. Robinson, a keen experimenter, who from time to time has been a vigorous correspondent in Wireless Weekly. Wireless Willie is going to give these four gentlemen his keenest support. They have taken on work that will take up quite a lot of their time, and as they are all keen experimenters it behoves us all to assist them. Mr. J. S. Marks, while testing out his new transmitting set on a small loop aerial was heard at Beecroft, on the outside aerial his music is excellent. Quite a number of prominent amateurs have gone to the Conference, including Messrs. B. Cooke, C. A. Taylor, and O. Mingay. Do you know where the prominent Secretary of the Wireless Institute spends his week-ends? Wait for next week's issue and I will tell you all about it.

Mr. R. G. Marsden after much preparation, put over a very successful test last Sunday evening, Miss Lee White and Mr. Clay Smith, the well-known theatrical artists, rendered a number of items.

I note quite a number of transmitters seem to go at the same time. The "Roster," I believe, is still in operation.

I do not know what sort of a gramophone Mr. J. S. Marks uses or who chooses his records—but I do know the machine is a good one and the records excellent.

Quite a number of ladies' voices in the aether lately, except in one or two cases they speak too rapidly.

2JM had a lady operator one night last week, I presume Mrs. M.

Yours etc.,

W.W.

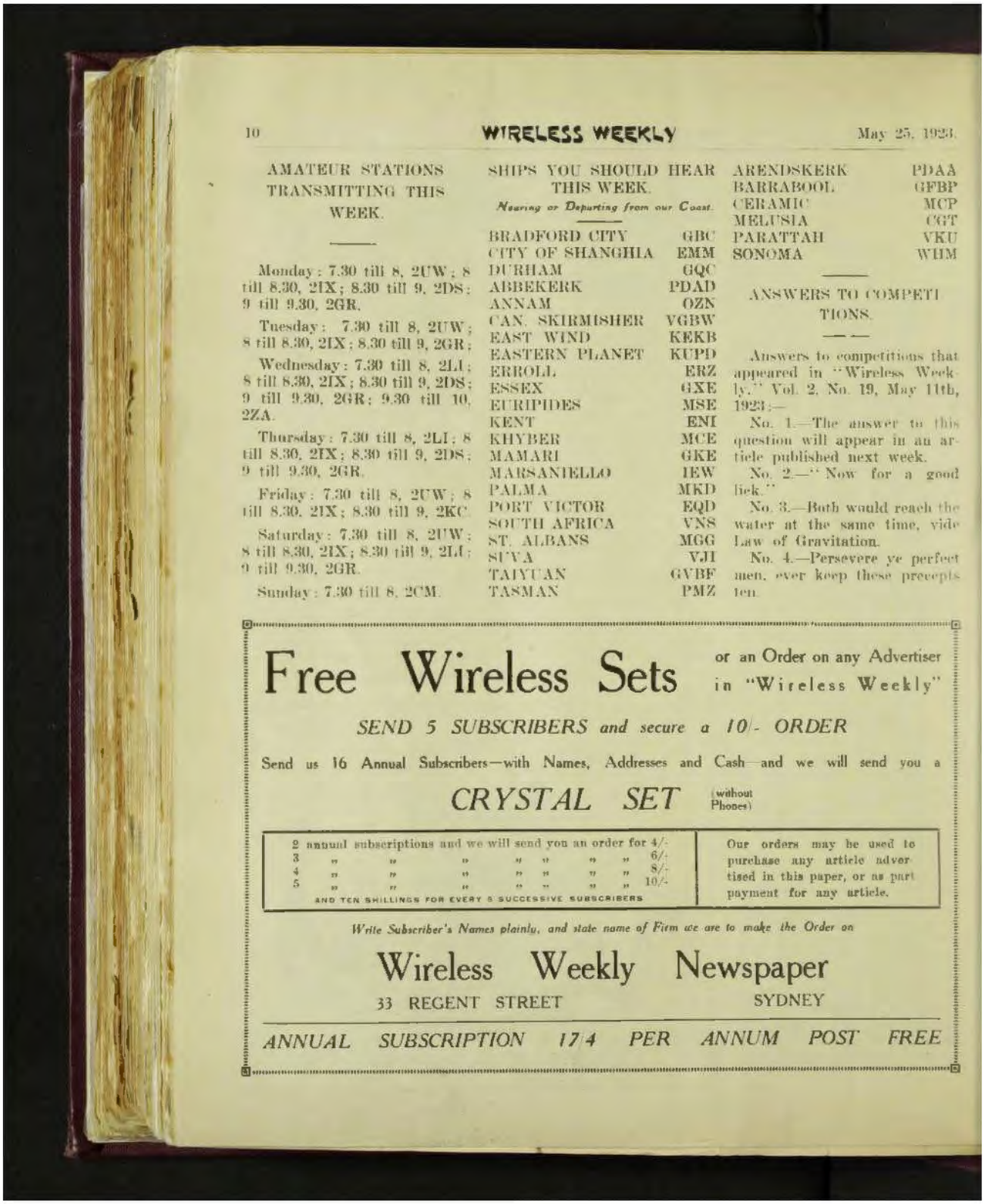
MR. MARSDEN'S (2JM) TEST.

