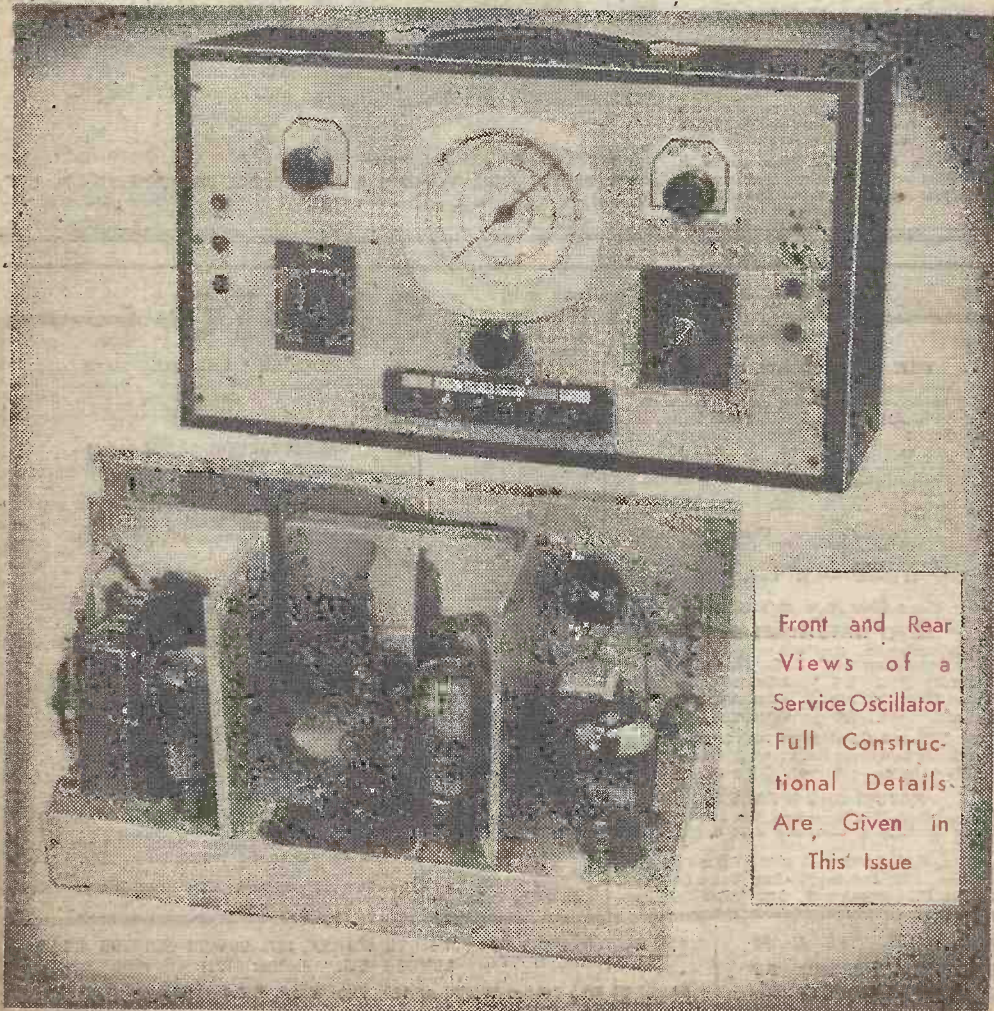
H.T. FROM L.T. SUPPLY

Practical Wireless

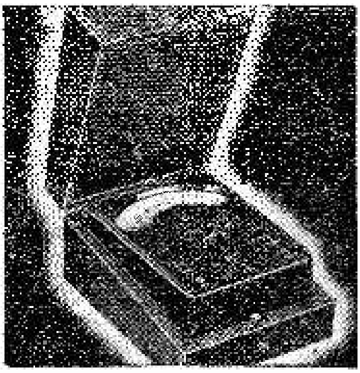
9D EVERY MONTH

Editor F. J. CAMM

Vol. 19. No. 444. NEW SERIES. JUNE, 1943.



Front and Rear Views of a Service Oscillator. Full Constructional Details Are Given in This Issue



AVO

Regd. Trade Mark.

PRECISION TESTING INSTRUMENTS

The D.C. AvoMinor

Electrical Measuring Instrument

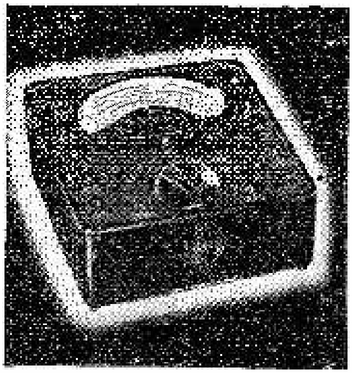
A high-grade 13-range D.C. meter providing direct readings of voltage, current and resistance. Supplied in case, with leads, test prods and crocodile clips.

Universal AvoMinor

Electrical Measuring Instrument

A 22-range A.C./D.C. moving coil precision meter providing direct readings of A.C. voltage. D.C. voltage, current and resistance. Supplied with leads, test prods and crocodile clips.

Some delay in delivery of Trade Orders is inevitable, but we shall continue to do our best to fulfil your requirements as promptly as possible.



" Avo " Instruments by their simplicity, extreme versatility and high accuracy, make possible that economy of time which is the essential feature of profitable servicing and maintenance.

Extensively used by radio manufacturers, service engineers and throughout industry, they set a recognised standard of accuracy and fine workmanship by which other instruments are judged.

Sole Proprietors and Manufacturers :—

AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO., LTD.
Winder House, Douglas Street, London, S.W.1 *'Phone : VICtoria 3404-7*

PREMIER RADIO

NEW PREMIER S.W. COILS

4- and 6-pin types now have octal pin spacing and will fit **International Octal** valve-holders.

4-pin Type			6-pin Type		
Type	Range	Price	Type	Range	Price
04	9-15 m.	... 2/6	06	9-15 m.	... 2/6
04A	12-26 m.	... 2/6	06A	12-26 m.	... 2/6
04B	22-47 m.	... 2/6	06B	22-47 m.	... 2/6
04C	41-94 m.	... 2/6	06C	41-94 m.	... 2/6
04D	76-170 m.	... 2/6	06D	76-170 m.	... 2/6
04E	150-350 m.	... 3/-			
04F	255-550 m.	... 3/-			
04G	490-1,000 m.	... 4/-			
04H	1,000-2,000 m.	... 4/-			

Chassis Mounting Octal Holders 10½d. each.

New Premier 3-Band S.W. Coil, 11-25, 25-38, 38-86 m., 4/9.

Rotary Wave Change to suit above, 1/6.

SHORT-WAVE CONDENSERS

Trolitul insulation. Certified superior to ceramic. All brass construction. Easily ganged.

15 m.mfd.	... 2/4	100 m.mfd.	... 3/-
25 m.mfd	... 2/6	160 m.mfd.	... 3/7
40 m.mfd.	... 2/6	250 m.mfd.	... 4/-

2-gang .0005 m.f. Condensers with trimmers, 5/6.
Brass Shaft Couplers, ¼in. bore. 7½d. each.
Flexible Couplers, ¼in. bore, 1/2 each.

MOVING COIL SPEAKERS

Celestion 8-in. P.M. Speaker, 25/-. Above Speaker is complete with output transformers.
Rola 5in. P.M. Speaker, 3 ohms Voice Coil, 21/-.
Rola 6½in. P.M. Speaker, 3 ohms Voice Coil, 25/-.
Rola 8in. P.M. Speaker, 3 ohms Voice Coil, 25/-.

PREMIER REPLACEMENT VALVES

4-volt A.C. types, 5-pin, ACHL, 5/3 each.

BAKELITE DIELECTRIC REACTION CONDENSERS

.0001 mf., 1/3.
.0003 mf., 2/6.
.0005 mf., 2/9 each.
.0003 mf. Differential, 2/11.

H.F. CHOKES

S.W. H.F. Choke 10-100 m., 10½d.
Standard H.F. Choke, 1/-.
Binocular H.F. Choke, 1/6.

"LEARNING MORSE ?"

Then purchase one of the new practice Oscillators. Supplied complete with valves on steel chassis 27/6

Practice Key, 3/3. TX Key, 5/9.
Super Model, on Wooden Base, 11/6.
Brown's Headphones, 19/6 pair.
3 Henry Chokes, 10/-
Good Quality Buzzer, 3/-

PREMIER 1 VALVE DE LUXE

Battery Model S.W. Receiver, complete with 2-volt Valve, 4 Coils, Covering 12-170 metres. Built on steel chassis and Panel, 55/- including tax.

ELECTROLYTIC CONDENSERS

Tubular wire end type, 25 mf. 25v., 1/6 each ; 50 mf. 50v., 3/- each.

PREMIER MICROPHONES

Transverse Current Mike. High-grade large output unit. Response 45-7,500 cycles. Low hiss level, 23/-.
Premier Super-Moving Coil Mike. Permanent Magnet model requiring no energising. Sensitivity 56db. Impedance 15 ohms. Excellent reproduction of speech and music, £5/5/-.
Microphone Transformers, 10/6 each.
Chromium Collapsible Type Microphone Stand, 52/6.
Mains Resistances, 660 ohms .3A. tapped 360 + 180+60+60 ohms, 5/6. 1,000 ohms. .2A, tapped at 900, 800, 700, 600, 500 ohms, 5/6. 1 ohm ± 1 per cent., suitable for Bridges, 5/- each.
Valve Screens, for International and U.S.A. types, 1/2 each.
Push-Back Connecting Wire, 2d. per yard.
Resin-cored Solder, 7½d. per coil.
Systoflex Sleeving, 2mm., 2/6 per doz. yards.
Waterproof Covered Cable, 3-way, 1/3 per yard ; 5-way, 1/6 per yard.
Screened Braided Cable. Single, 1/3 per yard ; twin, 1/6 per yard ; maximum lengths, 6 yards approx.
7-pin Ceramic Chassis Mtg. English type Valve-holders, 1/6 each.

ALL ENQUIRIES MUST BE ACCOMPANIED BY A 2½d. STAMP

ALL POST ORDERS TO : JUBILEE WORKS, 167, LOWER CLAPTON ROAD, LONDON, E.5. (*Amherst* 4723)

CALLERS TO : Jubilee Works, or 169, Fleet Street, E.C.4. (*Central* 2833)

Practical Wireless
and PRACTICAL TELEVISION
11th YEAR OF ISSUE
EVERY MONTH
Vol. XIX. No. 444. JUNE, 1943.
Editor F. J. CAMM

COMMENTS OF THE MONTH BY THE EDITOR

Hire Purchase Order

THE Hire Purchase (Control) Order has been revoked, and replaced by the Hire Purchase and Credit Sale Agreements (Control) Order, which came into force on March 22nd last. This new Order is of a more comprehensive character than the one which has been revoked, and covers both hire-purchase and sale agreements. The effect of the new Order is to prohibit the sale at a price over and above the retail cash price of all price-controlled goods, new or second-hand, sold through hire-purchase or credit sale agreements, except in the case of certain articles, which include wireless receiving sets of the domestic or portable type, and deaf aids. It is likely, however, that by the time these words appear in print an Order under Section 2 of the Goods and Services (Price Control) Order may have been made restricting or controlling the price and purchase of these.

Modifications

WILL readers please note that we are unable to modify designs of commercial receivers, nor can we undertake to supply circuit diagrams to special requirements. Although the terms of our Free Advice Bureau are clearly printed in each issue, some readers ignore them. For example, the queries we do not undertake to answer include those which request circuit diagrams of complete multi-valve receivers, alterations or modifications of receivers described in contemporaries, alterations or modifications to commercial receivers, and requests for special wiring diagrams or Service Data Sheets relating to commercial receivers. We cannot undertake to answer queries over the telephone, nor can we grant interviews to querists. Queries are dealt with in strict rotation, and should be addressed to the Editor, and not to contributors or members of the staff personally. We cannot undertake to give special priority to a particular query, in fairness to all querists. We can quite understand at the present time, when components are scarce, that many readers are buying up junk sets. It is seldom that these are in working order, and we can sympathise with them when they receive a curt refusal to assist from the manufacturer of the set. At the same time we cannot undertake to shoulder a burden which really should be carried by the manufacturer. We, too, are suffering from staff shortage. An alteration of this sort would occupy a member of the staff for several hours; and readers will, we know, understand that this amount of time cannot be given to one query. In happier times we have sometimes stretched a point in these cases. Our main task during the war must be to produce the paper, and we hope readers will co-operate with us in submitting only really urgent questions. If they will take the trouble to consult past issues they will find that most of the queries have already been answered in print. Some of the queries arrive like a recurring decimal. We answer them through the post and in print scores of times, and we do not think that we are expecting too much of a reader in asking him to make quite sure before using paper that the query has not already been dealt with.

Electrical Industries Red Cross Fund

"HOPE and the Red Cross make life worth living to us here; they are our salvation of mind and body." So writes a sergeant-major who is a prisoner of war, and sergeant-majors are not notorious as sentimentalists. These two sentences not only summarise the efforts made by the Red Cross and St. John Joint War Organisation for prisoners of war, but the word "salvation" crystallises both the urgent need for such efforts and the success that is attending them.

By the provision of regular food parcels to supplement deficiencies of diet, by the despatch of books, games and sports equipment to combat boredom, by arrangements for educational facilities, by its special care for prisoners who are ill or blinded or deaf, the Red Cross has done much to earn such high praise and deep gratitude.

The services to prisoners of war have tended to overshadow the other great responsibilities which rest on the Red Cross and St. John, but, as the war develops, first one and then another aspect is thrown into relief.

During the heavy air raids in the past the Red Cross amplified the work done by official relief services in every conceivable way, and was instrumental in saving hundreds of lives, bringing thousands back to health and restoring the faith of hundreds of thousands by little acts of comfort throughout the country. There is still a Luftwaffe. The Red Cross must stand prepared.

As for the future, who dare hope for final victory without a heavy increase in Service casualties? The Red Cross must be, and is, ready to supplement basic medical treatment provided by the Forces, so that between base hospital and final recovery the wounded may look to it for that full measure of kindness, comfort and wellbeing to which they are entitled, and which many have already found in the Middle East.

Care for the children, assistance on a vast scale to our allies, particularly Russia, comfort for those who, safe themselves, have husbands or sons missing, prisoners or wounded—how impossible it is briefly to summarise the great task of the Red Cross and St. John. Perhaps the sergeant-major comes nearest to a definition with his "salvation of mind and body" for those whom war has chosen as its special victims.

The fund has passed the £8,000 mark.

Editorial and Advertisement Office: "Practical Wireless," George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. 'Phone: Temple Bar 4363. Telegrams: Newnes, Rand, London. Registered at the G.P.O. for transmission by Canadian Magazine Post.

The Editor will be pleased to consider articles of a practical nature suitable for publication in PRACTICAL WIRELESS. *Such articles should be written on one side of the paper only, and should contain the name and address of the sender. Whilst the Editor does not hold himself responsible for manuscripts, every effort will be made to return them if a stamped and addressed envelope is enclosed. All correspondence intended for the Editor should be addressed: The Editor,* PRACTICAL WIRELESS, *George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.*

Owing to the rapid progress in the design of wireless apparatus and to our efforts to keep our readers in touch with the latest developments, we give no warranty that apparatus described in our columns is not the subject of letters patent.

ROUND THE WORLD OF WIRELESS

New Spanish Stations

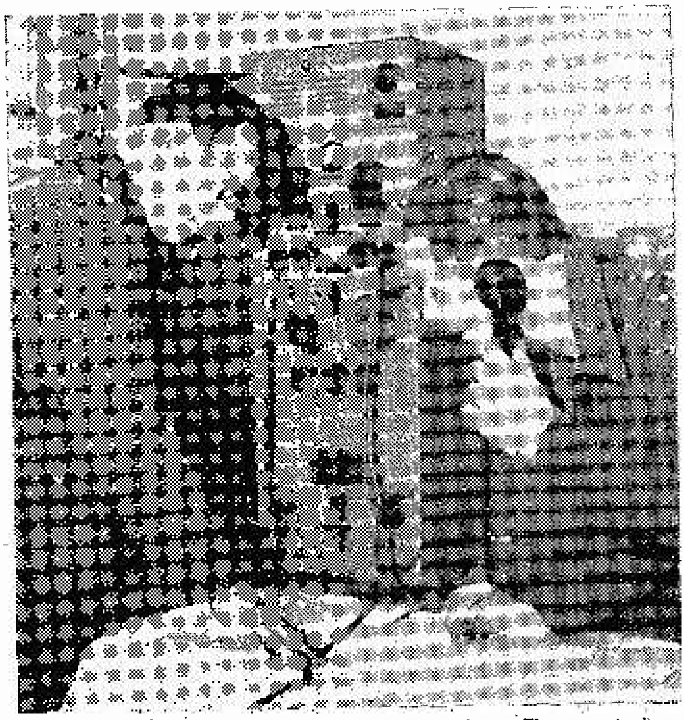
IT is reported that two new broadcasting stations are in course of construction at Arganda, about 12 miles east of Madrid. One intended to operate on the medium waveband will have a power of 120 kW., and the other, which will be used on the short waves, is to have a power of about 40 kW.

Lord Gainford

WE regret to record the death, at the age of 83, of Lord Gainford, who had been associated with broadcasting since its early days. He was the first chairman of the board of directors of the B.B.C., a post which he held from 1922 until 1926, when the British Broadcasting Corporation was constituted under Royal Charter.

The Army at Sea

SAILORS in khaki are the men of the Royal Army Service Corps. Among their important duties are the transport of guns, ammunition, of War Department stores of all kinds to gun-sites along the British estuaries. There is also the transport by fast motor-boat of security officers to ships at sea, the towing of targets for gun practice by the fixed defences ashore, and the removal to hospitals of casualties at sea. All officers must be suitably qualified in marine engineering, and have a working knowledge of the maintenance of all types of sea-going craft. These soldiers at sea must not only be able to repair their own ships, but also to salvage them. For these purposes they have their own shipyards, piers, wharves, cranes and dockside workshops. (See illustration below.)



Receiving a report by radio in the office of an R.A.S.C. depot. The report is then transmitted by telephone to officers in charge of workshops on the dockside.

Sir Louis Sterling

IT was announced recently, following a meeting of the board of A. C. Cossor, Ltd., that Sir Louis Sterling had ceased to be a director of Cossor, and that T. A. Macauley had been appointed to succeed him as chairman.

U.S.-China Link

IT was recently reported that the first direct inter-continental radio telephone link across the Pacific between San Francisco and Chungking will be opened in the near future.

American F.M. Stations

ACCORDING to a recent survey of F.M. stations, there are at present eight experimental transmitters and 37 commercial stations in use in the United States. In addition, there are a further 17 transmitters under construction.

Golf-Bowls!

CYRIL WATLING, in a recent broadcast of "News from South Africa," told his listeners that it is almost impossible now to buy golf balls in most parts of Rhodesia. So a firm in Bulawayo has started making them out of wood. With very satisfactory results, it seems. The wooden golf balls have mesh marking just like the usual ones, and a 130 yards' drive can be got out of them.

Chapter and Verse in the Navy

INTERVIEWED at the B.B.C. overseas microphone recently, Lieutenant W. Jackson, R.A.N.V.R., told a good story of signalling during convoy work. They'd arrived at a point where the convoy was to split up and go to different ports. Lieutenant Jackson said there were two corvettes with them, and his ship didn't know whose turn it was to take a certain portion of the convoy, so they signalled both corvettes telling them this. A reply sent back from one corvette referred them to a certain chapter and verse the Bible. They looked it up and found this: "And the Lord said, Whom shall I send, and who will go for us? Then said I, here am I. Send me."

Pity the poor Nazis

"IN our struggling days we were very poor Nazis." Thus Dr. Goebbels, a month or two back! How far from poor these Nazis are after 10 years of office, with no more need to struggle, was disclosed in the B.B.C.'s German Service a day or two ago.

Two instances were given: that of Dr. Goebbels, Minister of Enlightenment and Propaganda, and that of Dr. Ley, Reich's Labour Leader. Dr. Goebbels owns a house in Berlin, a villa in Schwanenwerder, a castle in Bernau and the Waldhof estate on Lake Constance—close to the Swiss frontier; for, as the broadcaster pointed out, Dr. Goebbels has always thought of all eventualities. Dr. Ley owns a villa in the fashionable Tiergarten quarter of Berlin, a house in Cologne, one in Coblenz—the Geiselsteig Villa—a summer villa on the Starnbergsee, a villa in Muenchen—

Gruenwald on the Isar and the Waldbrohl estate. This last—the speaker mentioned—had recently been sold by Dr. Ley for a nice sum. To? The Labour Front:

Uganda's Appreciation of B.B.C. Broadcast

FOLLOWING the B.B.C. Uganda Day programme—broadcast on April 1st, from "Uganda Hut," on the site of an A.A. searchlight battery manned entirely by women—to mark Uganda's fiftieth year as a British Protectorate, the following cabled message has been received from the Governor of Uganda, Sir C. Dundas:

"I wish to thank you for the delightful and generous broadcast given in honour of Uganda's jubilee. We are always indebted to you for your magnificent service, which means so much to all of us living in the outposts of the Empire, particularly in these anxious days, and the world-wide mention of Uganda on this occasion impresses upon us once more the inestimable value of the B.B.C. as a medium for making known to one another the many countries of the Empire."

Among those who took part in the broadcast were Mr. Noel Sabine, of the Colonial Office; Mr. A. C. Mann, director of the jewellers to the British Crown, who made and sent to Uganda the crown for the Kabaka—His Highness Mutesa II.

A "Sparks" Girl

WHEN war broke out, Fern Blodgett, a Canadian girl, was 20 years old, and early in 1940 she decided to take a course in wireless telegraphy at a Toronto night school. Sixteen months later she passed out—a fully-fledged wireless operator. Although the authorities were not in favour of employing women wireless operators on board ship, Fern eventually took her place as wireless operator with the 34 officers and men of the Norwegian freighter *Mosdale*.

For the first 14 months of her service she was the only wireless operator on board. Now, under new regulations, there are three, and Fern shares watches with them, doing four hours on and eight off. (See illustration on this page.)

Norwegian News Leaves Home Service

AS from March 28th the period in the Home Service from 6.30—6.45 p.m. which was filled by the Norwegian news has been used for further programmes in English. From that date the news for Norwegians has been broadcast on the European wavelengths only. With this decision the Norwegian Government—between whom and the B.B.C. excellent co-operation exists—is in agreement. The quality of the service is high.

The other two daily news transmissions in Norwegian—at 12.20 a.m. and 6.30 a.m. B.S.T. on the Home Service wavelengths—will be continued, and news for Norway will still be broadcast on the short waves used in the European service. With the expansion of the European service at the end of March an additional programme time was allocated to Norwegian news.

The time thus freed in the Home Service will be a great boon to the programme-planners. This period will not be used for any specific series at present, but it will afford scope for increased diversity of items.

U.S. Radio Manager's Appointment

MR. A. E. AKEROYD, manager of Replacement Sales, Raytheon Production Corporation, Newton, Massachusetts, has recently been assigned to special work in the Electrical Equipment Division of the Raytheon Manufacturing Company, Waltham, Massachusetts.

It is expected that this special assignment will result in a full-time application of Mr. Akeroyd's efforts at Waltham, and therefore Mr. R. O. Lund has been transferred from the Raytheon warehouse and office at Chicago to Newton. Mr. Lund is familiar with distributor problems, and is fully competent to answer the many questions of the radio jobbing trade in connection with their valve problems at this critical time.

Dutch News from London

A LETTER from a Belgian in Lisbon states that when the Jews in Belgium were ordered to write "Jew" on their shops, all Belgian shopkeepers marked the word on theirs. Similarly when the Nazis decreed that Jews should wear a yellow armlet, yellow armlets became fashionable among the whole population. Typical of a great many letters is this extract: "They regularly listen to the Dutch news from London, also to Radio Orange, on which, I can say without exaggeration, the whole of Holland lives to-day." And this from France—from a student at Lyons: "Generally speaking people's morale depends entirely on the news; you can read the news on people's faces, particularly in the occupied zone, where people don't mind getting up hungry from table if the B.B.C. news is good."

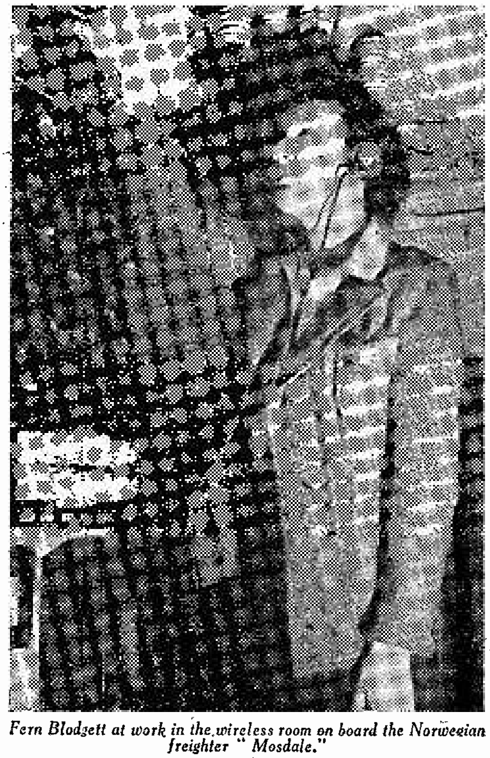
A Broadcast Decided It

WHILE customers at a Bournemouth hotel were discussing what they should do with a sum of £40 which they had collected by sticking coins on a mirror, the wireless was turned on and they listened to the B.B.C. "Shipmates Ashore" programme. A 10-minute "spot" in it was broadcast, on that occasion, from the Seamen's Mission in Bristol, and the Lord Mayor of Bristol, Mr. H. Wall, sent a message to the men of the Merchant Service. The licensee of the hotel, Mr. Harry Hopkins, remarked to his customers that he himself was a Bristolian and knew the Lord Mayor well.

"That settles it," someone cried. "Send him the £40 for the Merchant Navy," and the suggestion met with a chorus of approval. The cheque has been duly received.

Resignation

WE are informed by Taylor Electrical Instruments, Ltd., that Mr. L. J. Mold has resigned his directorship of the company as from February 17th last.



Fern Blodgett at work in the wireless room on board the Norwegian freighter "Mosdale."

H.T. from L.T. Supply

How to Obtain an Economical Supply of H.T. from a 2-volt Accumulator. By W. NIMMONS

SCARCE high-tension batteries turn the thoughts to alternative sources of H.T. current. Is it possible to obtain the necessary voltage in any other way—or rather is it a practicable proposition from the point of view of running costs?

It is the intention of the writer to show that an efficient and economical source of H.T. supply can be obtained from a 2-volt accumulator. This is achieved by using a transformer with a high step-up ratio, interrupting the primary current with a suitable buzzer, and rectifying and smoothing the high voltage from the secondary with an ordinary receiving valve. In this way a sufficient output for the average 1—v—1 receiver is obtained, providing the set does not take more than about 10 milliamps.

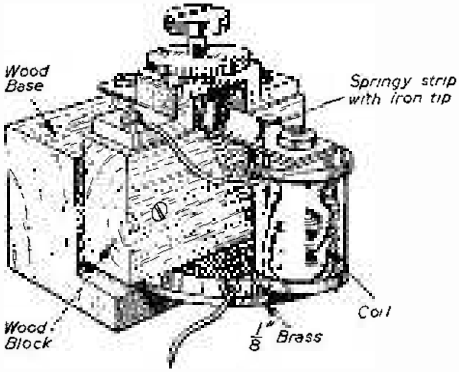


Fig. 3.—The buzzer for use with the unit.

Rectifying Valve

The choice of rectifying valve is narrowed down to one of the super-power class (for half-wave rectification), or a Class B valve for full-wave rectification. In the case of the super-power valve the anode and grid are strapped together to make a diode, while in the case of the Class B valve the anodes and grids of the two halves are strapped together to make a double diode valve. A Class B valve can also be used for half-wave rectification by strapping all the anodes and grids together, thus turning it into a diode, and this gives a valve of low impedance which is necessary for good regulation.

A glance at Fig. 1 will show all the parts required for the half-wave system of rectification. The low resistance primary of the transformer is connected in series with a buzzer across the accumulator, which latter also supplies the filament of the valve. There is a 1 mfd. condenser across the contacts of the buzzer to minimise sparking and thus ensure constant running. The diode valve has its anode joined to one end of the secondary of the transformer, the other end of which is connected to chassis and thence through the H.T. minus lead to the earth line of the receiver.

When power is applied to the circuit alternate half-cycles of the A.C. voltage generated in the transformer secondary make the anode positive with respect to filament and thereby enables a current to pass. During the remaining alternate half-cycles the anode is negative and no current passes. The series of unidirectional pulses flow into the 4 mfd. condenser, through the L.F. choke, and thence to the 2 mfd. condenser, which components serve to smooth the pulses and turn them into a source of D.C.

Full-wave Rectifier

The operation of a full-wave rectifier is somewhat similar, except that both halves of the cycles are rectified. The two anodes are joined to opposite ends of the transformer secondary, the centre tap of which is connected to the earth line, as can be seen from Fig. 2.

Coming now to the actual design, it will be apparent that we need a transformer with a high voltage step-up—something in the region of 1/75 or 1/100. Since only 2 volts are going into the primary and we need an output of 120 volts, and, allowing for losses, it will be understood that a turns ratio of the order named will be required. If half-wave rectification is desired a speaker transformer can be pressed into service. This should have been designed for pentode operation, and should be as massive as possible. If the speech winding has several tappings, this will be an advantage. In this case, of course, the primary becomes the secondary and the low resistance secondary the primary.

Should it be necessary to wind a transformer, the following should be kept in mind. We want an approximate input of 2 watts. Since the voltage is 2, this means that the current should be 1 ampere, and if the primary winding is, say, 50 turns, this is 50 ampere-turns. The secondary winding is 100 times the primary winding, i.e., 5,000 turns.

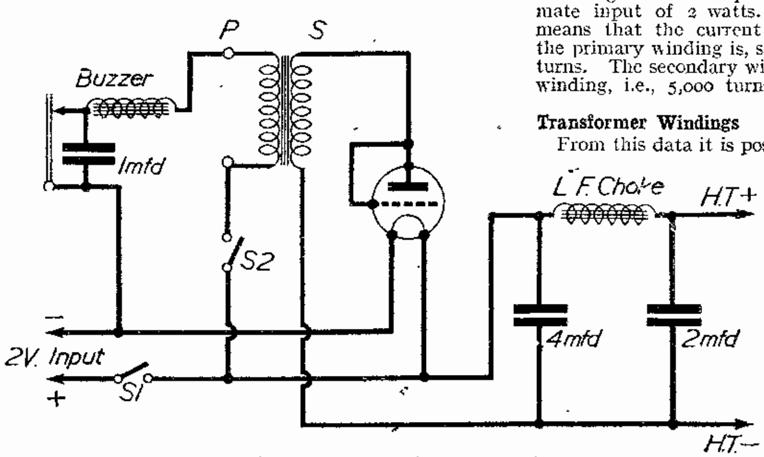


Fig. 1.—Circuit diagram of half-wave rectification.

Transformer Windings

From this data it is possible to work out the windings and the gauge of the wire employed. For example, with 4½ doz. pairs of No. 5 stalloy stampings, the primary winding can consist of 50 turns of 20-gauge enamelled wire in two layers, and 5,000 turns of 38-gauge enamelled wire for the secondary. It is presumed that the usual precautions are taken to ensure good insulation between the windings and also between the windings and the core. By employing larger stampings, such as the No. 4 size,

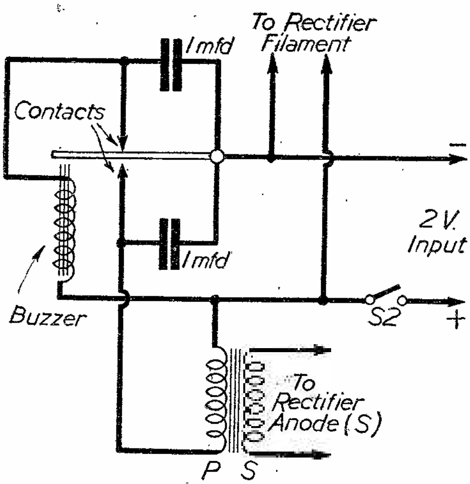


Fig. 4.—Showing how the full voltage may be applied across the transformer primary.

it is possible to double the number of turns on the primary, but this means that the secondary turns must also be doubled if the transformation ratio is to be kept the same.

The ordinary speaker transformer with a centre-tapped primary, such as is used for push-pull systems, can be employed for full-wave rectification. As mentioned previously, the primary winding now becomes the secondary, the input going to the old secondary. In this case, as can be seen from Fig. 2, the total voltage across the secondary is now split up by the centre tap connection, half the voltage being applied to each anode. To provide a step-up ratio of 1/100 or thereabouts we need, in theory, to have a transformation ratio of this order from primary to each half-secondary, and not from primary to whole secondary as in half-wave rectification. This can be done by a tapping on the primary, but I must warn readers that if they use any old speaker transformer the whole thing becomes a hit-or-miss affair and they may be disappointed by the output not reaching the desired proportions.

Buzzer

The ordinary buzzer (or electric bell with the hammer sawn off) cannot be used for interrupting the primary current because of its high resistance. With only 2 volts to work on there is no surplus voltage to throw away, and Fig. 3 shows a buzzer designed by the writer which works well and at the same time causes only a small decline in the voltage actually reaching the transformer primary.

Most of the mountings of this were obtained from an old W/D buzzer. The contacts which are pure platinum, are trouble free when properly adjusted, and with the addition of the 1 mfd. condenser the spark is virtually non-existent. The electro-magnet consists of an iron bolt 1in. long and 3/16in. diameter. The winding of this was 90 turns of 22 gauge d.c.c. wire in 6 layers—15 turns each layer. The cheeks for this winding were circles of paxolin screwed on the bolt in the same way as a nut and spaced ¾in. apart.

So far we have been considering the buzzer and transformer primary as being in series. It is possible, however, by means of a second contact on the vibrating reed, to ensure that the full voltage reaches the primary without the losses incurred in the buzzer. Fig. 4 shows how this can be accomplished. When the reed touches the top contact the coil becomes energised and attracts the soft iron at its tip; the bending of the reed which follows breaks contact with the buzzer and automatically applies the full voltage to the primary through the lower contact. By this time the restoring force of the reed asserts itself, the reed is drawn upwards again, thus breaking the contact with the transformer primary but completing the circuit once more through the buzzer. This cycle of operations continues as long as the operator desires.

One advantage of this scheme is that the buzzer can have any resistance within reason since it is no longer any hindrance to the voltage we have at our disposal, but merely serves to switch it on and off. An additional 1 mfd. condenser will be required to minimise sparking at the contacts.

Operational Details

To get the unit into operation connect the leads marked H.T.— and H.T.+ in either Fig. 1 or Fig. 2 to the respective leads of the receiver. Switch on the receiver, then close S1 in the unit itself, and finally close S2 in the unit, thus setting the buzzer into operation. Always make sure the rectifier valve is alight before switching on the vibrator part. The voltage across the secondary of the transformer on open circuit is several times the voltage on load, and the valve may easily be damaged if this voltage exists as the filament warms up.

In use the rectified and smoothed A.C. can just be distinguished by a low murmur, reminiscent of mains hum, with the ear close to the loudspeaker of the receiver. This, however, is entirely drowned by a station, and is no disadvantage. In connection with the mechanical noise of the buzzer it is recommended that the entire unit be enclosed in a felt-lined box, with rubber dampers at the corners.

The operating costs are low when used with a fair-sized accumulator—say 40 A.H. Though the resistance of the primary is very low the back E.M.F. reduces the current to about 1 ampere. Add to this .2 amp. or .4 amp., depending on the valve in use and we have a total current of 1.2 or 1.4 amp. The current through the primary is not a continuous one but is intermittent so that a 40 A.H. accumulator will last for approximately 50 hours. If it costs 6d. to recharge, this is approximately 1/8th of a penny per hour, as against 3/5ths of a penny

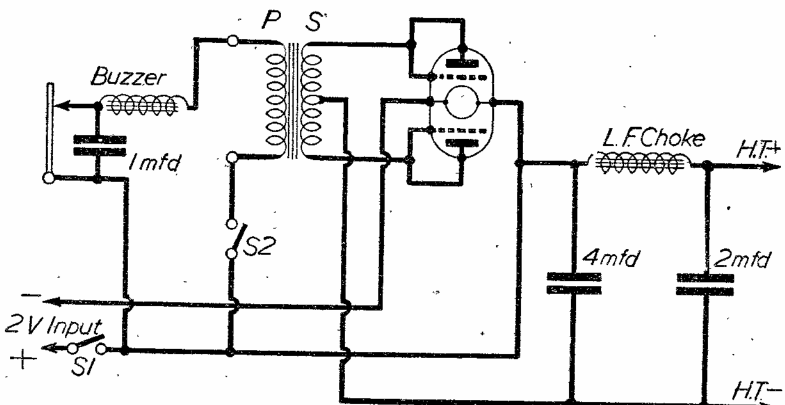


Fig. 2.—Circuit diagram illustrating the operation of a full-wave rectifier.

per hour with a standard H.T. battery. On this score alone the scheme is well worth while.