A most successful test was made by Mr. R. C. Marsden on Sunday last. With an arrangement of microphones a number of vocal items were transmitted. The artists were Miss Lee White, Messrs. Clay Smith, Hector St. Clair, F. Charlton and J. M. Stanley (2JS).

Mr. Marsden states that the successful test was partly due to the valuable assistance given by Mr. Stanley.

Miss Lee White intimated that she would be pleased to repeat the dose in about three weeks' time.

Trials of the Experimenter.



AMATEUR STATIONS TRANSMITTING THIS WEEK.

Monday: 7.30 till 8, 2UW; 8 till 8.30, 2IX; 8.30 till 9, 2DS; 9 till 9.30, 2GR.

Tuesday: 7.30 till 8, 2UW; 8 till 8.30, 2IX; 8.30 till 9, 2GR;

Wednesday: 7.30 till 8, 2LI; 8 till 8.30, 2IX; 8.30 till 9, 2DS; 9 till 9.30, 2GR; 9.30 till 10, 2ZA.

Thursday: 7.30 till 8, 2LI; 8 till 8.30, 2IX; 8.30 till 9, 2DS; 9 till 9.30, 2GR.

Friday: 7.30 till 8, 2UW; 8 till 8.30, 2IX; 8.30 till 9, 2KC.

Saturday: 7.30 till 8, 2UW; 8 till 8.30, 2IX; 8.30 till 9, 2LI; 9 till 9.30, 2GR.

Sunday: 7.30 till 8, 2CM.

SHIPS YOU SHOULD HEAR THIS WEEK.

Nearing or Departing from our Coast.

BRADFORD CITY	GBC
CITY OF SHANGHIA	EMM
DURHAM	GQC
ABBEKERK	PDAD
ANNAM	OZN
CAN. SKIRMISHER	VGBW
EAST WIND	KEKB
EASTERN PLANET	KUPD
ERROLL	ERZ
ESSEX	GXE
EURIPIDES	MSE
KENT	ENI
KHYBER	MCE
MAMARI	GKE
MARSANIELLO	IEW
PALMA	MKD
PORT VICTOR	EQD
SOUTH AFRICA	VNS
ST. ALBANS	MGG
SUVA	VJI
TAIYUAN	GVBF
TASMAN	PMZ
ARENDSKERK	PDAA
BARRABOOL	GFBP
CERAMIC	MCP
MELUSIA	CGT
PARATTAH	VKU
SONOMA	WHM

ANSWERS TO COMPETITIONS.

Answers to competitions that appeared in "Wireless Weekly," Vol. 2, No. 19, May 11th, 1923:—

No. 1.—The answer to this question will appear in an article published next week.

No. 2.—"Now for a good lick."

No. 3.—Both would reach the water at the same time, vide Law of Gravitation.

No. 4.—Persevere ye perfect men, ever keep these precepts ten.

Six of Your Most Pressing Radio Questions Answered.

By the Information Editor.

"How can I improve my radio set?"

This is the question eternally uppermost in the minds of thousands of radio fans.

Curiously enough, almost equally numerous are the two main trends taken by questions of this kind. "How can I increase the distance range of my set?" is the most frequent plea from the radio fan, and "How can I increase the volume of sound from my set?" closely follows it.

There are many answers, of course, to the first question. In general, it is safe to say that by a close study of the design of a radio receiving set, it is possible to receive over distances of from 500 to 1000 miles, merely by using a detector and one stage of amplification. As a matter of fact, 1000 miles is often covered by the use of a single detector tube.

In the construction of such a set, careful attention must be given to the tuning elements, since at these great distances, selectivity is of primary importance. A set that will not tune very closely cannot be used to span great distances.

This selectivity can be obtained by the use of a variocoupler-variometer hook-up or a variocoupler with an extra rotor, the winding of which acts as a tickler coil. The primary of the variocoupler should have just about the required number of turns to receive efficiently the programmes sent out on the broadcasting wave lengths. This means from 25 to 35 turns on a tube 3½ or 4in. in diameter. By tapping off every turn between the twenty-fifth and thirty-fifth turns, it is possible to vary the wave length of the circuit to rather close limits. To vary it within the limits of one turn, a Vernier variable condenser can be used, either in parallel or in series with the primary coil.