The output is about 120 volts at 10 ma., i.e., 1.2 watts. This is sufficient for the average 3-valve set providing it is not a Class B or Q.P.P. one. The whole unit, excluding the accumulator, can be accommodated in a case equal in size to a standard H.T. battery.

Throughout I have kept to a single cell as the source of supply. Some readers, however, may have a car battery lying idle which they may wish to utilise, or they may have a windcharger plant. In this case we can revert to about 10 turns per volt for the primary winding with No. 4 stalloy stampings, the number of turns on the secondary being arranged to give an output on load of 150 volts at 30 milliamps—sufficient to operate the biggest battery set.

The Tuned-anode Circuit

Derivation of Resonant Frequency and Dynamic Resistance

By C. HEYS

IN a previous article it was shown that before a valve can act as a voltage amplifier, a resistance R must be connected in the anode circuit as in Fig. 1. It is the amplified voltage variation across the resistance R which is applied to the grid of the succeeding valve. When it is desired to amplify high or radio frequencies the use of a tuned anode circuit has decided advantages.

Amplification at High Frequencies

One of the most commonly used intervalve couplings employed in high-frequency amplification is that where the anode load resistance R of Fig. 1 is replaced by a tuned anode coupling, i.e., an inductance or tuning coil possessing inductance L and resistance R (R being the high-frequency resistance which may be three or four times the D.C. resistance), shunted by a variable condenser C which can be adjusted to the particular frequency being received, this arrangement is shown in Fig. 2(*a*), the equivalent A.C. circuit being as in Fig. 2(*b*).

When a high-frequency alternating voltage of R.M.S. value Vg is applied to the grid and filament of the valve, it can be represented in the equivalent circuit Fig. 2(*b*) as a voltage μVg equal in phase and frequency to Vg. Thus in effect there is in the anode circuit a source of alternating voltage μVg with internal resistance r_a which is the A.C. impedance of the valve, across which is connected the tuned anode circuit, which sets up an alternating current component Ia.

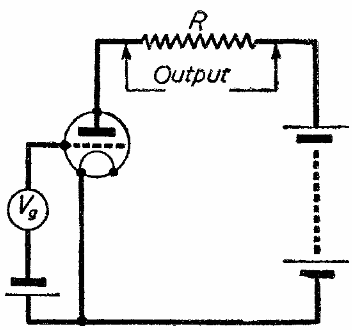


Fig. 1 (Left).—Diagram showing the resistance in the anode circuit Fig. 2 (Right).

In addition to this A.C. current component there is also the D.C. component which is, of course, necessary for the satisfactory working conditions of the valve.

Dynamic Resistance

The anode coupling is essentially a parallel circuit, tuned to the resonant frequency corresponding to the carrier frequency of the station being received, which is also the frequency of Vg. A very important point about a circuit of this kind is that for currents at resonant frequency the tuned circuit behaves as a non-inductive resistance, generally referred to as the dynamic resistance, its value in ohms being given by—

$$R_d = \frac{L}{CR}$$

The proof of this can be obtained as follows. Consider the parallel circuit of Fig. 3 connected across a source of A.C. supply of voltage E.

The current I flowing to the parallel circuit is given by the difference between the current I_Z through the coil LR, and the current through the condenser I_c, these currents must be subtracted vectorially as shown in the vector diagram of Fig. 4 and not arithmetically.

The Resonant Frequency

At resonance the current through the condenser $I_c = I_Z \sin\phi$ but $I_c = \omega CE$ and $I_Z = \frac{E}{Z}$, and $\sin\phi = \frac{\omega L}{Z}$, Z being the impedance of the inductive branch of the circuit which is given by $Z = \sqrt{R^2 + \omega^2 L^2}$

$$\text{Therefore } \omega CE = \frac{E}{Z} \times \frac{\omega L}{Z} = \frac{E\omega L}{Z^2}$$

$$\omega C = \frac{\omega L}{Z^2}$$

$$C = \frac{L}{Z^2} = \frac{L}{(\sqrt{R^2+\omega^2 L^2})^2} = \frac{L}{R^2+\omega^2 L^2} \quad \ldots (1)$$

$$\text{or} \quad R^2 + \omega^2 L^2 = \frac{L}{C}$$

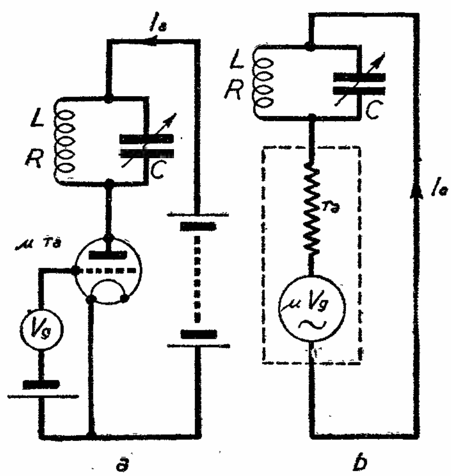


Fig. 2.—Circuit diagrams of intervalve couplings.

$$\omega^2L^2 = \frac{L}{C} - R^2$$

$$\omega = 2\pi f = \sqrt{\frac{1}{CL} - \frac{R^2}{L^2}}$$

$$\therefore \text{ Resonant frequency } f = \frac{1}{2\pi}\sqrt{\frac{1}{CL} - \frac{R^2}{L^2}}$$

This approximates to $f = \frac{1}{2\pi}\sqrt{\frac{1}{CL}}$ as $\frac{R^2}{L^2}$ is very small in practice.

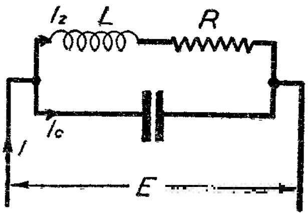


Fig. 3.—Circuit for testing dynamic resistance.

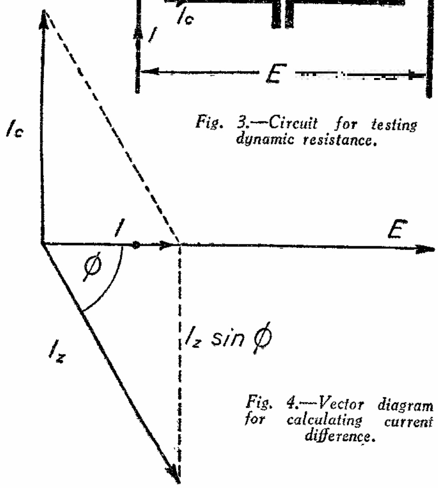


Fig. 4.—Vector diagram for calculating current difference.

Dynamic Resistance (Rd)

As the current I taken from the supply, and E are in phase (see vector diagram) the parallel circuit is behaving as a pure resistance of a value $R_d = \frac{E}{I}$.

Now from the vector diagram $I = I_Z \cos \phi$

$$\therefore R_d = \frac{E}{I_Z \cos \phi} = \frac{E}{\frac{E}{Z} \times \frac{R}{Z}} = \frac{Z^2}{R} \quad \text{.......... (2)}$$

as $I_Z = \frac{E}{Z}$ and $\cos \phi = \frac{R}{Z}$

from (1) above $C = \frac{L}{Z^2}$ or $Z^2 = \frac{L}{C}$

substituting $Z^2 = \frac{L}{C}$ in (2) we obtain $R_d = \frac{L}{CR}$.

This proves that a tuned anode circuit when tuned to resonance will behave like a pure resistance, the impedance being termed the dynamic resistance of the circuit. It is the actual resistance offered to the alternating currents at resonant frequency, and is a very important quantity.

Voltage Amplification

As the voltage amplification factor m when a pure resistance R is used in the anode circuit is given by

$$m = \frac{\mu R}{r_a + R}$$

when employing a tuned anode circuit $R = R_d = \frac{L}{CR}$

Therefore

$$m = \frac{\mu \frac{L}{CR}}{r_a + \frac{L}{CR}}$$

Example: An amplifying valve has an A.C. resistance of 50,000 ohms, and an amplification factor μ of 50. Find the actual amplification of the valve when the anode circuit contains (*a*) a resistance of 20,000Ω (*b*) a tuned circuit (at resonance) having $L = 500\mu H$; $C = 1{,}000\ \mu\mu fd$ and $R = 2.5$ ohms.

$$m \text{ with resistance load } \frac{\mu R}{r_a + R} = \frac{50 \times 20{,}000}{50{,}000 + 20{,}000} = 14.3$$

$$m \text{ with tuned anode load} = \frac{\mu \frac{L}{CR}}{r_a + \frac{L}{CR}}$$

$$\frac{L}{CR} = \frac{500 \times 10^{-6}}{1{,}000 \times 10^{-12} \times 2.5} = 200{,}000 \text{ ohms.}$$

$$\therefore m = \frac{50 \times 200{,}000}{50{,}000 + 200{,}000} = 40.$$

There is also one more important point when considering the anode load, that is the voltage drop caused by the load resistance, which in turn will govern the value of the high-tension supply. Consider the above two cases. If for satisfactory working of the valve it has to have an anode potential of 150 volts, and at this value of plate voltage the steady D.C. current component is 3 mA the volts drop in the load will be:

$$IR = 3 \times 10^{-3} \times 20{,}000 = 60 \text{ volts}$$

which means that the high-tension voltage will have to be equal to the anode voltage plus the volts drop due to R, that is 150+60=210 volts as shown in Fig. 5.

When the tuned anode circuit is used, although the dynamic resistance is 200,000 ohms, this is the resistance to the alternating component only and not to the steady D.C. component. The resistance to the D.C. component is that due to the resistance of the coil only. This D.C. resistance is less than the high-frequency resistance given in the example as 2.5 ohms, but if we take the value of 2.5 ohms it will serve our purpose. Therefore for the same operating voltage on the anode of 150 v. and plate current of 3 mA the voltage of the battery will only have to be $150 + (3 \times 10^{-3} \times 2.5) = 150.0075$ volts, which for practical purposes is the voltage at the anode. Thus a considerable saving of H.T. supply is effected with an increase in voltage amplification also.

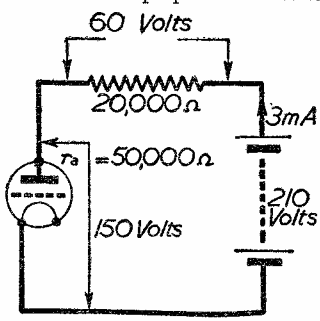


Fig. 5.—Illustrating voltage drop caused by load resistance.

The Use of Litz Wire for H.F. Coils

When to Use Litz Wire and the Advantages to be Gained

By DAVID FORD

THE performance of radio equipment, particularly of H.F. circuits, largely depends upon the quality of the inductance coils used, so that every possibility of improving the design of inductances should be carefully considered by the experimenter. It is well known that under certain conditions stranded wire gives an improved performance compared with ordinary solid copper wire when used for winding coils, but unfortunately it sometimes gives a worse performance and it is only by trial and error that the average constructor can find out whether it is worth while using the stranded wire. It is this lack of information plus the difficulty of handling stranded wire by the inexperienced which has prevented many people from benefiting from its use, because, as is shown later, the stranded type of conductor can improve the performance of a tuning coil by 100 per cent. if it is correctly used.

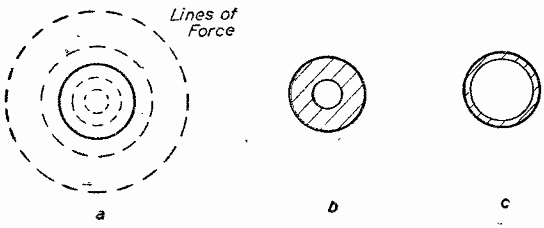


Fig. 1.—Current in a conductor at H.F.

It should be understood that when stranded wire is mentioned it means the special Litzendraht (or litz for short) wire whose construction is described below, and not just plain stranded flexible copper wire.

Why Litz is Used

In order to understand the action of litz wire, we must first consider the behaviour of solid wire at high frequencies. A solid copper wire increases in resistance as the frequency increases due to what is commonly called the skin effect. As the frequency increases the current in the wire tries to flow near to the surface in preference to the centre of the wire and at very high frequencies the current is concentrated solely in the skin of the conductor. This reduction in the effective cross-section which is carrying current means that the resistance at H.F. must be much larger than that measured at D.C. The simplest way of explaining why this occurs is as follows. Every current flowing in a wire produces a magnetic field which can be represented by concentric lines of force as shown in Fig. 1 (a), and these lines of force exist inside the conductor as well as outside. This means that the centre part of the wire links with more lines of force than the outer parts of the conductor, and since the current and therefore the magnetic field is alternating, this is exactly the same thing as saying that the self-inductance of the centre part of the wire is greater than the outer part. Therefore, as the frequency is increased, the impedance in the centre will increase much more rapidly than in the outer skin, so that the current, trying to follow the line of least resistance, will tend to keep to the outside of the wire. This effect is illustrated in (b) and (c) Fig. 1, which shows the way in which the current is distributed over the cross-section of the wire at a medium frequency and at a relatively high frequency.

In an attempt to overcome this increase in resistance the use of stranded wire was suggested. Each strand is insulated by a coating of enamel, and then very carefully interwoven so that every strand is alternately taken to the centre of the wire and then brought to the surface again. By this means the current is forced to divide itself fairly evenly between the individual strands and the skin effect is thus greatly reduced. The manner in which the stranding is carried out is very important and the best results are obtained by working in multiples of three. Three wires are twisted together, then three of these are combined to give nine strands, three of the groups of nine may be twisted together to give 27 strands, and sometimes three of these are used to give 81 strands. It is for this reason that proper litz wire is usually supplied with either 3, 9, 27 or 81 strands.

Disadvantages of Litz Wire

Unfortunately, as in most things, there is a price to pay for this improvement. The use of enamel between each wire causes capacities between the strands, and these capacities have a dielectric loss just like an ordinary condenser, and this loss appears as an increase in the resistance of the wire. At low frequencies the effect is very small and can be neglected, but at higher frequencies it increases rapidly so that a frequency is reached where this extra loss offsets the improvement obtained by using stranded wire. This frequency is called the critical frequency, and above this, stranded wire is worse than solid wire. The critical frequency is different for different sizes of wire and this point is dealt with later on.

A second disadvantage of litz wire is the fact that compared with a solid wire of equal overall diameter it has less copper in it and therefore starts off with a higher D.C. resistance.

The Critical Frequency

Now it is obvious that if we know how to determine the critical frequency of stranded wire we are in a position to say whether it is going to be worth while considering it for a particular job. As far back as 1919 a German

TABLE 1.

Approximate critical frequencies for different sizes of litz wire.

No. of Strands	Gauge of Strands (S.W.G.)			
	40 S.W.G.	42 S.W.G.	45 S.W.G.	47 S.W.G.
	kc/s	kc/s	kc/s	kc/s
3	2,100	3,000	6,200	12,100
9	1,500	2,100	4,300	8,400
27	1,000	1,500	3,000	5,800
81	700	1,000	2,000	4,000

TABLE 2.

Gauge of solid wire which has the same overall diameter as litz wire.

No. of Strands	Gauge of Strands (S.W.G.)			
	40 S.W.G.	42 S.W.G.	45 S.W.G.	47 S.W.G.
3	35	37	40	43
9	28	30	35	38
27	23	25	28	33
81	18	20	23	26

named Rogowski wrote an article giving the necessary formulas for calculating the critical frequency. These formulas are rather complicated but by making one or two assumptions it has been possible to calculate the figures given in Table 1. This table shows the approximate critical frequencies for the more usual sizes of litz wire. As an example, this table tells us that the critical frequency of 27/45 gauge (that is 27 strands each of 45 S.W.G.) is 3,000 kc/s, so that above this frequency it is better to use the solid wire, while below it an improved coil can be obtained by using litz wire. Actually these critical frequencies depend slightly upon the spacing between adjacent wires and this is one of the simplifications made. The values given are sufficiently accurate for all normal experimental work.

The obvious question now arises: How much better is the stranded wire than the solid wire, and is the extra cost and trouble justified? The amount of improvement actually varies considerably with the type of coil and the frequency. The greatest improvement usually occurs at about one-third of the critical frequency and this point should be kept in mind. Experience shows that litz wire can increase the performance of a coil from about 50 to 100 per cent. and this is, of course, well worth while.

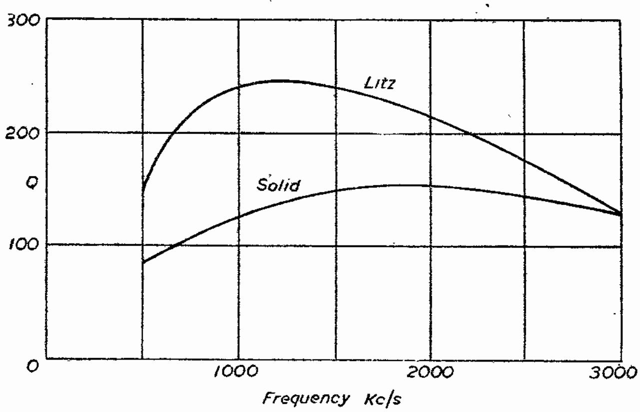


Fig. 2.—A comparison between litz and solid wire.

How to Design a Coil with Litz Wire

In Table 2 a list of the equivalent sizes of solid wire for the different types of stranded wire is given, and this enables a change from solid to stranded wire to be made without affecting the size of the coil. By using Tables 1 and 2 it is very easy to determine whether any benefit is to be obtained by the litz wire. After the coil has been designed in the usual way and the largest gauge of wire which can be used has been found, then the equivalent litz wire with the same overall diameter is found from Table 2. Table 1 then gives the critical frequency for this size of litz wire, and if the coil is to be used at frequencies lower than this, then an improvement can be obtained by using the litz wire.

As an example, consider a coil with the following dimensions: diameter of former 1½in., 40 turns of 26 S.W.G. copper wire wound in a single layer. This coil is required to operate at a frequency of 1,000 kc/s, is it worth while using litz? From Table 2 the equivalent size of stranded wire is 27 strands of 45 S.W.G., and from Table 1 this has a critical frequency of 3,000 kc/s. Therefore, at 1,000 kc/s a much better coil should be obtained by using the stranded wire.