The secondary coil should have about 50 turns and the tickler coil, 70 turns. Where the variometers are used, they should have from 30 to 60 turns on the primary and approximately the same number on the secondary.

"What is the actual value of a potentiometer, and how can it be connected into the circuit?" is a question that has come to me hundreds of times.

When the ordinary type of B battery, tapped in the last few cells, is used, the difference in the voltage can be varied only by 1½-volt steps. A potentiometer makes a finer adjustment possible. To hook one into a standard circuit, it is necessary to connect the negative of the B battery with the moving member, or slider, and the negative of the storage battery with one end of the potentiometer while the positive pole is connected with the other end of resistance element of potentiometer. The plate voltage can then be varied within small limits by moving the slider of the potentiometer from one end of the resistance element to the other.

"How are Vernier condensers connected into a circuit?" troubles many of my correspondents.

Vernier condensers simplify the critical tuning of the set. Most radio fans have had the experience of bringing in a station without being able to tune it in to best advantage because a very slight adjustment would lose the station. To overcome this difficulty, Vernier condensers should be connected in parallel with condensers already in use.

Typical of questions that come under this division of how to increase the range of radio sets are, "Should the rotary plates be connected with the ground or the aerial side of a circuit?" and "Should the condenser be connected with the ground lead or the aerial lead?"

Wherever possible, the rotary plates should be connected with the grounded part of the circuit. In a secondary circuit, the lead from the secondary coil going to the A battery should be grounded and the rotary condenser plates should be connected with this side of the circuit. The reason for this is that the rotary plates are the ones connected with the shaft of the condensers and a certain capacity effect is introduced between the hand that is grounded and the part of the circuit to which the rotary plates are connected. If the rotary plates are connected with ground, however, this capacity effect will not be present.

This covers pretty fully the main types of questions I receive as to how to increase the range of the set without resorting to the use of radio frequency amplification.

"I am getting pretty good results," says the other great group of my correspondents, "but I'd like to know how I can make the music come in as loud as a phonograph."

Continued on page 12

can be floated on the surface of the solution in the jars to help prevent evaporation, and also prevent sparking at the surface of the liquid. This latter, although pretty to look upon, causes a rapid deterioration of the plate at the point of occurrence.

A tray is next in order of construction. Make this of the form shown, and of well seasoned wood, from a half to seven-eighths of an inch thick. Allow space for the four jars, with a slight separation between them to admit a circulation of air.

The panel can be made of marble, bakelite, or even hard wood, and should be of the width of the tray and of a height depending upon the size and number of instruments that you intend to use on it; the arrangement in the drawing being only suggestive. It can be fastened to the tray with screws along the bottom, or small brackets can be used at the sides. If it is made of wood, paint it with shellac or some other insulating varnish.

The instruments shown include an ammeter, a rheostat, and two double pole-knife switches. The switches can be used to take care of a possible short circuit or other accident. The meter will indicate the amount of current that is allowed to pass into the battery by the rheostat. One of the switches is connected on the input, or A.C., side, and the other is connected on the direct current output side. The rheostat should be designed to adequately handle five amperes at 100 volts. Binding posts can be mounted on the D.C., and a flush connection plug on the A.C. side of the apparatus.

Now, you can make the necessary connections. Use number 14 or 16 rubber covered wire for this purpose. Before connecting permanently, you must "form" the aluminium plates. Otherwise, when first connected up, the rectifier will have the effect of short circuiting the line. You can do this forming process by connecting the rheostat and the ammeter in series with the A.C. leads and the rectifier, the jars being arranged as they are in the diagram. Leave the D.C. leads open. Cut in a fairly large amount of resistance and turn on the "juice." A current will flow at first, but will gradually die down to almost zero. Now cut out some of the resistance. A rise in current will take place, but this current will also gradually die down. Keep up this process until the resistance of the rheostat has been cut out of the circuit, and the rectifier refuses to pass any appreciable current. When this condition is reached, the plates have been formed, and the rectifier is ready to be connected up in the manner shown in the diagram. Be sure and get the right polarity connection on your meter. This can best be determined by experiment. A reversed polarity will tend to move the indicating arrow backward. The lead from the aluminium plates, on the output side, is positive. It is best to mark this near the output binding posts, to avoid mistakes.

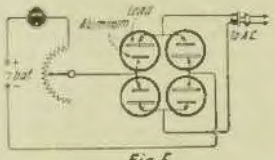


Fig. 5

The outfit is now ready for service, and if you have followed instructions carefully it will give good service. The only cause for poor results is faulty construction, or the use of impure aluminium or ammonium phosphate. Add water from time to time to make up for that lost by evaporation. If excessive heating is experienced you should cut in more resistance, thereby lowering the current. Three or four amperes can be delivered for many hours at a time without undue heating. With larger jars, or with a special cooling arrangement, greater amounts of current can be successfully passed.

Continued from Page 11

In order to get greater volume, it is often necessary to use two stages of amplification for use with a loud speaker, and if you "want it as loud as a phonograph," it may be necessary to use three stages of audio frequency amplification.

It is often advisable to use what is termed a "grid biasing" or C. battery. This may consist of about five flashlight cells connected in series, or a small 22½-volt B battery may be used. The positive 22½-volt terminal is connected with the negative of the 22½-volt detector or B battery. The F terminals of the transformers, instead of being connected with the A battery filament circuit, are connected with the various taps or binding posts of this new biasing battery. Experimenting with various values of battery voltage will soon show the values that give best results with a given amount of plate voltage.

These, then, are the questions that come most frequently to the desk of a busy radio information editor. What is your trouble, and what question do you most want answered?

LEICHHARDT AND DISTRICT RADIO SOCIETY.

A very pleasant ceremony was performed at the meeting of members of the Leichhardt and District Radio Society, held at the Club Room, 176 Johnston Street, Annandale, on Tuesday, May 15th, when Mr. F. Thompson was presented by his fellow-members with a wedding present, in the form of an eight-day clock. The presentation was made by the President—Mr. F. Morrison, who spoke feelingly of the respect and esteem in which Mr. Thompson was held by his fellow members. The recipient of the gift responded briefly, but fittingly, and all joined in wishing him the very best of good luck and future happiness.

The Society holds its weekly meeting every Tuesday night, and all inquiries should be addressed to the Hon. Secretary, Mr. W. J. Zech, 145 Booth Street, Annandale.

BONDI RADIO CLUB.

The last meeting of the Bondi Radio Club was held at Mr. Shaw's residence, with Mr. Rutherford in the chair.

After the business of the meeting was finished, members of the Club listened-in on Mr. Shaw's three-valve set, long and short wave stations being clearly heard.

At the conclusion of the evening, a vote of thanks was passed to Mr. Shaw for his kindness.

It has been decided to hold another meeting at 276 Birrell Street, on the 29th instant, to come to a definite arrangement concerning the new premises. As this is an important meeting, all concerned are asked to be present.

Address any communications to A. Callaway, 33 Ocean Street South, Bondi.

NORTHBRIDGE AND DISTRICT WIRELESS EXPERIMENTAL SOCIETY.

The inaugural meeting of the Northbridge and District Wireless Experimental Society was held at Mr. L. Forsythe's residence, Sailor Bay Road, Northbridge, on Wednesday, May 11th. There was a large and enthusiastic attendance.

The following officers were elected: President, Mr. L. E. Forsythe; Vice-President, Mr. R. W. L. Woolridge; Hon. Secretary, Mr. A. H. Vincent.; Hon. Treasurer, Mr. R. Larsen; Executive, Messrs. E. Mills, E. Beard, J. Figgis; Technical Committee, Messrs. Scrivener, Forsythe and Beard.

Commodious club rooms have been acquired, through the courtesy of Mr. L. E. Forsythe, where it is proposed to instal the very latest in wireless equipment.