Measured Results

Experimental facts are usually worth pages of theory, and so the results on an actual coil should be of interest. Two coils were constructed, one with 26 S.W.G. solid copper wire, and the other with 27/45 S.W.G. litz wire (that is, 27 strands of 45 S.W.G.). The size of the coils was similar to the example chosen above, that is, 45 turns on a 1½in. diameter former wound with the turns touching. The inductance in both cases was practically the same at 65 microhenries.

The most convenient method of comparing the qualities of two coils is to measure their factors of merit, or Q's, on a Q-meter. This factor Q is, of course, the reactance of the coil divided by its resistance ($\omega L/R$). Both coils were measured at a number of frequencies and a graph was plotted of the Q against the frequency giving the curve shown in Fig. 2. These curves show that at 3,000 kc/s both coils have the same Q values, but at lower frequencies the stranded wire gives a much better coil, and at about 900 kc/s the improvement, expressed as a ratio, is greatest at just over 100 per cent. These measured results therefore agree with the predicted values which we obtained previously, namely, that the critical frequency for this size of wire is about 3,000 kc/s and the frequency at which the improvement is greatest should be round about 1,000 kc/s.

How to Solder Litz Wire

Anyone who has tried to solder litz wire by carefully cleaning the enamel off each strand will know that this is a very tedious if not an impossible task, and it is this fact which has discouraged the use of stranded wire more than any other. Fortunately, there is a very easy way of cleaning the strands quickly and effectively. All that is necessary is a small metal container about 1in. in diameter filled with methylated spirits. The meths. to set alight and the end of the wire to be tinned heated to red heat in the tip of the flame. Immediately the wire end is red-hot, it is plunged through the flame into the methylated spirits for about two seconds. When withdrawn it will be found that each separate strand can be wiped clean and ready for soldering. Very little practice is required to become efficient. Incidentally, do not worry if one of the strands breaks off short, it will make very little difference.

Your Service Workshop—3

Constructional Details of a Service Oscillator. By S. BRASIER

THERE are several good reasons why the service man should construct his own apparatus, but perhaps the most important is the fact that he *does know* his instruments, and is therefore in a position to carry out any slight adjustments that may be necessary from time to time as well as making additions or alterations as future requirements may demand. Apart from the multi-range test set, there is probably no other instrument that is so useful to the radio man as the service oscillator, also referred to as signal generator, test oscillator, etc. The tuning circuits of a superhet receiver cannot be accurately aligned without it, and its useful applications in many varied tests cannot be overrated.

As most readers will know, the instrument consists essentially of a valve maintained in a state of continuous oscillation, and so arranged that its output—in the form of a miniature carrier wave—can be either radiated from a tiny aerial, and the signal picked up on a receiver in the usual manner, or it can be injected into the receiver via a screened cable, which is the method usually adopted. The wavelength or frequency of the transmitted signal must be capable of being accurately adjusted to a figure determined by the operator, and likewise the strength or power of the signal must be made variable at will from minimum to maximum. In order to provide the intelligible signal, which is usually required, the oscillator valve is modulated by some low frequency source—usually another valve oscillating at low frequency. These, then, are the rough requirements for the apparatus under discussion, but it will be understood that refinements are necessary in actual practice.

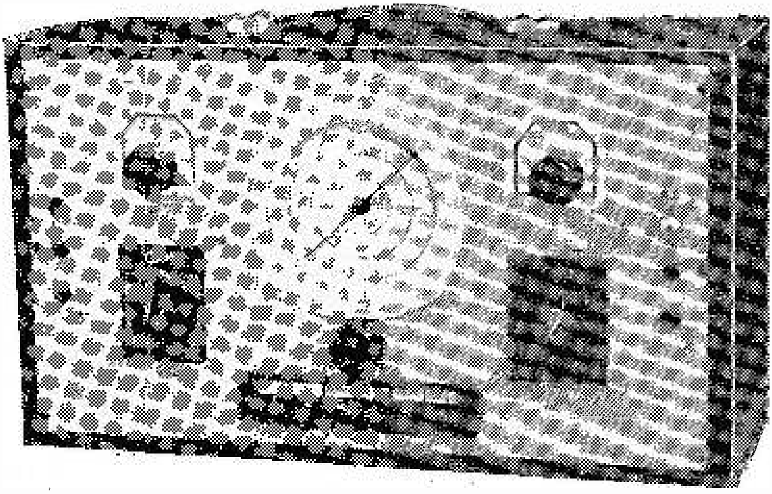
Circuit Considerations

Dealing now with the instrument shown here, it will be observed from the circuit diagram of Fig. 1 that the S.O. is operated entirely from A.C. mains, half-wave rectification being employed. Both valves—oscillator and modulator—are of the triode type and internal anode modulation is provided for by means of a regenerative transformer coupled system which may be switched off, or external modulation can be applied. Audio frequency is taken from sockets so marked. The actual oscillator circuit makes use of the familiar Hartley system, various wave-ranges being selected by a 2-pole 5-way switch. The radio frequency output is controlled by the potentiometer across which is connected the coupling coil L.1, energised by the grid/anode coil L.2.

Finally, the instrument is completely screened, as are the various sections of it, and, for this reason, construction may be perhaps a little more difficult than usual. The panel, chassis and screens were all constructed from tinned iron sheet, measurements being given in the drawings. In this respect, however, it is not essential to adhere exactly to these sizes, and so long as the general layout and screening is followed no doubt a ready-made chassis could be used. Consideration of the difficulties in obtaining components and valves has been given in designing this S.O., so that many parts will probably be on hand. This does not mean that any old junk may be utilised, for the components must be selected with due regard to their quality. The variable condenser, for example, should be of sturdy construction, preferably of the ball-bearing type with a pigtail connection to the rotor. It is not wise in an instrument of this nature to rely on a rubbing contact. It will be seen from the circuit diagram that the moving vanes are not at earth potential, therefore it is necessary to insulate them by some means. In the original model the difficulty was overcome by using fibre washers on the fixing bush and a short length of ebonite rod between spindle and dial assembly.

Coils

Details of the coils are given in Fig. 4. They are simple to wind, but the turns should be arranged evenly and quite tightly on the former, so that they cannot move. Remember that constancy of calibration depends almost entirely on the construction of the coil, and for this reason a *thin* coat of shellac may be applied to it when finished. All windings are connected in series, but it is convenient to wind the centre single layer winding before fitting and securing the paxolin washers for the long wave sections. The coupling coil former is of a size that, when wound, permits of its entry into the larger former with a tight sliding fit. Because of this the tappings taken from the tuning coil L.2 should not pass through to the inside of the former, as is usually the case. The coil assembly is supported underneath the chassis by means of 6 B.A. bolts, and short lengths of ebonite tube. Take care when positioning the coil to see that it will be equidistant between the inside top of the chassis and floor of cabinet. The position of the coupling coil in the other is not critical, but is best placed inside the former at the grid end of the coil. The range selector switch is actually a press-button unit, and since it is only necessary to provide for two simple make and break switches operated by each button, almost any type could be used if the one specified is not obtainable. The writer understands, however, that a certain number are available, but without knobs. It will be noted that the switches of the first button are unused, but this may be useful at some future date for extension of wave-range.



Front view of the finished oscillator.

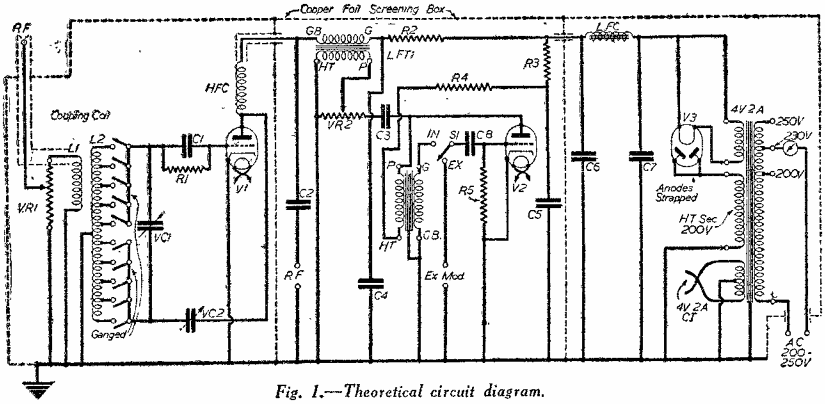


Fig. 1.—Theoretical circuit diagram.
(For component values see page 278.)

Mains Transformer

The mains transformer is not a standard component although any good quality transformer giving about 200 volts at 10 milliamps or over, will be suitable, plus, of course, the low tension secondaries; if the high tension current rating is very much in excess of 10 mA it may be necessary to absorb some of it by means of a bleeder resistance. Details of the transformer, wound especially for this instrument, are given in Fig. 6. The stampings used provided a cross-section core area of just over one square inch so that 8 turns per volt gives good regulation. Any stack of laminations giving the same cross-sectional area of the winding line—one square inch—may be used and the data shown in Fig. 6 will apply providing, of course, that the bobbin will accommodate the windings. In this respect the low total current makes it possible to use a fine gauge of wire which is advantageous where space is limited. The total wattage of the transformer is under 25 watts, which makes it possible to use a small core assembly. Further information on the subject of transformer construction is available in the PRACTICAL WIRELESS publication, "Wireless Coils, Chokes and Transformers."

The value of the decoupling condensers is not critical nor, in the case of C.5, is the type, which may be of the electrolytic type if desired, but C.4, owing to its higher capacity, is more compact in electrolytic form. The slow-motion drive should be selected for its accuracy and smoothness of action, while a fairly high ratio of gearing is desirable. It will be noted that in the original model the dial used necessitated the removal of a large portion of metal from the panel; this would normally impair the screening efficiency but is counteracted by the metal plates behind the dial—a point to watch.

Constructional Details

It is advisable when commencing construction to make and fit all screens to the panel and chassis, even bolting them into position. Having ascertained that the whole is a good fit in the cabinet—which, incidentally, is lined with copper foil—the screens may be removed and all components mounted. In this connection it will be seen that certain ones mounted underneath the chassis, notably the L.F. choke and the L.F. transformer, must be of reasonably small dimensions The H.F. choke is of screened variety and needs to be effective up to about 3,000 metres so that a good quality one is indicated. The mains on-off switch is of the rotary type (merely in order to preserve a symmetrical panel layout) and in the original consists of a volume control switch—the resistance element being faulty.

Wiring of the original model should be followed as closely as possible, using thick wire, well-insulated and good soldered connections. Note the heavy bare copper busbar which runs in a continuous length through the

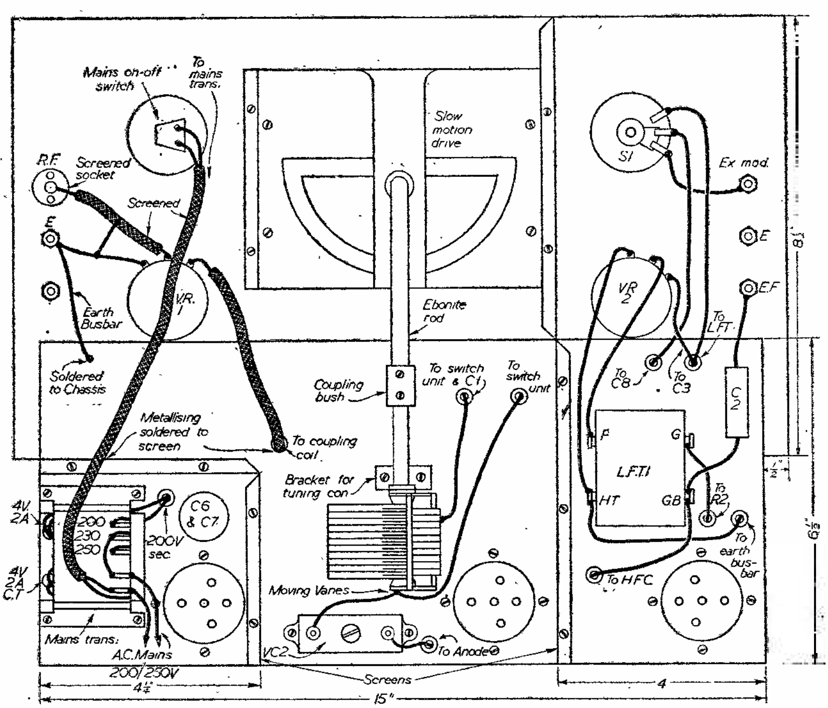


Fig. 2.—Wiring diagram of panel and top of chassis.

screens from one end of the chassis to the other and up through to the earth socket. This is most important, since its object is to provide an earthing point of negligible resistance of all earth returns. The low tension leads, after passing through the first screen to the oscillator and modulator valve heaters, are of twisted screened cable, the casing of which should be soldered to chassis at one or two points. It is advisable to fit rubber grommets to the holes in the chassis and screens through which wires pass, thus ensuring perfect insulation. Care is necessary when wiring the coil and press button switch, since the proximity of these components may necessitate connecting the tappings to the lower contacts of the switch before mounting the coil permanently. The importance of making a sound job of the wiring and, for that matter, the whole instrument, cannot be stressed too much, for upon this will depend the accuracy or otherwise over a long period.

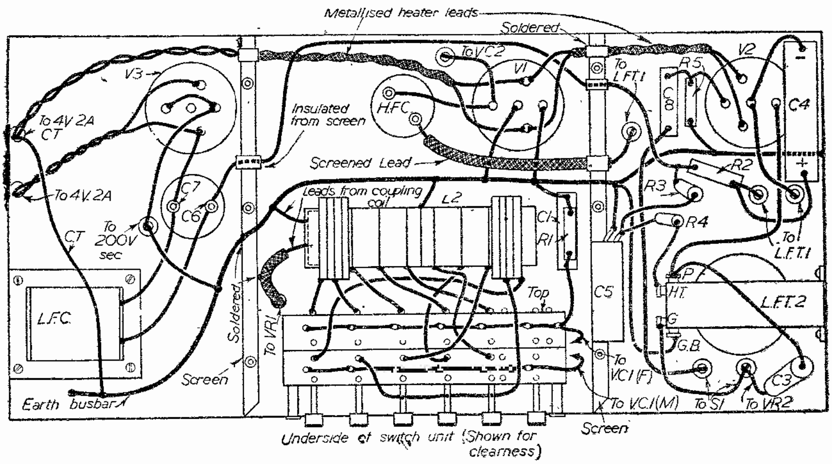


Fig. 3.—Underside wiring of chassis.

Valves

With the wiring completed and checked, the service oscillator is ready for test, but perhaps a word about valves may not be out of place at this stage. The oscillator valve, V.1, needs to be of fairly high impedence, such as the M.H.L. type, although an Osram M.H.4 functions quite satisfactorily. V.2, the modulator valve, can be almost any triode, the above types again being suitable or, alternatively, one of the L class may be used. A half-wave rectifier is employed for V.3 and this is obtained by strapping together the anodes of a full-wave type. In cases of necessity it is possible to make use of an ordinary A.C. triode here, strapping the grid to anode, while the cathode is joined to one side of heater.

Testing

After joining the instrument (out of its cabinet) to the mains and switching on, it should be left for a minute or so in order that the valves attain their correct temperature. The L.F. modulator may then be checked by plugging in 'phones to the L.F. sockets and setting the modulator switch to "Internal." Failure to obtain a note is usually due to the windings of the L.F. transformer—under chassis—being out of phase and will therefore necessitate a reversal of either primary or secondary connections. The accepted standard frequency for the modulating note is 400 cycles, and although it is near enough correct with the components and values shown, it is really not necessary to adhere to this particular frequency. V.R.2, mounted below the modulator switch, will control the strength of modulation and the note should be fairly constant in pitch up to about three-quarters of its travel, after which it will rise considerably. Since, however, the strength of the normal note at its loudest point is ample for the purpose, this irregularity is immaterial. The pitch or frequency of the note may be influenced by the type of valve and/or transformer, the high tension voltage and the respective values of R.3, R.4, and C.3. External modulation may be applied after placing the switch to that position, and the volume control will still be effective; also, by turning it to minimum, internal or external modulation may be cut right off.

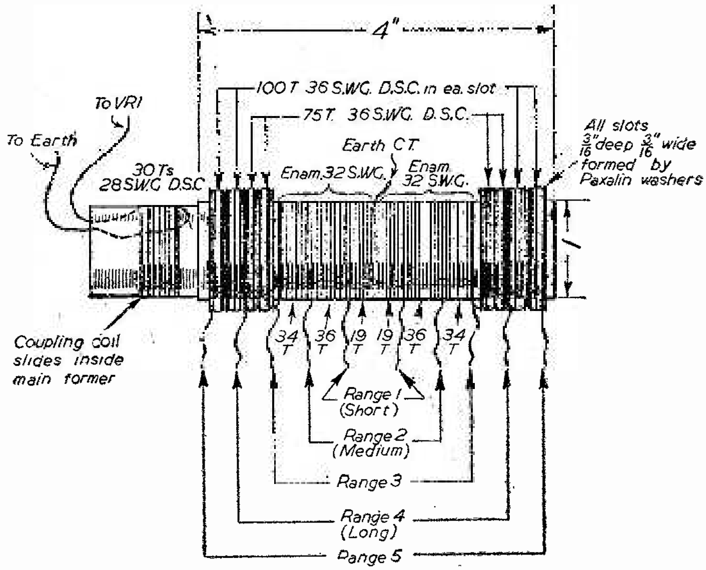


Fig. 4.—Multi-range coil details.

The radio frequency oscillator may be checked in conjunction with a standard receiver, connecting it to the former via a screened cable incorporating a dummy aerial or a fixed condenser of approximately .0003 mfd. Alternatively, a short length of wire—about 5 ft.—may be plugged in to the R.F. socket

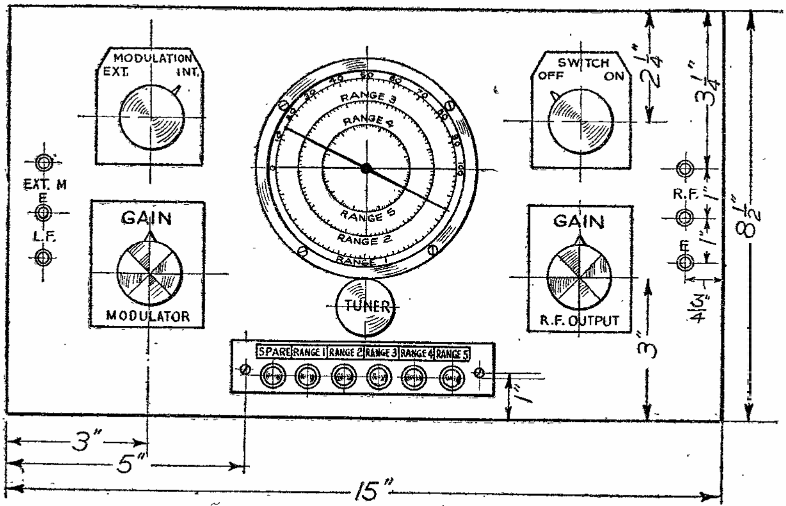


Fig. 5.—Layout of panel front.

and laid over the receiver cabinet, the normal aerial being disconnected. At this stage it is necessary to know the wave-ranges given by the various buttons, and these are approximately as follows: Range 1, 40-190 m.; Range 2, 180-600 m.; Range 3, 250-700 m.; Range 4, 700-2,000 m; Range 5, 1,500-2,900 m.