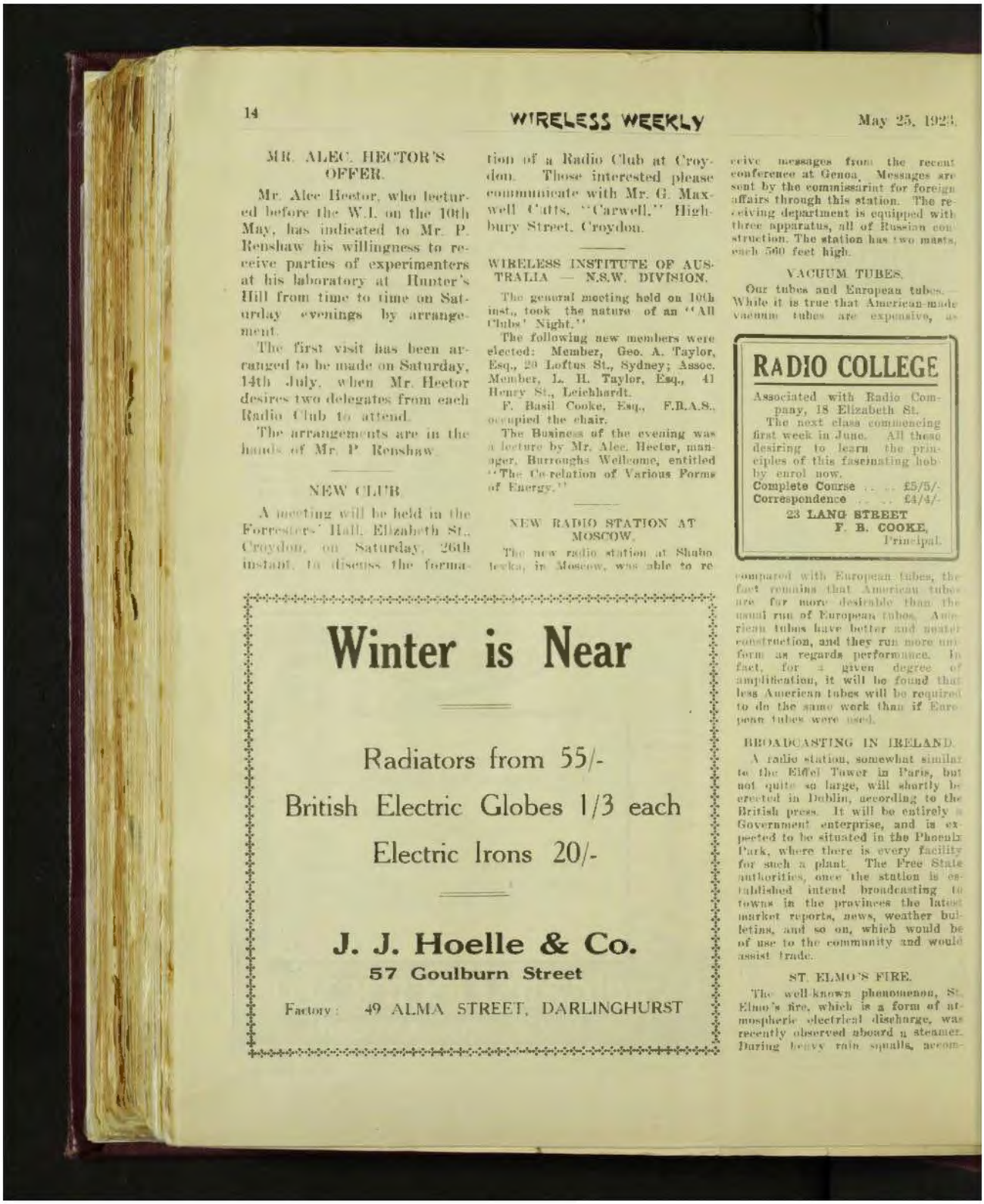
The objects of the new Society are to further the scientific and technical investigation of wireless telegraphy and telephony, assist social intercourse, and provide entertainment by wireless, and do all such other things as are incidental or conducive to the attainment of that object.

It is worthy of mention that the Club Rooms will be available at all time, thereby giving members the opportunity of carrying on unhindered with experimental work. Already workrooms have been erected for this purpose.

The general meetings of the Society is held each Wednesday, when new members and visitors are welcome. A lecture and concert have been arranged for next Wednesday night.

A large number of buzzer sets have been installed, and members are reminded that ample facilities are now available for code practice.

Particulars concerning the Society may be obtained from the Hon. Secretary, Mr. A. H. Vincent, "Abbeville," Sailor Bay Road, Northbridge.



MR. ALEC. HECTOR'S OFFER.

Mr. Alec Hector, who lectured before the W.I. on the 10th May, has indicated to Mr. P. Renshaw his willingness to receive parties of experimenters at his laboratory at Hunter's Hill from time to time on Saturday evenings by arrangement.

The first visit has been arranged to be made on Saturday, 14th July, when Mr. Hector desires two delegates from each Radio Club to attend.

The arrangements are in the hands of Mr. P. Renshaw.

NEW CLUB.

A meeting will be held in the Foresters' Hall, Elizabeth St., Croydon, on Saturday, 26th instant, to discuss the formation of a Radio Club at Croydon. Those interested please communicate with Mr. G. Maxwell Cutts, "Carwell," Highbury Street, Croydon.

WIRELESS INSTITUTE OF AUSTRALIA — N.S.W. DIVISION.

The general meeting held on 10th inst., took the nature of an "All Clubs' Night."

The following new members were elected: Member, Geo. A. Taylor, Esq., 20 Loftus St., Sydney; Assoc. Member, L. H. Taylor, Esq., 41 Henry St., Leichhardt.

F. Basil Cooke, Esq., F.R.A.S., occupied the chair.

The Business of the evening was a lecture by Mr. Alec. Hector, manager, Burroughs Wellcome, entitled "The Correlation of Various Forms of Energy."

NEW RADIO STATION AT MOSCOW.

The new radio station at Shabolevka, in Moscow, was able to receive messages from the recent conference at Genoa. Messages are sent by the commissariat for foreign affairs through this station. The receiving department is equipped with three apparatus, all of Russian construction. The station has two masts, each 560 feet high.

VACUUM TUBES.

Our tubes and European tubes.—While it is true that American-made vacuum tubes are expensive, as compared with European tubes, the fact remains that American tubes are far more desirable than the usual run of European tubes. American tubes have better and neater construction, and they run more uniform as regards performance. In fact, for a given degree of amplification, it will be found that less American tubes will be required to do the same work than if European tubes were used.

BROADCASTING IN IRELAND.

A radio station, somewhat similar to the Eiffel Tower in Paris, but not quite so large, will shortly be erected in Dublin, according to the British press. It will be entirely a Government enterprise, and is expected to be situated in the Phoenix Park, where there is every facility for such a plant. The Free State authorities, once the station is established intend broadcasting to towns in the provinces the latest market reports, news, weather bulletins, and so on, which would be of use to the community and would assist trade.

ST. ELMO'S FIRE.

The well-known phenomenon, St. Elmo's fire, which is a form of atmospheric electrical discharge, was recently observed aboard a steamer. During heavy rain squalls, accom-

pointed by heat lightning, the port wire of the radio aerial aboard the steamer became illuminated for its entire length with a glowing white light, giving the wire a fuzzy appearance. This continued for about ten minutes, after which the light gradually faded from the ends of the wire and finally disappeared from the centre of the aerial. The compasses were not affected.

AUDIO-FREQUENCY TRANSFORMERS.

Little does the average radio novice realise the elaborate workmanship which enters into the usual audio-frequency transformer. Indeed, the low price of such devices tends to conceal the elaborateness of these devices, but the low price is due solely to a cut-throat competition which brings down selling prices irrespective of quality and cost of manufacture. Thus one of the best known transformers on the market has 3800 turns of No. 40 enamelled wire for the primary winding. Glassine paper is used between layers, and a one-eighth inch paper projection on each end serves for mechanical protection. The secondary winding is separated from the primary winding by three thicknesses of .005 inch moleskin paper, and has 13,500 turns of No. 40 enamelled wire with the same insulation and end protection. The primary and secondary leads are 16 strands of No. 38 bare copper wire stranded together and covered with one wrapping of green silk. The coil is impregnated under vacuum process in a compound consisting of beeswax and rosin, and is covered with black pebbled book-binders' cloth.

ELECTRONS FROM HOT FILAMENTS.

When metals are heated in high vacuum electrons, or atoms of negative electricity, evaporate from their surfaces. If there is another electrode in the evacuated space to which a positive charge is given the electrons drift over to this electrode (anode) so that a current flows between the two electrodes. The electron emissions from a large number of different materials have recently been measured, according to "Electrical World." The thoriated tungsten cathode gives a current at a temperature of 1500 degrees absolute, which is about 130,000 times greater than that secured from or-