These ranges, of course, cannot be guaranteed exactly in other models since they depend largely upon the type of variable condenser employed, the way the coil is wound, and inter-wiring capacity, etc., etc.

It now remains to select some particular wave-range—say, the medium band, range 2—setting modulation off, V.C.2 screwed about half-way in, and the output control at maximum. The receiver is switched to medium-wave and its dial set to about 500 metres. At roughly the same position on the oscillator dial a point will be found where a strong carrier wave is heard and this may be "followed" up and down the dial by altering the wave-length of first the oscillator, then the receiver, and so on until the whole waveband has been covered. The procedure must be repeated on all ranges, using harmonics where the fundamental is not available on the receiver; this will apply in the case of the top ends of ranges 3 and 5, which take in the 465 kc/s. and 110 kc/s. bands respectively. These tests will ensure that V.1 is oscillating satisfactorily, and in this respect no difficulty should be encountered providing that the design is adhered to. V.C.2 is the only component that may need adjusting, treating it more or less as an ordinary reaction condenser. There some overlapping of the wave-ranges, but this is useful for checking calibration from time to time. The large coverage on the short wave-range is due to the .0005 mfd. condenser employed in conjunction with it; this makes the settings a little critical but may be overcome if desired by arranging for a .0005 mfd. fixed condenser to be switched in series with the variable on this range only. Unused contacts operated by the range 1 button could easily be utilised for the purpose.

Calibration

Actual calibration is best carried out (after securing the instrument in its cabinet) in conjunction with an accurately calibrated receiver, and provision is made on the dial for direct markings in wavelength or frequency for each range. For this purpose the scale is marked out in Indian ink on a piece of celluloid or good quality card, Fig. 5. It is wise, though, to draw up a set of carefully prepared graphs for extreme accuracy. A point to note is that the output control is not of the constant impedence type and calibration will not hold exactly for all settings of V.C.1. It is necessary, therefore, to select some arbitrary point on the output control scale and carry out calibration with it at this position in order to provide for extreme accuracy such as checking intermediate frequencies, etc. For all ordinary purposes, however, the control is most useful as it *does* reduce the signal to zero. In this connection it is necessary to ensure that the joins in the cabinet screening really do join up, and that the connections are electrically perfect; also those between panel and cabinet edge when the whole is assembled. This instrument, if joined to an outside or large indoor aerial, will transmit quite a powerful signal and it is necessary to remind readers that its use for the purpose is illegal.

The use of oscillators in servicing is dealt with in "The Practical Wireless Service Manual," price 9s. by post from the offices of this journal.

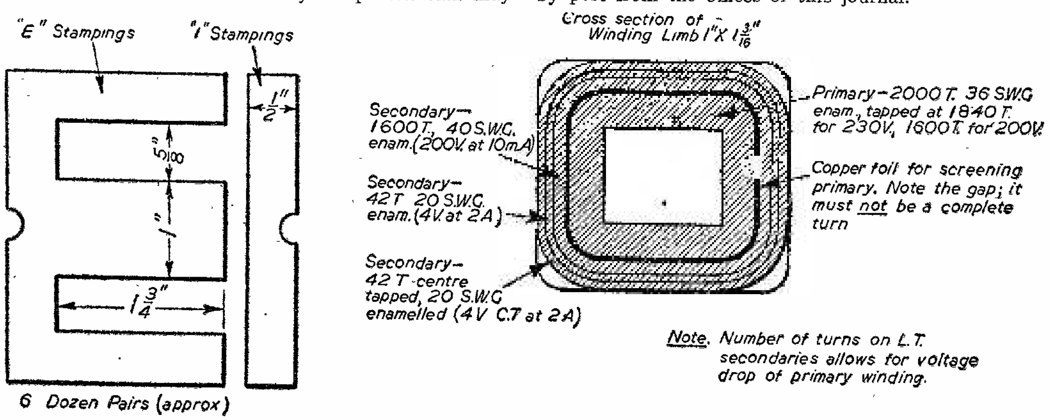
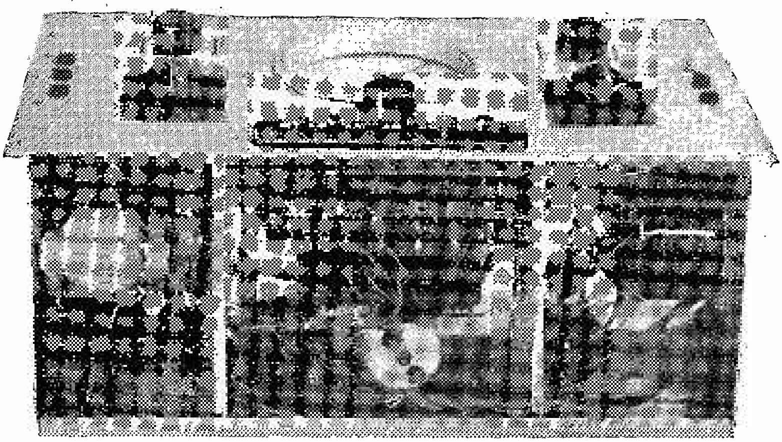


Fig. 6.—Mains transformer details.

Values of Components Shown in Fig. 1.

V.R.1	— 5,000 Ω
V.R.2	— 0.25 M Ω
R1	— 0.1 M Ω
R2	— 50,000 Ω
R3	— 30,000 Ω
R4	— 0.1 M Ω
R5	— 1.0 M Ω
V.C.1	— 0.0005 mfd.
V.C.2	— 0.0003 mfd. (Preset.
C1	— 0.0001 mfd.
C2	— 0.1 mfd.
C3	— 0.1 mfd.
C4	— 8.0 mfd. (Electrolytic).
C5	— 0.5 mfd.
C6	— 8.0 mfd. } Electrolytic
C7	— 8.0 mfd. } Electrolytic
C8	— 0.002 mfd.



A view of the underside of chassis, showing layout, wiring, etc. Note the screens dividing the various stages.

(NOTE.—In the list of components for the Workshop receiver, given on page 228, May issue, the values of the two gang condenser were erroneously given as .0005 × .0003 mfd. These values should, of course, read .0005 × .0005 mfd.)

LIST OF COMPONENTS

One chassis 14in. by 6½in. by 2¼in. deep.
One panel 15in. by 8½in.
Metal for screens.
One mains transformer (output 200 v. at 10 mA, 4 v. 2 amp., 4 v. 2 amp. centre tapped). See text.
Two L.F. transformers, 3 to 1 ratio.
Three × 5-pin valveholders.
One L.F. choke (20 H. at 20 mA.).
One variable condenser .0005 mfd.
One bracket for above.
One slow-motion dial.
One S.P/D.T. switch.
One press-button unit (Fred's Radio Cabin) as advertised.
One Rotary on-off switch. See text.
One screened H.F. choke.
One pre-set condenser .0003 mfd. max.
One Multi-range coil. See text.
One screened plug and socket.
Three plain sockets.
Two insulated sockets.
Resistors: One 30,000 ohm, one 50,000 ohm, two 0.1 megohm, one 1 megohm, one potentiometer 5,000 ohms (carbon), one potentiometer 0.25 megohms.
Condensers: One .0001 mfd., one .002 mfd., two 0.1 mfd., one 0.5 mfd. (see text), one 8 mfd. (125 v.w. electrolytic) one 8+8 mfd. (250 v.w. can type electrolytic).
One cabinet lined with copper foil.
Nuts, bolts, screws, etc; ebonite tube and rod; coupling bush.
Connecting wire, sleeving, screened wire.
Valves: One Osram M.H.L.4, one Osram M.H.4, one Mazda U.U.5 rectifier.

(*To be continued.*)

B.B.C. Year Book for 1943

AN interesting part of the B.B.C. Year Book, 1943, which was published on Friday, April 16th, is the chapter "Calling Europe," by I. A. Kirkpatrick, Controller of the B.B.C. European Service. Of all broadcasts by the B.B.C. in wartime, there are none of greater importance than those which carry the truth to the temporarily enslaved nations of the continent, and Mr. Kirkpatrick writes of the purpose and practice of this radio offensive.

Engineering Work

The work of the engineers and their assistants, without whom there could not be a B.B.C., is also described in the Year Book. As Sir Noel Ashbridge, their controller, points out in his opening sentence, "If one may judge from remarks one frequently hears, it almost seems that many people imagine the B.B.C. staff to be mainly composed of announcers. . . ." Sir Noel recalls that just before the war there were 1,300 men, largely trained engineers, employed all over the country in the engineering division alone. With the vast expansion of the Overseas and European Services, transmitter hours have increased nearly six-fold and to-day the engineering division numbers more than 3,000. No fewer than 417 B.B.C. peacetime engineers are serving in the Forces. Colourful highlights of B.B.C. history, such as "The First Command Performance of a radio show ever given . . .," "the greatest venture of British religious broadcasting . . .," "Ten years of Empire broadcasting. . . .," are described in the Year Book.

The Command Performance was when Tommy Handley, irrepressible "Mayor" of "Foaming-at-the-Mouth," and the whole cast of "Itma," gave at Windsor Castle a show in honour of Princess Elizabeth's birthday; the notable event in religious broadcasting was the series of 12 plays by Dorothy Sayers on the Life of Christ; and a decade of Empire broadcasting was celebrated in December—noteworthy events in the history of a broadcasting service which comes of age this year.

Transatlantic Broadcasting

Other sections of the Year Book deal with the great growth of transatlantic broadcasting (see the article by Edward R. Murrow, European Director of the Columbia Broadcasting System of America), outstanding feature programmes, plays, variety and talks (there were 5,600 talks in 1942). Sir Allan Powell (B.B.C. Chairman) has written a foreword and there are extracts from speeches by Mr. R. W. Foot and Sir Cecil Graves, Joint Directors-General of the B.B.C.

The price of the B.B.C. Year Book, 1943, is 2s. 6d. (2s. 10d. post free), and it may be obtained from the B.B.C. Publications Department, The Grammar School, Scarle Road, Wembley, Middlesex, or from any bookstall.

ON YOUR WAVELENGTH

By THERMION

From Overseas

THE mutation of our readership, or as the Government departments prefer to call it the shift of the public, is well exemplified by my Overseas post, and at the same time it is a tribute to the services our readers are rendering to the country and by reflection to the services which this journal renders in common with all other technical papers. Another point which emerges from the correspondence is that among the Tunisian tintinnabulation, the Russian rumblings, the African amblings, and the Japanese jinglings, those in the Services are not in the least disconcerted, their minds are still in the realms of radio. After that alliterative passage, I should like to refer to one letter, from one J. H. Addison, who at present is in the salubrious district of Freetown, B.W. Africa. His letter positively bubbles with enthusiasm for this journal, and incidentally hands out appreciation to your present scribe. He thinks that I would be superior in every way to the Brains Trust, for whom he does not seem to have much regard. This reader deplores the absence of Maurice Reeve from our pages, but Maurice Reeve is in the Services, too, and is facing music of a different sort. The three features he does not like are, The Refresher Course in Mathematics (I hope he is not weak in them!), Radio Examination Papers (perhaps these are a bitter reminder to him of his own efforts in that direction), and Elementary Electricity and Radio. This latter series is written for readers such as J. H. Addison, and it is written in language which every reader can understand. I cannot understand hence where friend Addison is experiencing difficulty, especially as he is a Leading Radio Mechanic.

Another letter arrives from the President of the China Amateur Radio League.

"In conjunction with the 1942 Convention we sponsored a Nation-wide Amateur Radio Show at the same time. During the show there were displayed QSL cards of different countries, ham equipments as well as a number of radio products of the Chinese radio manufacturing companies. Radio trophies such as Jap made hand generators, throat microphones, field sets, etc., which were captured in the field by our army were also among the exhibits. What attracted our visitors most, however, was the 'Radio Man' who could talk, answer questions and also wink his eyes. The 1942 Convention was in reality quite a success.

"As Great Britain is one of our Allied nations and as we have contacted quite a number of British ham stations through XUOA, our headquarter station, we do not hesitate to write you this letter asking for your kind co-operation in this event. The stations which we contacted were G8DL, G4CI, G3BI, G2LU, G2TR, etc. Any assistance rendered through your kindness will certainly be most highly appreciated. We want to make the forthcoming Convention and show a success. This will not only help to promote the Chinese people in the study of radio science in particular but also increase their interest and understanding of international relations, both of which are important and vital, especially during the present war against fascism and Hitlerism."

Musical Frequencies

I THOUGHT I had written the last word about the musical scale. Not so, however. One reader wants to know the frequencies of the semi-tones, and so I spent a few of the spare hours which is the daily lot of a technical journalist, and hunted up all my text-books. There was not a word about the frequencies of semi-tones in any of them. Pursuing my studies into the subject I visited the Patent Office Library, and have pleasure in now passing along the following tit-bit of information about it. The frequencies are generally presumed to be half-way between the full-tone frequencies. I was able to find two tables of musical scale frequencies which give the frequencies of semi-tones. These scales are the equal-tempered chromatic scale, which was the standard pitch adopted by the Music Industries Chamber of Commerce of the United States in 1925; the equal tempered chromatic scale, International pitch, adopted in 1891. These two tables are given on page 416 of "The Handbook of Chemistry and Physics," Second Edition, 1936, by Charles D. Hodgman, published by The Chemical Publishing Co., Cleveland, Ohio, U.S.A.

Although theoretically the semi-tone is half-way between their adjacent tones, in practice they are not so. Thus, on the pianoforte keyboard E flat (D sharp), has a frequency half-way between its adjacent white notes D and E, but under the Equal-temperament system of tuning, some notes are tuned flatter and some sharper than the theoretical.

Weary

[Press Item.—The B.B.C. Brains Trust is to be rested for months of June, July and August.]

O frabjous day! Calloo! Callay!
The Brains Trust is to rest!
Of all the recent news we've had
This surely is the best!

Those brain pans, filled with knowledge vast,
No longer need they strain
To answer questions sensibly—
That gives them too much pain!

For scientific broadcasts
In the programmes there is room;
And if these scientists held forth
They'd meet with growing boom.

They'd give us facts, opinions ban,
Which bring no edification;
We want our science from men who've had
A science education!

"TORCH."

Our Roll of Merit

Readers on Active Service—Thirtieth List.

A. Flitcroft (Pte., R.A.O.C.).
W. Beard (Spr., R.E.).
C. T. Rivington (Sub. Lieut., R.N.V.R.).
R. F. Thomas (A.C.1, R.A.F.).
E. Hanson (L/Cpl., R.E.).
W. L. Preston (A.C.1, R.A.F.).
J. Millmore (Cpl., R.A.F.).
H. Dodgson (Driver, R.A.S.C.).
A. C. Steadman (Cpl., R.E.M.E.).
R. Smyth (Sgt., R.E.M.E.).
F. A. Ranger (A.C., R.A.F.).
F. G. Pearson (L.A.C.)
S. W. Thurgood (Pte., B.N.A.F.)
Middleton (Cpl., R.A.F.)
H. Vine (L.A.C.)
E. W. Bonson (A.C., R.A.F.)
M. Hayton (A.B., Royal Navy.)
F. W. Lowson (R.A.)

Elementary Electricity and Radio—5

By J. J. WILLIAMSON

(*Continued from page 240, May issue*)

Inductance

If the current that is passing through a conductor changes in magnitude, then the strength of the magnetic field around the conductor changes, lines of magnetic force therefore cut the conductor, inducing a back E.M.F., which, acting against the current, thus opposes the current's change.

In Fig. 1 we have plotted current against time; notice that the current takes a definite period of time to reach its Ohm's Law value $\left(\frac{V}{R}\right)$ or to fall to zero.

This property which opposes a change of current is known as "Inductance" (L).

The unit of inductance is the henry (H).

A circuit possesses an inductance of one henry when

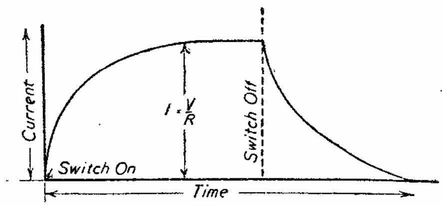


Fig. 1.—Change of current through inductance.

a change of current of 1 ampere per second induces a back E.M.F. of 1 volt.

The henry is divided into the millihenry (mH) and the microhenry (μH) for convenience.

$$1 mH = \frac{1}{1,000} H$$

$$1 \mu H = \frac{1}{1,000} mH = \frac{1}{1,000,000} H.$$

Capacity

If we apply a direct voltage to two plates insulated from one another and observe the current that flows, we shall find that at the instant we switch on a current flows and then falls slowly to zero. If we remove the source of supply and short-circuit the plates we shall find that a current once again flows for a short period of time, but in the opposite direction.

Apparently the plates received a charge of electricity and when short-circuited gave it up.

This ability of a circuit to store up an electric charge is known as "capacity" (C).

The unit of capacity is the Farad (F).

A circuit has a capacity of one farad when it receives a charge of 1 coulomb at a potential of 1 volt.

The Farad is divided into the microfarad (μF) and the micro-microfarad or picofarad ($\mu\mu F$ or PF).

$$1 \mu F = \frac{1}{1,000,000} F.$$

$$1 \mu\mu F = \frac{1}{1,000,000} \mu F = \frac{1}{1,000,000,000,000} F.$$

Opposition to Alternating Currents

The opposition of inductance to alternating (changing)

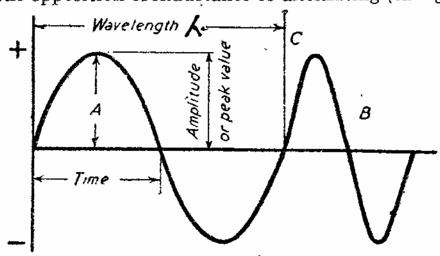


Fig. 3.—Definition of an alternating quantity.

current is called Inductive Reactance (X_L), and increases with an increase of frequency (greater rate of change) and inductance,

i.e., $X_L = 2\pi fL$ ohms, where 2π is a constant, made necessary by the mode of mathematical interpretation used.