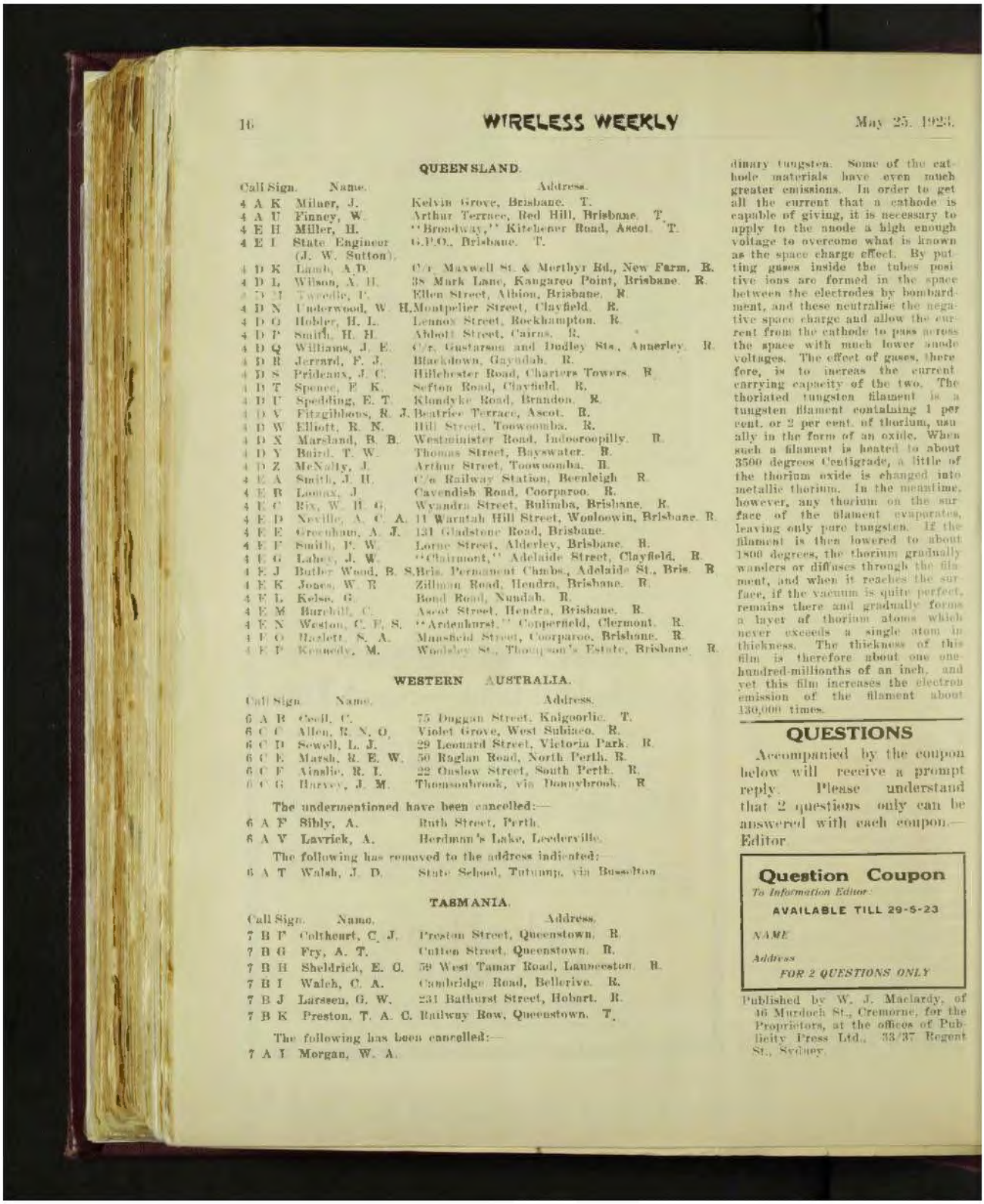
Amateur Calls

SOUTH AUSTRALIA.

Call Sign.	Name.	Address.
5 A E	Honner, J. H.	Alpha Road, Prospect. T.
5 A D	Snowsell A. R.	Harris Street, Exeter. T.
5 B D	Earle, F. E.	321 Fifth Avenue, St. Peters. T.
5 A C	Cook, V. R. P.	37 John's Road, Prospect. T.
5 C D	Stone, W. J.	7 Roebuck Street, Mile End. R.
5 C E	Silva, W. L.	Montpelier Street, Exeter, Port Adelaide. R.
5 C F	Malone, C. J.	Eighth Avenue, St. Peters. R.
5 C G	Colebatch, E. V.	24 Osmond Terrace, Norwood. R.
5 C H	Shinkfield, R. C.	49 Magill Road, St. Peters. R.
5 C I	Chandler, C. H.	4 Melrose Avenue, Beulah Park. R.
5 C J	Phillis, L. P.	Lubra' Road, Paynehan South. R.
5 C K	O'Daniel, L. C.	58 Thomas Street, Unley. R.
5 C L	Spencer, C. J.	Saddleworth. R.
5 C M	Sagar, E. N.	Ralston Street, Largs Bay. R.
5 C N	Searle, C. E.	38 Cross Road, Highgate. R.
5 C O	Thompson, A.	11 Percy Street, Millswood. R.
5 C P	Coward, Wm.	Irish Harp Road, Prospect. R.
5 C Q	Fawcett, W D'A.	High Street, Kapunda. R.
5 C R	Harper, L. A.	29 Millswood Crescent, Goodwood. R.
5 C S	Ashley, L.	Seventh Avenue, St. Peters. R.
5 C T	Theel, K. M.	81 First Avenue, St. Peters. R.

The following have been cancelled:—

5 A C Flannagan, J. R.
5 A S Othen, C. J.



QUEENSLAND.