Similarly, the alternating current opposition of capacity, Capacitive Reactance (X_C), *decreases* with an increase of frequency and capacity.

$$\text{i.e., } X_A = \frac{1}{2\pi fC} \text{ ohms.}$$

X_C or X_L may replace R in Ohm's Law, thus

$$V = I(X_L \text{ or } X_C) \qquad I = \frac{V}{(X_L \text{ or } X_C)}$$

$$X_L \text{ or } X_C = V/I$$

The total opposition of a circuit to alternating currents is known as the impedance of the circuit. Symbol—Z.

(*Continued on page* 283.)

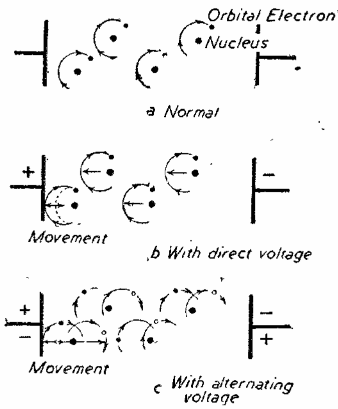
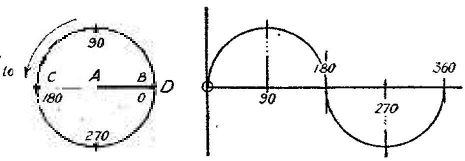


Fig. 2.—Displacement currents through a condenser.

Fig. 4 (Right).—Vectors to illustrate waveforms.



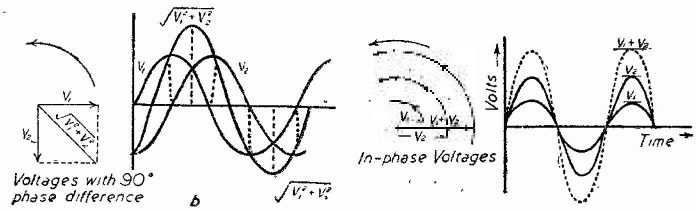


Fig. 5.—Addition of vector quantities.

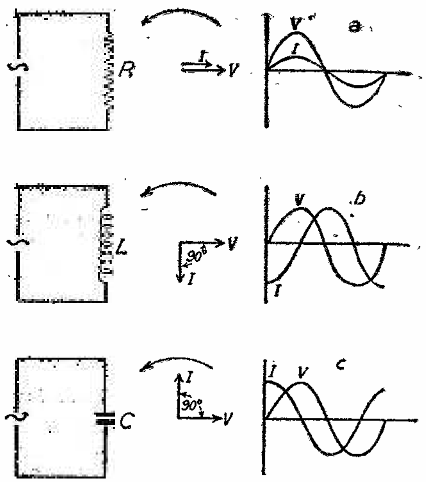


Fig. 6.—Alternating voltage across resistance, inductance and capacity.

How Alternating Current Passes Through a Condenser

In Fig. 2 (a) we have a simple condenser with the insulator's (dielectric's) atomic structure shown in a greatly simplified manner.

When a voltage is applied to the condenser one plate becomes positive (deficient in free electrons) and the other negative (surplus of free electrons), thus the positive plate attracts and the negative plate repels the *orbital* electrons of the dielectric's atoms.

As shown in Fig. 2 (b) the paths of the orbital electrons are distorted, the degree of distortion representing an electron movement (a current) in the direction of the positive plate.

The attractive force between the atoms' nuclei and their orbital electrons obviously sets a limit to the orbital displacement, thus the current (displacement current) is only momentary.

A voltage which "pulls" harder than the force of the nuclei will cause the orbital electrons to break free, causing the dielectric to break down. (Breakdown voltage.)

If we replace the battery with a source of alternating current (current continually changing its direction) then the displacement of the orbits occurs between two limits, Fig. 2 (c), thus an alternating current passes its effects easily, i.e., a condenser stops direct current unidirectional) but passes alternating current.

Alternating Quantities Expressed as Waveforms

When anything possesses an alternating or reversing motion we can depict this movement as shown in Fig. 3. Motion in one direction being shown above a zero line and a reverse motion below the zero line. The greater the motion (amplitude) the greater the deflection above or below the zero line (A).

The more rapid the alternations (higher frequency) the less time it takes for one complete series of events (one cycle) to occur, and the more cramped the waveform becomes (B).

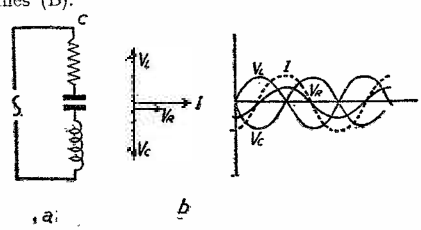


Fig. 7.—The series tuned acceptor circuit.

Frequency is defined as the number of cycles that occur every second (f=c.p.s.).

The distance between any two similar parts of the waveform one cycle apart is known as the wavelength, and represents the distance the wave covers during one cycle (C).

Obviously, if the alternating quantity is to represent a wave travelling then there is a definite relationship between the velocity of the wave (v), the wavelength (λ—lambda) and the frequency (f),

i.e., $v=\lambda f$

$\lambda=v/f$

$f=v/\lambda$

The speed of radio wave is approximately 186,000 miles per second, or 300,000,000 metres per second.

thus if $v=\lambda f$

$300{,}000{,}000=\lambda f$

$$f=\frac{300{,}000{,}000}{\lambda} \text{ cycles per second.}$$

$$\lambda=\frac{300{,}000{,}000}{f} \text{ metres.}$$

It is more convenient to speak in terms of "kilocycles per second" (kc/s.p.s.), or "megacycles per second" (mc/s.p.s.).

1 kc.p.s. = 1,000 c.p.s.

1 mc.p.s. = 1,000 kc/s. = 1,000,000 c.p.s.

$$\text{thus } \lambda=\frac{300{,}000}{f \text{ in kc/sp.s.}} \text{ metres}=\frac{300}{f \text{ in mc/s.p.s.}} \text{ metres}$$

$$\text{and } f=\frac{300{,}000}{\lambda} \text{ kc/s.p.s.}=\frac{300}{\lambda} \text{ mc/s.p.s.}$$

Waveforms Expressed as Vectors

Several waveforms shown together are difficult to visualise clearly, thus to facilitate calculation we express a pure alternating quantity (sinusoidal wave) as a rotating vector. A vector being defined as a straight line with no definite position in space but possessing amplitude and direction.

In Fig. 4 AB is a vector and is visualised as rotating anti-clockwise; the line CD on which it lies is known as the zero line. The *maximum* amplitude of the wave (peak value) is represented by the length of the vector. The circumference of the circle represents the time taken for one cycle, thus one cycle equals 360 deg., half a cycle equals 180 deg., a quarter-cycle equals 90 deg., etc. This notation enables us to gain an easy comparison of two waveforms of the same frequency but out of step (out of phase) with one another.

Addition of Vectors

In Fig. 5 (a) we have two alternating voltages, V_1 and V_2, rising and falling together (in phase). The two vectors are shown side by side for clarity; obviously the total maximum voltage will be V_1 plus V_2, and the resultant voltage will be in phase with V_1 and V_2.

In Fig. 5 (b) two alternating voltages, V_1 and V_2 but 90 deg. ($\frac{1}{4}$ cycle) out of phase with each other have to be added. Obviously we cannot add them together as in the in-phase case.

Referring to Fig. 5b by Pythagoras' Theorem

$$c^2=a^2+b^2$$

$$c=\sqrt{a^2+b^2}$$

thus resultant voltage V_R becomes

$$V_R=\sqrt{V_1^2+V_2^2}$$

For any angle other than 90 deg. we usually resort to trigonometry, but fortunately most relationships when dealing with alternating voltages and currents can be resolved to components of 90 deg. phase difference.

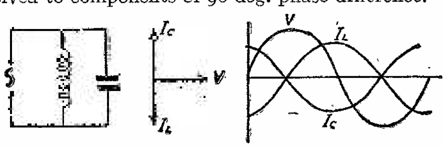


Fig. 8.—The parallel tuned rejector circuit.

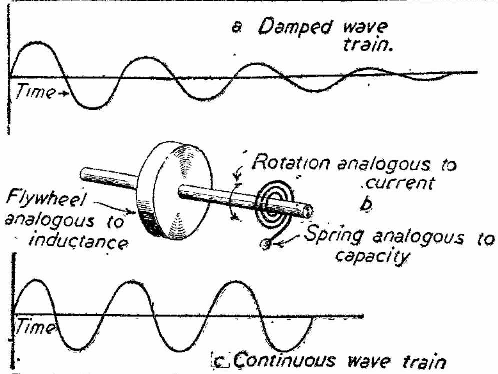


Fig. 9.—Damped and continuous wavetrains, and analogy inductance capacity and current.

Alternating Voltage Across Resistance

The current through a resistance reaches its maximum at the same time as the voltage; thus in Fig. 6 (a) we have the voltage and current vectors lying upon the same line and rotating together.

Thus resistance introduces no phase difference between current and voltage.

Alternating Voltage Across Inductance

Inductance in a circuit causes the current to reach its maximum value 90 deg. ($\frac{1}{4}$ cycle) after the voltage, i.e., the current lags on the voltage by 90 deg. The vectors and waveforms in Fig. 6 (b) show this clearly.

Alternating Voltage Across Capacity

Capacity causes the voltage to lag on the current by 90 deg. (Fig. 6 (c)).

Resistance, Inductance and Capacity in Series

When considering resistance, inductance and capacity we have taken a circuit to possess only one of these properties, whereas in practice it is impossible to do this, i.e., every circuit possesses all three properties, the desirable one being accentuated by the circuit design.

Fig. 7 (a) depicts R, L and C in series. The definition of a series circuit being—a circuit having a common current in every part of it. Obviously the current through R, L and C cannot have different values, and therefore the voltages developed across these components must be affected.

Referring to Fig. 7 (b) we have the voltage across the resistance in phase with the current; the voltage across the inductance leads on the current, while the voltage across the condenser lags on the current. In the vector diagram V_C and V_L oppose one another, thus if the two are equal they will cancel out, leaving only V_R acting across the circuit.

The magnitude of V_C and V_L depends upon the inductive and capacitive reactances and the current, i.e., $V_C = IX_C$ volts.

$V_L = IX_L$ volts.

thus $V_C \propto X_C$

$V_L \propto X_L$

Therefore, when $X_C = X_L$ the reactive opposition to the alternating current disappears—the only opposition remaining being represented by the resistance—and a large current flows. This condition is known as "resonance."

$$X_C = \frac{1}{2\pi\sqrt{LC}} \text{ ohms.}$$

$$X_L = 2\pi fL \text{ ohms.}$$

Thus resonance occurs when:

$$2\pi fL = \frac{1}{2\pi fC}$$

$$^2 = \frac{1}{2^2\pi^2 LC}$$

$$= \frac{1}{2\pi\sqrt{LC}}$$

f being known as the resonant frequency of the circuit. A circuit having inductance and capacity in series is known as an "acceptor" circuit because it passes or accepts a large current when the current is at the circuit's resonant frequency. By adjustment of L or C, the circuit can be made to respond to any frequency, or "tuning" may be achieved.

Capacity and Inductance in Parallel

In Fig. 8 we have C and L in parallel—by the definition of a parallel circuit the voltage across L and C must be the same, thus the currents in the two branches must have their phasing altered.

Once again, if, $X_L = X_C$ or $I_C = I_C$, the currents flow in opposite directions; if I_L flows up the circuit and I_C down, then the result will be to form a large current circulating in the closed circuit. This condition occurs when

$$= \frac{1}{2\pi\sqrt{LC}}$$

and it follows that the circulating current will be oscillating at the frequency of the supply.

The total opposition of such a circuit to an alternating current rises to a high value, and thus the current taken from the supply is minimum at the resonant frequency, thus the circuit rejects the frequency to which it is adjusted by means of L or C and hence is called a "rejector" circuit. This is not quite true, because of the influence of resistance in the circuit.

The Oscillatory Circuit

If we have a condenser and inductance in parallel and charge up the condenser by connecting it across a source of supply, when the charging source is removed, the condenser discharges through the inductance, the inductance keeps the current flowing causing the condenser to recharge in the opposite direction, thus the circuit produces a series of oscillations, which rapidly die away owing to loss of energy in the resistance of the circuit. Such a train of waves is called a "damped" wave train, Fig. 9 (a).

In Fig. 9 (b) we have a flywheel whose inertia is analogous to inductance, a spring being analogous to capacity while the speed of rotation of the shaft represents the magnitude of current.

Let us wind up the spring—charge up the condenser; release the shaft—remove the source of supply; the weight of the flywheel retards the initial movement of the shaft due to the spring—the inductance opposes the "building-up" of the current due to the condenser's voltage; the shaft gains speed, and when the spring is completely unwound, reaches its maximum speed—the current increases, reaching maximum when the condenser is discharged; the inertia of the flywheel keeps the shaft turning, although the spring is unwound—the inductance keeps the current flowing although no voltage is acting from the condenser; the spring winds up in the opposite direction and the shaft comes to rest—the condenser charges up in the opposite direction and the current falls to zero. The whole process then begins again.

Obviously the alternating motion of the shaft would slow down and stop as energy was lost at the bearings, etc., thus, to make the motion continuous the system would have to receive timed pulses of energy even as a swing has to be pushed at definite intervals in order to keep it moving. In the same way the oscillatory circuit would have to be supplied with timed pulses of energy in order to produce continuous oscillations as in Fig. 9 (c).

The methods employed to maintain such a circuit in oscillation will be discussed later.

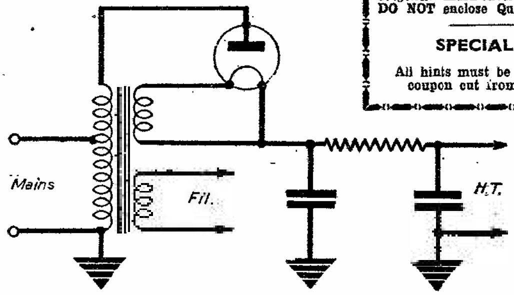
Single-valve Regenerative Receiver: A Correction

WITH reference to the article under the above heading which was published in last month's issue, a slight error occurs in the list of components given on page 225. The midget variable condenser should, of course, be .50 mmfd., and not 50 mfd. as printed.

Practical Hints

Emergency Auto-transformer

THIS dodge can be used in an emergency, for supplying H.T. and L.T. current to a midget mains receiver. All that is needed is a push-pull speech transformer. It will be seen from the diagram that the mains are put one side of the transformer and the centre tap. With a little experimenting 400 volts can be applied to the rectifier. I rewound the secondary to give the volts and amps. required. A resistance was used as a choke.—J. CUMMINS (Bristol).



Circuit diagram of an emergency auto-transformer arrangement.

Metal Valve Cable Plugs

HAVING difficulty in obtaining suitable connecting plugs for some disc recording equipment, I remembered the method of improvising connections with old valve bases and valve-holders. Possessing several worn-out metal valves, I decided to remove all the electrodes, leaving just the bakelite base and the metal envelope. Then, by drilling holes at the top (A) or in the side (B), according to valve type, for the screened cable entry, with a rubber grommet insert, the wires could be soldered to the pins and the envelope slipped up and attached to the base. (The metal envelope can be earthed for improved screening, see (A).) Thus, I provided myself with several neat and useful plugs.—DONALD W. ALDOUS (Torquay).

Making Electro-magnet Bobbins

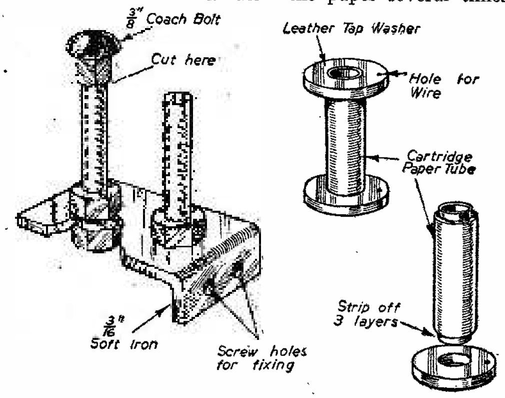
A QUICK method of making electro-magnet bobbins for clocks, bells or buzzers is as follows:

The components consist of ordinary leather tap washers (as used for repairing leaky water taps), coach bolts and nuts, good quality cartridge paper or manilla paper, good quality gum, and a piece of soft strip iron. The best size tap washers to obtain are those about 1in. diameter. Lay two of these on a piece of soft iron $1\frac{1}{2}$in. wide by $2\frac{1}{4}$in. long by $^3/_{16}$in. thick, and mark their centres for drilling holes for the size of coach bolts you are using. Coach bolts are obtainable in all sizes from $^3/_{16}$in. upwards, and two nuts should be obtained with each.

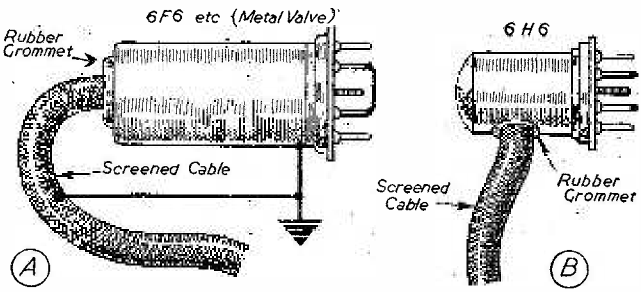
Drill the holes in the soft iron bed and assemble the bolts tightly in same, using the nuts each side to hold them. Saw off the bolt heads evenly below the squares under the heads, then file, and thoroughly smooth the bolts with emery cloth.

Now punch or drill the leather tap washers $^1/_{16}$in. oversize, and remember to pierce a small hole to pass the wire through. This is very important as it is difficult to do it later.

Two more coach bolts are now needed to act as formers for rolling the cartridge or manilla paper round to make the bobbin centres. These bolts should be preferably longer, and well smoothed with emery cloth to make the paper tubes slide easily off when dry and hard. Cut the paper to the height of the bobbin you require, and the length of the paper will be equal to five turns round the former bolt. Roll the paper several times round the bolt before gumming, so that it will take its final tube shape. Apply good quality gum, but be careful not to gum too near the portion near the bolt, otherwise it will be almost impossible to remove or slide off. When properly dry and hardened for 24 hours a small strip $^3/_{16}$in. wide may be peeled off at each end to form a shoulder on to which to press the punched out tap washer. Two or three layers should be peeled off. Gum well both the shoulder and the inside of the tap washer, fix and leave to set. This is then ready to slide off the former bolt, and place on the electro-magnet assembly after winding with the wire.—R. BARHAM (Coulsdon).