Call Sign.	Name.	Address.
4 A K	Milner, J.	Kelvin Grove, Brisbane. T.
4 A U	Finney, W.	Arthur Terrace, Red Hill, Brisbane. T.
4 E H	Miller, H.	"Broadway," Kitchener Road, Ascot. T.
4 E I	State Engineer (J. W. Sutton).	G.P.O., Brisbane. T.
4 D K	Lamb, A. D.	C/r. Maxwell St. & Merthyr Rd., New Farm. R.
4 D L	Wilson, A. H.	38 Mark Lane, Kangaroo Point, Brisbane. R.
4 D M	Tweedie, P.	Ellen Street, Albion, Brisbane. R.
4 D N	Underwood, W. H.	Montpelier Street, Clayfield. R.
4 D O	Hobler, H. L.	Lennox Street, Rockhampton. R.
4 D P	Smith, H. H.	Abbott Street, Cairns. R.
4 D Q	Williams, J. E.	C/r. Gustarson and Dudley Sts., Annerley. R.
4 D R	Jerrard, F. J.	Blackdown, Gayndah. R.
4 D S	Prideaux, J. C.	Hillchester Road, Charters Towers. R.
4 D T	Spence, F. K.	Sefton Road, Clayfield. R.
4 D U	Spedding, E. T.	Klondyke Road, Brandon. R.
4 D V	Fitzgibbons, R. J.	Beatrice Terrace, Ascot. R.
4 D W	Elliott, R. N.	Hill Street, Toowoomba. R.
4 D X	Marsland, R. B.	Westminister Road, Indooroopilly. R.
4 D Y	Baird, T. W.	Thomas Street, Bayswater. R.
4 D Z	McNally, J.	Arthur Street, Toowoomba. R.
4 E A	Smith, J. H.	C/o Railway Station, Beenleigh. R.
4 E B	Loomax, J.	Cavendish Road, Coorparoo. R.
4 E C	Rix, W. H. G.	Wyandra Street, Bulimba, Brisbane. R.
4 E D	Neville, A. C. A.	11 Warntah Hill Street, Wooloowin, Brisbane. R.
4 E E	Greenham, A. J.	131 Gladstone Road, Brisbane.
4 E F	Smith, P. W.	Lorne Street, Alderley, Brisbane. R.
4 E G	Lahey, J. W.	"Clairmont," Adelaide Street, Clayfield. R.
4 E J	Butler Wood, B. S.	Bris. Permanent Chmbs., Adelaide St., Bris. R.
4 E K	Jones, W. R.	Zillman Road, Hendra, Brisbane. R.
4 E L	Kelso, G.	Bond Road, Nundah. R.
4 E M	Burchill, C.	Ascot Street, Hendra, Brisbane. R.
4 E N	Weston, C. F. S.	"Ardenhurst," Copperfield, Clermont. R.
4 E O	Hazlett, S. A.	Mansfield Street, Coorparoo, Brisbane. R.
4 E P	Kennedy, M.	Windsley St., Thompson's Estate, Brisbane. R.

WESTERN AUSTRALIA.

Call Sign.	Name.	Address.
6 A R	Cecil, C.	75 Duggan Street, Kalgoorlie. T.
6 C C	Allen, R. N. O.	Violet Grove, West Subiaco. R.
6 C D	Sewell, L. J.	29 Leonard Street, Victoria Park. R.
6 C E	Marsh, R. E. W.	50 Raglan Road, North Perth. R.
6 C F	Ainslie, R. I.	22 Onslow Street, South Perth. R.
6 C G	Harvey, J. M.	Thomsonbrook, via Donnybrook. R.

The undermentioned have been cancelled:—

6 A P	Sibly, A.	Ruth Street, Perth.
6 A V	Lavrick, A.	Herdman's Lake, Leederville.

The following has removed to the address indicated:—

6 A T	Walsh, J. D.	State School, Tutunup, via Busselton.

TASMANIA.

Call Sign.	Name.	Address.
7 B F	Coltheart, C. J.	Preston Street, Queenstown. R.
7 B G	Fry, A. T.	Cutten Street, Queenstown. R.
7 B H	Sheldrick, E. C.	59 West Tamar Road, Launceston. R.
7 B I	Walch, C. A.	Cambridge Road, Bellerive. R.
7 B J	Larsson, G. W.	231 Bathurst Street, Hobart. R.
7 B K	Preston, T. A. C.	Railway Row, Queenstown. T.

The following has been cancelled:—

7 A I	Morgan, W. A.	

dinary tungsten. Some of the cathode materials have even much greater emissions. In order to get all the current that a cathode is capable of giving, it is necessary to apply to the anode a high enough voltage to overcome what is known as the space charge effect. By putting gases inside the tubes positive ions are formed in the space between the electrodes by bombardment, and these neutralise the negative space charge and allow the current from the cathode to pass across the space with much lower anode voltages. The effect of gases, therefore, is to increas the current carrying capacity of the two. The thoriated tungsten filament is a tungsten filament containing 1 per cent. or 2 per cent. of thorium, usually in the form of an oxide. When such a filament is heated to about 3500 degrees Centigrade, a little of the thorium oxide is changed into metallic thorium. In the meantime, however, any thorium on the surface of the filament evaporates, leaving only pure tungsten. If the filament is then lowered to about 1800 degrees, the thorium gradually wanders or diffuses through the filament, and when it reaches the surface, if the vacuum is quite perfect, remains there and gradually forms a layer of thorium atoms which never exceeds a single atom in thickness. The thickness of this film is therefore about one one-hundred-millionths of an inch, and yet this film increases the electron emission of the filament about 130,000 times.

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