A quick method of making electro-magnet cores and bobbins.



Improvised connecting plugs for disc-recording equipment.

Experiments With Circ

Obtaining Full-wave Detection, and Using Twc

IT has always been the desire of the experimenter to obtain greater detector efficiency, and one apparently obvious method is to use full-wave detection instead of half-wave. Even in the days when crystal sets were in wide use (and they appear to be returning as "stand-by" receivers) it was realised that there must be a good deal of loss due to the fact that only one half-wave was being utilised.

While not overlooking the fact that there are many practical difficulties in the way of efficient full-wave detection, a few possible directions for experiment will be outlined. Some readers will have tried them before, but to many they will appear new. Many of the circuits given will apply to crystal detectors—because of their simplicity, but the underlying principles can, of course, be applied to valves by those who prefer to do so.

Nevertheless, it is the crystal which gives most scope, because with that we have no means of amplification. With a valve we can improve the output to a considerable extent by the application of reaction. There are many who now use a crystal set for the reception of the news bulletins, partly because it does not require any battery supply, and partly because a number of valve receivers are temporarily out of commission due to the shortage of valves.

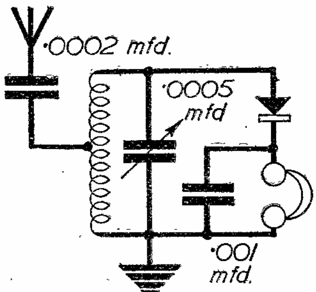


Fig. 1.—A standard simple crystal circuit giving half-wave detection.

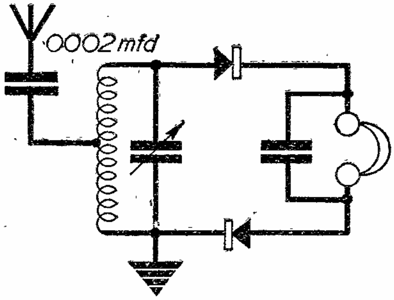


Fig. 2.—An attempt at full-wave detection, using two crystal detectors.

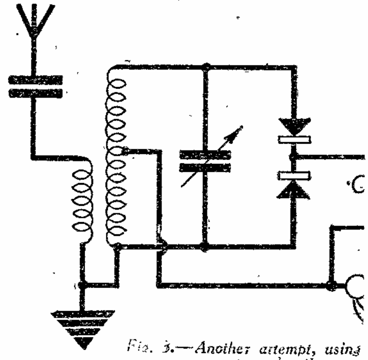


Fig. 3.—Another attempt, using tapped coil.

The Usual Arrangement

Fig. 1 shows a standard and simple type of crystal circuit, where tuning is by means of a .0005 mfd. variable condenser in parallel with a single waveband coil. The aerial is fed through a small fixed condenser to a tapping on the coil, to gain a reasonable measure of selectivity; by moving the aerial tap sufficiently low it is generally possible to separate the "Home" and "Forces" programmes, given a fairly good short aerial.

It will be seen that the crystal detector gives only half-wave rectification. That means that every other half-cycle of signal is virtually "wasted." Can we not find a means of rectifying both halves of every cycle? Fig. 2 shows a circuit in which this has been attempted by the simple expedient of wiring two crystal detectors in series, with the telephones and by-pass condenser between them. In practice it will probably be found that reception with this arrangement is no better than it is with the circuit shown in Fig. 1. At the same time experimenters are advised to try it, paying careful attention to the setting-up of the two crystal detectors.

If possible the two detectors should be of the same type, and they should be wired "in opposition," as indicated. Permanent or semi-permanent detectors are to be preferred, because it is not easy to adjust two delicate cat-whiskers simultaneously. One method of setting the crystals is to short each in turn, and then set the other for best signals.

Full-wave Detection

Another full-wave circuit is shown in Fig. 3, and it will be seen that this is the same in principle as a full-wave valve rectifier, as used for rectifying the mains supply for use as H.T. in an A.C. receiver. There are, again, two crystal detectors, and the junction between them is taken to one side of the 'phones, the other side of which goes to a centre-tap on the tuning coil. It will be noticed that a separate aerial winding is shown coupled to the tuning winding. This is sometimes better than using a tapping, but it is given merely as an alternative, and not as an essential part of the circuit. It is also sometimes found that better balance between the two halves of the detector circuit is obtained by omitting the earth connection from the lower end of the tuning winding. The difference is not as great as one might at first expect, because the aerial coil is essentially coupled so closely that the balance of the tuning coil is upset.

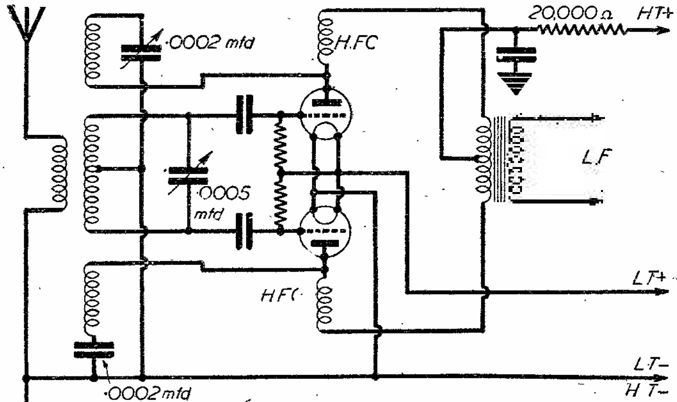


Fig. 6.—Push-pull detector circuit using a pair of matched triodes.

Double-detector :uits

› Detectors to Reduce Fading on Short Waves

a centre

An Electrical Centre Tap

The centre tapping must be found by experiment, since we require, not a purely physical centre, but an electrical, or " H.F.," centre. For this reason it is best to make tapping points at every turn near the centre of the coil, or to make contact to the turns by means of a pin attached to the end of a wire from the 'phones. If the second method is employed a permanent connection can later be made to the optimum tapping point. Adjustment of the crystals with this circuit is rather difficult, for it is not satisfactory to short out one before setting the other. When using semi-permanent detectors, however, each can be set up in turn by fitting them in a circuit of the type shown in Fig. 1.

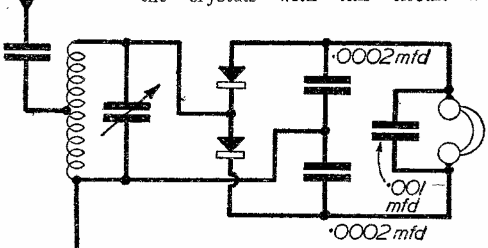


Fig. 4.—A voltage-doubler full-wave circuit of the type used for A.C. rectification.

The Voltage-doubler

Fig. 4 shows a full-wave circuit which will be recognised as that known as the voltage-doubler in A.C. work. The only differences are that crystal detectors replace sections of a metal-oxide rectifier, and that the capacities of the condensers employed are much smaller, because of the appreciably higher frequencies involved. Here, also, crystal adjustment is not easy, but there is no coil tapping to worry about. It is not claimed that the circuit will give double the output, despite the " voltage-doubler " arrangement, but there is a good deal of interest in trying it if you have not previously done so.

Another full-wave circuit that will be recognised as the " bridge " circuit so frequently employed for A.C. rectification, is shown in Fig. 5. There are now four crystal detectors involved, so unless these are all carefully adjusted before wiring them in the " bridge," good results cannot be contemplated. If they are carefully adjusted, the verdict after trying the circuit will probably be that results do not justify the number of crystal detectors, and the difficulties of adjustment, which are involved.

Full-wave Valve Detection

Of the circuits given, only that in Fig. 3 is readily adaptable to use with valves, since with the others separate L.T. supplies would be needed due to the filaments being at different potentials. Fig. 3 can be used with a class B valve or with a couple of triodes, connecting the two anodes to the ends of the tuning coil. Reaction can be applied if a coil is made with two small reaction windings. Fig. 6 gives an idea of the arrangement of a push-pull detector circuit using two triodes, and feeding the output into an L.F. amplifier. It will be seen that the transformer used has a centre-tapped primary; if 'phones were used, the junction

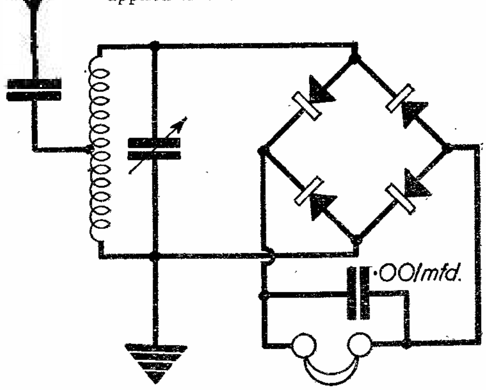


Fig. 5.—A " bridge " rectifier circuit used for full-wave crystal detection with four separate crystal detectors.

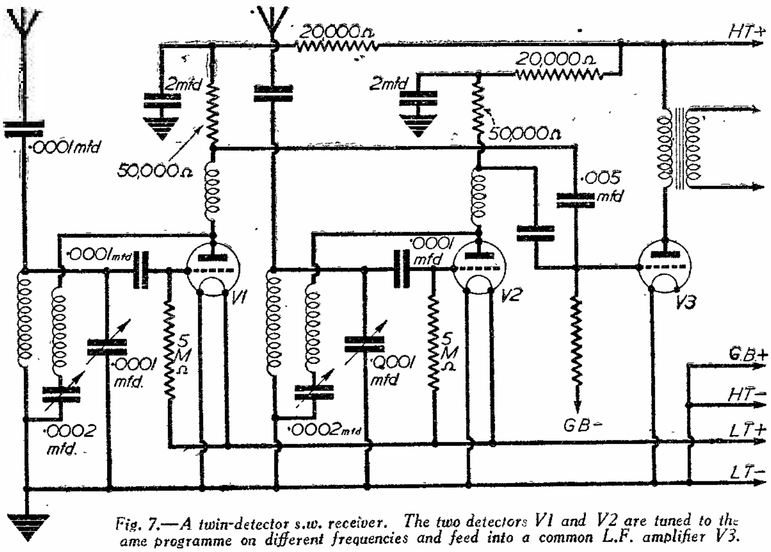


Fig. 7.—A twin-detector s.w. receiver. The two detectors V1 and V2 are tuned to the same programme on different frequencies and feed into a common L.F. amplifier V3.

between the two earpieces would be taken to H.T.+. The circuit is not new, and although it has not proved particularly useful it is worth a trial.

Two Separate Detectors

An entirely different method of using two detectors is illustrated in Fig. 7, and this is one which has been found to be fully justified. Examination of the circuit

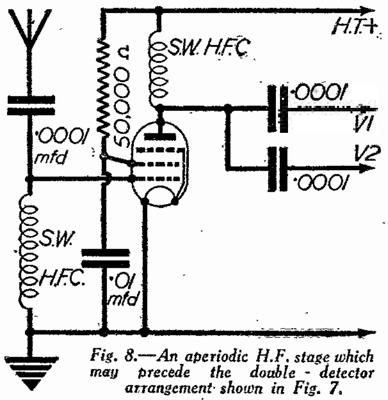


Fig. 8.—An aperiodic H.F. stage which may precede the double - detector arrangement shown in Fig. 7.

will show that there are two complete single-valve detectors, each with its own tuning and reaction circuits. Separate aerials are also shown for the two valves, but this is not essential; both detectors could be fed, through small fixed condensers, from a single aerial. The output from the two valves feeds into a common L.F. amplifier.

Minimises Fading

This circuit is intended primarily for short-wave reception. The idea is to tune both detectors to the same programme on different frequencies; thus, the circuit can be used only for stations which transmit simultaneously on two different wavelengths. The object is to prevent—or at least to minimise—the fading which normally occurs on short waves. It is known that while fading takes place on one frequency, the same conditions often do not apply on another frequency. And even when the two frequencies are on the same band and fairly close together, it is found that for the majority of the transmitting time the signals on one are "swinging" or rising in strength, while those on the other are "fading" or falling in strength. Thus, if the two can be combined it should be possible very largely to eliminate fading—or, rather, the results of fading as they appear in the output reproduction.

These simple arguments are borne out in practice, and it is often possible to obtain a steadier signal with an elementary type of receiver having twin detectors than it is with a more pretentious superhet with A.V.C. The circuit is not given as a final one, but rather as a basis for interesting experiments. The values assigned to components are average figures, and may call for slight modification according to the valves and other components employed. It might also be considered worth while to use S.G. or H.F. pentode valves in place of the triodes, illustrated for simplicity. In fact, experiment has shown that extremely good results are possible by using H.F. pentodes in this circuit.

Pre-H.F. Amplifier

An elaboration of the circuit consists of adding an H.F. stage, not so much for the (limited) amount of amplification that it will give, but because it will "smooth-off" reaction control and simplify the manipulation of the set. It would scarcely be justifiable to use two H.F. stages—one for each detector—and a single one can be used to feed both if its tuning is very broad. This can be obtained by using the circuit shown in Fig. 8, where "tuning" of both grid and anode circuits is by means of short-wave H.F. chokes. These give aperiodic tuning, and if they are chosen according to the waveband on which the set is most frequently to be used the H.F. stage can be very useful.

In first tuning a receiver of the type under discussion it is best to disconnect the aerial lead from one of the detectors, and then to tune the other detector to one of the frequencies of the required station. The aerial can then be reconnected and removed from the other valve so that it may be tuned to the second frequency. After both aerial connections have been made, slight readjustment of tuning and reaction can be made in the usual manner. If both tuning coils and condensers are alike tuning will be very much simplified, and after a little practice it will probably be possible to tune both detectors together.

A Million Pounds for B.B.C. Wartime Good Causes

JUST over a million pounds has been subscribed to B.B.C. Week's Good Cause Appeals since they were reinstated on a wartime basis in November, 1939. From that time, with but one exception, an appeal has been broadcast every Sunday, and only 30 have produced less than £1,000, while 25 have brought in over £10,000, the record result being the response of £101,756 to Lord Baldwin's appeal for King George's Fund for Sailors in December, 1939.

A great variety of subjects has been covered, including welfare and recreational work on behalf of serving men and women, not forgetting the Merchant Navy; charities of a more general nature—children's homes and orphanages, hospitals, etc.; also the relief of distress caused by the war, both in Great Britain and on behalf of the people or refugees of countries allied or friendly to Britain —Poland, Turkey, Norway, Greece, Ethiopia, and China.

General Appeals

Although the higher totals were more noticeable at the beginning of the war when topical appeals for allied and war charities predominated, the more general appeals which have been included since the widening of the scope of Good Causes early last year, have still received a generous response from listeners, and the total for the year 1942, in spite of increased taxation, still shows an increase over the highest amount received in any one year in peacetime. Many subscribe regularly to the Sunday Appeals by taking advantage of the facilities offered by the Week's Good Cause Fund, by which a lump sum may be deposited with the B.B.C. and distributed to good causes over a period of six months or a year.

In addition to the million pounds given to Week's Good Causes, more than £68,000 has been contributed to the Christmas Day Appeals for the British "Wireless for the Blind" Fund, while the Children's Hour Christmas Appeals by "Uncle Mac," brought in nearly £41,000.

Many talks and postscripts have been broadcast covering every aspect of the Red Cross Society's activities, also talks on Flag Day collections for London Hospitals and Alexandra Rose Day. In addition to these and others, of which it is impossible to estimate the financial results, £51,279 was contributed to the two postscript appeals in 1942 for the Aid to China Fund, and £170,000 in response to Mrs. Churchill's Appeal last New Year's Eve for the "Aid to Russia" Fund, while the monthly Red Cross Radio Contests, broadcast since December, 1940, have brought in £167,482.

The B.B.C. is indebted to its Appeals Advisory Committee of outside experts, of which Dame Meriel Talbot is chairman, both for its advice on the choice of Week's Good Cause Appeals, and for wise guidance on its Appeals policy as a whole.

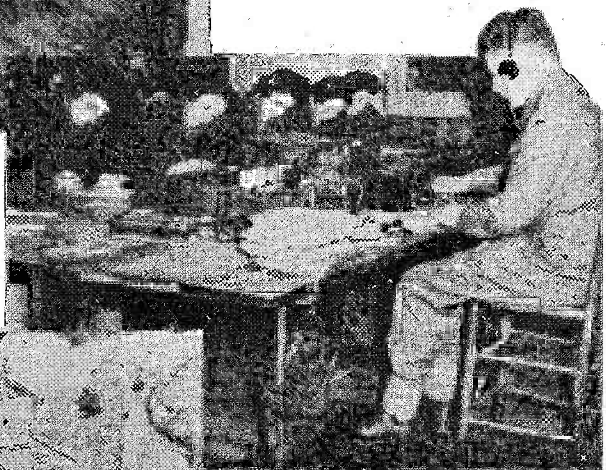
The "Owls" at Work

The first mixed training school has commenced in London for A.T.S. who will be known as " OWLS." They will replace the radio operators with the army to enable the release of more men for front line duties. From this school, the first London A.T.S. will pass their examinations to qualify as " OWLS " and they will be the first women to transmit the army's messages by wireless. The course lasts 12 weeks for men and girls.

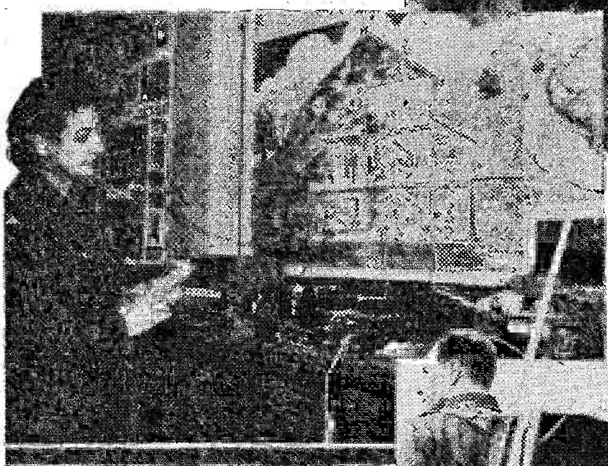
* * *

An " OWLS " officer and a private work together practising sending morse by a buzzer at the training centre. The officer facing the camera is 2nd Subaltern Patricia Gronow, from Aberdeen whose father was a signals instructor in the last war.

(Below) A corporal of the Royal Corps of Signals sending out morse to a class of "OWLS" to transcribe. They must reach 15 words a minute.



(Below) Corporal S. Wetherall, of Bolton, Lancs, instructing men of the Royal Corps of Signals how to operate a man-pack wireless set at the training school in London.



A 2nd subaltern who is training to be an " OWL." She is studying a humorous diagram linked up with ribbons, showing where different instruments connecting with a radio office are placed and used.

Radio Examination Papers—19

A Further Selection of "Self-test" Questions, with Suitable Answers by THE EXPERIMENTERS

QUESTIONS

1. *Given a simple battery receiver which was completely "dead," how would you diagnose the fault?*
2. *What is meant by the Miller Effect, as applied to radio valves?*
3. *There are two different components of the waves radiated from a transmitting aerial. Briefly, give the chief properties of each component.*
4. *If in a S.W. receiver circuit you saw that the cathode bias resistor of a H.F. valve was by-passed by both a 50-mfd. electrolytic and a .002 mfd. mica condenser, how would you explain the presence of the two condensers in parallel?*
5. *State briefly the essentials of a band-pass filter, and draw the circuits of four different types of band-pass coupling.*
6. *How does the anode load of a valve affect the voltage amplification obtained?*

What would be the voltage amplification provided by an R.C.-coupled valve of 30,000 ohms internal resistance and amplification factor (μ) 40 if the anode resistor had a value of (a) 20,000 ohms; (b) 60,000 ohms.

1. Tracing a Receiver Fault

SINCE the receiver was completely "dead," it would be logical to start testing from the L.F. or output end. The reason for this is that if the output and speaker circuits were operative there would at least be a faint "background" noise from the speaker, and a "click" when the H.T. supply was connected and disconnected. This assumes that the H.T. and L.T. supplies are in good condition, and it can be taken that they have already been checked.

As a further test it would be a good plan to remove and replace the negative H.T. wander plug with the set switched on to make quite sure that there is no audible noise from the speaker. If another speaker or a pair of phones were available, the next step would be to connect one of these as a check on the original speaker. Should the receiver operate correctly with the new reproducing device, the leads to the normal speaker would be checked for continuity before blaming the speaker itself.

Should there be no change when using the spare speaker or phones, and assuming the connections to be sound, the output valve would next become suspect. If a new one of suitable type could be used as a temporary replacement, that would give a check on the original valve. Failing a replacement, it might be possible to transfer a previous L.F. or detector valve to the output position—suitably adjusting the bias voltage. If the speaker then showed signs of "life" when removing the H.T. negative wander plug, it would be reasonable to suppose that the output valve was faulty. It should be noted that signals would not be received when making this test—merely "clicks" when breaking and making the H.T. circuit.

Should the set still appear "dead" the H.T. circuit from the H.T. wander plug to the anode socket of the valve holder should be carefully traced through and examined; the same test should be made in the screening-grid circuit of a pentode. If a voltmeter were to hand, this test could be simplified by checking for voltage between the earth line and the anode and screening-grid sockets.

2. The Miller Effect

In very simple terms, the Miller Effect is the apparent capacity between the cathode and grid of a valve which is, in fact, due to the grid-anode capacity. It was discovered by Miller that the effective capacity between the cathode and grid is much higher than the actual capacity between these two electrodes. This "image" capacity is actually equal to the grid-anode capacity multiplied by (1 + V.A.F.), where V.A.F. is the voltage amplification of the valve.

The meaning of voltage amplification is more fully explained in the answer to Question 6.

Although the apparent of "reflected" capacity cannot very easily be measured, it is not difficult to prove that it exists, and use is made of this capacity in certain circuit arrangements.

3. Electric and Magnetic Waves

All radiated wireless waves consist of electrical and magnetic components. It is known that an aerial has capacity to earth, and it will be remembered that there are electrical lines of force between the plates of a condenser. Thus, with a vertical aerial, for example, there are more or less vertical electrical lines of force, as shown in Fig. 1. These lines tend to diverge when they leave the aerial, but after that they go fairly directly to earth; the aerial forms one plate, and earth the other, of a condenser. On each half-cycle the lines build up and collapse. This process continues as long as the aerial is fed with H.F. energy, and the waves radiate in all directions around the aerial.

In addition to these electrical lines there are magnetic lines, just like those which form round a coil carrying alternating or pulsating current. These lines are circular, in the form of rings round the aerial wire. These also build up and collapse at each half cycle, and are radiated.

It will be seen that the electric lines are in a vertical plane, and that the magnetic lines are in a horizontal plane. Another way of expressing this is that the electric radiation is vertically polarised, and the magnetic radiation horizontally polarised. The two go together, giving rise to what are popularly known as electromagnetic waves.

4. Double By-passing

Of the two by-pass condensers referred to in the question, the electrolytic condenser serves to by-pass

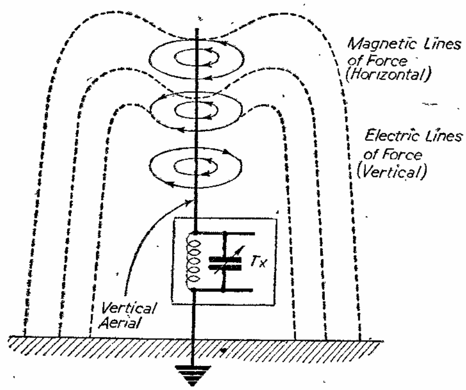


Fig. 1.—A simple diagram which shows the two components of an electro-magnetic wave as radiated by the aerial of a transmitter.

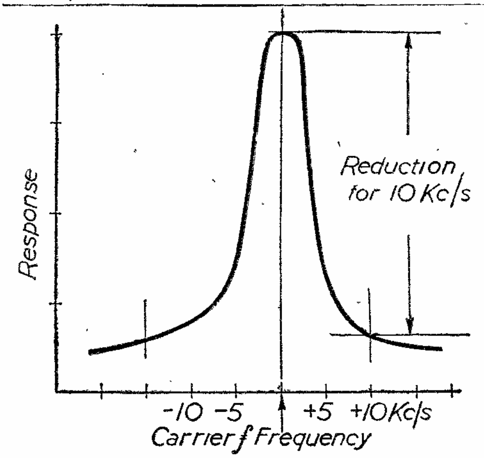


Fig. 2.—The "peaky" response curve for a highly-selective single-circuit tuner.

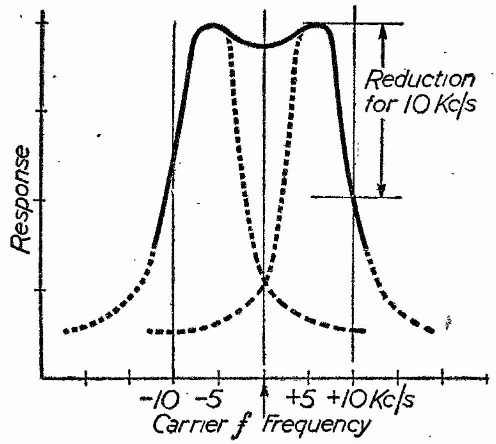


Fig. 3.—The type of response curve obtained by using a band-pass filter. Compare with Fig. 2.

low-frequency current, and ripples in the supply. But this type of condenser has a high reactance to H.F. currents, especially those of such frequencies as are encountered in a short-wave receiver. This is partly due to the form of construction employed for electrolytic condensers, and partly because condensers of this type are polarised; that is, they have positive and negative terminals.

And although the reactance of a .002 mfd. condenser is appreciably higher than that of a 50 mfd. condenser (25,000 times higher, in fact), this does not apply at high frequencies, and where an electrolytic condenser is concerned. It might well be that a .002 mfd. mica condenser—which is virtually non-inductive—would have a reactance several thousand times smaller than the 50 mfd. electrolytic at the frequencies employed in a U.S.W. (ultra short-wave) receiver. As a matter of interest, the reactance of a .002-mfd. condenser to a frequency of 30 megacycles, which corresponds to 10 metres, is only about 2.5 ohms.

The object of a band-pass filter, as the name suggests, is to allow the passage of a band of frequencies. We know, for example, that for reception of frequencies up to 10,000 cycles the tuning circuits must not only respond to the transmitted carrier-wave frequency but to this frequency plus and minus the two side-bands.

For selectivity, the tuning circuits must give a sharp cut-off. And if we use a single-circuit tuner of high selectivity we get a very "peaky" response curve, as shown in Fig. 2. It will be seen, however, that the response given to frequencies slightly higher or lower than the transmitter frequency is very small. But if we combine two such tuning circuits, and arrange that the peak of one is slightly displaced from the peak of the other, we obtain what is virtually a flat-topped response curve, as illustrated in Fig. 3.

It is this combination which is referred to as a band-pass filter. Fig. 4 shows four different forms of band-pass circuit. The first of these employs "top-capacity" coupling, there being a small condenser between the high-potential ends of the two "peaky" tuning circuits. In the second, use is made of "bottom-capacity" coupling, the condenser in this case having a fairly high capacity, of the order shown in Fig. 4. In the third arrangement inductive coupling is used between the two tuned circuits, and in the fourth we have a combination of inductive and bottom-capacitative coupling. This is known as link-circuit coupling.

In general it is true to state that the higher the anode load resistance the greater is the voltage amplification provided by the valve stage. It is obvious that there must be a practical limit to the value of the anode load resistance, because if it becomes too high it will seriously reduce the voltage actually applied to the anode.

The formula governing the voltage amplification of a valve is: V.F. or V.A.F. (voltage amplification factor) =

$$\frac{\mu R}{R + R_a} \quad \frac{\text{(amplification factor of the valve times anode load resistance)}}{\text{(anode load resistance plus valve internal resistance).}}$$

Applying this formula to the second part of the question:

we have (a) $\frac{40 \times 20{,}000}{20{,}000 + 30{,}000}$, which is 16,

(b) $\frac{40 \times 60{,}000}{60{,}000 + 30{,}000}$, which is approximately 26.5.

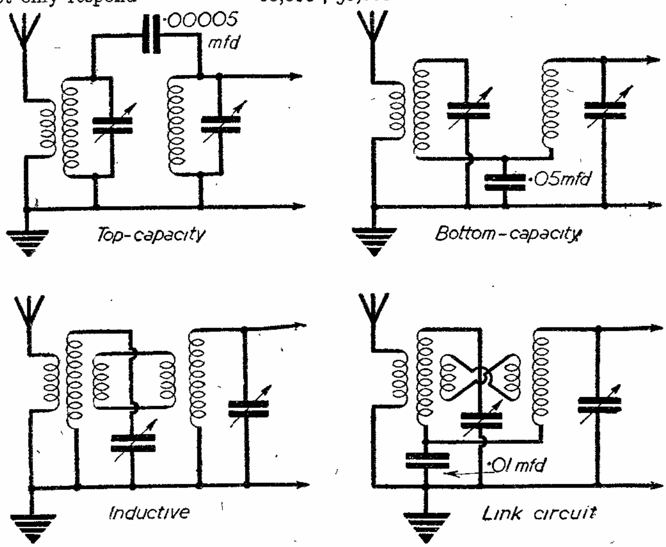


Fig. 4.—Four types of band-pass coupling referred to in the answer to question 5.

Permanent Magnets—IV

Heat-treatment of Cobalt Steel : Cast and Forged Magnets.

By L. SANDERSON

(*Continued from page 251, May issue.*)

OF the cobalt steels for permanent magnets, there are two air-hardening steels, one containing 9 per cent. cobalt, and both containing approximately 1 per cent. carbon, 9 per cent. chromium and 1.5 per cent. molybdenum. It is necessary, in order to obtain the best results, to give these steels a triple heat-treatment, namely: (a) air cool from 1,150 deg. C. to 1,200 deg. C.; (b) reheat to 750 deg. C. and air cool; (c) reheat to 970 deg. C. and air cool until magnetic, and then quench in oil.

The BH(max.) values obtained from these two steels are not less than 500,000 for the 9 per cent., and not less than 650,000 for the 15 per cent. cobalt.

Heat-treatment of Cobalt Steels

The oil hardening cobalt steel contains 35 per cent. cobalt, with 5 to 6 per cent. chromium, 4 per cent. tungsten, and 0.9 per cent. carbon. Here again the best results are obtained in theory by subjecting the steel to a triple heat-treatment, namely: (a) air cool from 1,150 deg. C. to 1,200 deg. C.; (b) reheat to 750 deg. C. and air cool; (c) quench in thin oil from 950 deg. C. In practice, with this material, however, it rarely pays to carry out these three treatments, and it is sufficient to give the steel the hardening treatment (c) only.

It is important that the heating to 950 deg. C. should not be prolonged. Soaking of the steel at this temperature gives poor magnetic results. This steel gives BH(max.) values of from 900,000 to 1,000,000.

The existence of an alloy having such high magnetic values as this made it possible to use permanent magnets on certain classes of apparatus for which, owing to considerations of size and weight, they were not practicable.

The curves, Fig. 1, show at a glance the comparison between the magnetic values of the old tungsten and the new cobalt steels. The tungsten has a high B_{rem} combined with a low coercive force and the cobalt steels have lower B_{rem}, but very much higher coercive force values. The tungsten steel should be compared with the 35 per cent. cobalt alloy. The B_{rem} of the tungsten steel is about 5/4ths that of the cobalt alloy, but its coercive force is only one quarter, so that in order to make a magnet from each of these steels capable of giving the same amount of energy, the one made from 35 per cent. cobalt steel would have to have a cross sectional area equivalent to 5/4ths of that of the tungsten, but it would only be necessary for it to have about a quarter of its length.

It must be noted that bars of the high cobalt steels cannot be supplied heat-treated because of the hardness and brittleness of the material in this condition.

Why 35% Cobalt Steel Needs Only One Treatment

We have written above that with the 35 per cent. cobalt steel it is inadvisable to use all three treatments. The reason is this. The BH(max.) is slightly superior after the three treatments than it would be after a single hardening in oil. The advantage of the three treatments is most marked when it has been necessary to anneal the steel well in order to be able to machine it. The result of heating up to 1,200 deg. C. is to put the steel back into its normal condition, and to remove the harmful effects of annealing. However, while with air-hardening steel containing 9–16 per cent. cobalt, it is very necessary to give the three treatments in order to obtain the best possible results from the magnetic point of view, with 35 per cent. cobalt steel, the advantages obtained by the three treatments are usually not sufficiently marked to justify the necessary labour, except in special instances where the steel has been submitted to extremely prolonged annealing for the purpose of softening it as much as possible for machining. In these instances, treatment at high temperature restores the magnetic properties of the steel.

The 35 per cent. cobalt steel is usually supplied in the annealed condition, but even after being annealed it is still fairly hard, though machinable. Sawing for magnet manufacture is best done with a hacksaw or a small toothed circular saw. Many manufacturers use a "Radiac" emery wheel cutting-off machine for cutting the bars up to the necessary lengths. If any bending or forming is required, this must be done hot, the steel being heated up to 1,050–1,150 deg. C. for this operation. After this, if any machining is necessary, the magnet must be first softened by heating up to 750 deg. C., and either cooled slowly in the furnace or withdrawn and cooled on the floor.

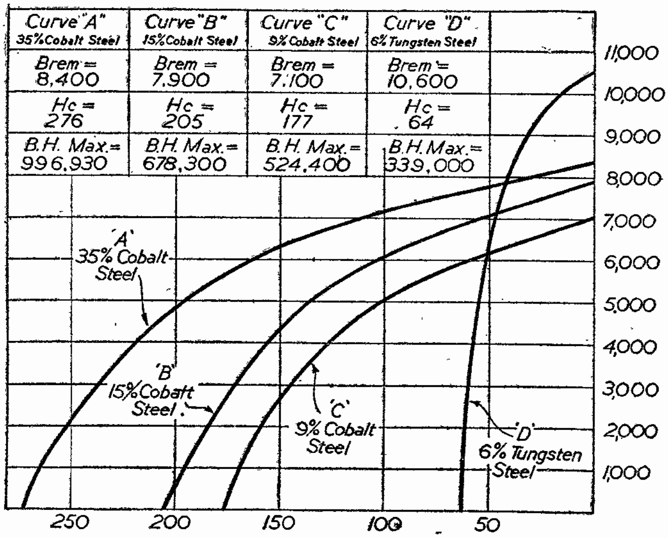


Fig. 1.—Curve showing magnetic values of tungsten and cobalt steels.

Final Hardening

For the final hardening, the furnace should be at a temperature between 970–1,000 deg. C. The magnets should be put in the furnace and watched. When they are nearly heated through, it is advisable to raise the furnace door slightly. In this way the point at which the carbides all go into solid solution can clearly be seen. The magnets absorb heat slowly at first, then quickly reach the temperature of the furnace. As soon as this point is reached, they should be withdrawn from the furnace and quenched right out in cool, thin oil. If any tapping is to be done on this steel, it will, perhaps, be helpful if the hole is drilled slightly larger than would usually be the case, so that not quite a full thread is obtained.

In regard to magnetisation, it must be remembered that as cobalt steel retains considerably more energy than tungsten steel, a larger magnetising force is necessary. In general, a value of H not less than 1,200 should be employed. The expression for calculating the number of turns on coil, current, etc., is as follows:

$$H=\frac{4}{10}\times\frac{IS}{L}$$

where H is the magnetising force, I the current in amperes, S the number of turns, and L the length of solenoid.

Bar Magnet for Loudspeaker

An interesting landmark in magnet history was the introduction for the first time by Messrs. Graham Amplion, Ltd., of a plain, short, straight bar magnet in place of the usual horseshoe or similar shaped magnet for radio loud speakers. This, of course, was all wrong according to the textbooks, but was nevertheless perfectly successful, and it enabled a loudspeaker to be marketed at the extraordinarily low price for that period (1930) of one guinea.

The trouble with short bar magnets is that they are difficult to magnetise and are supposed to lose their magnetism early, but being of 35 per cent. cobalt steel, these bar magnets retained their strength, partly because of the high quality of the magnet steel, and partly because of the design, which ensured a nearly closed magnetic path during the entire life of the instrument.

The unit itself consisted of a smooth die-casting upon which was mounted the bar magnet, together with the mild steel connecting yoke that carried the vibrating armature or reed. At the other end of the magnet was clamped a single laminated pole piece carrying the operating bobbin. The reed was so mounted that it tended to spring away from the pole piece, and was prevented from doing so by a stiff, helical spring, the tension of which was varied by means of an adjustment at the back of the speaker. The adjusting screw, which was operated by the user, carried a slot designed to take the edge of a penny. The adjusting spring was connected to the centre of the reed by a short screw, which was extended to form the operating rod, the function of which was to convey acoustic vibration from the reed to the cone. The top of the rod passed through a diminutive chuck in the centre of the cone, and it was clamped by screwing up the chuck when set in the correct position. The movement was mounted at the centre of three radiating arms, which were formed integrally with the bakelite rim, and one of these arms carried the two terminals. Between the unit and the supporting arms there was interposed a circular disc of light material finished in bronze. This served the purpose of concealing the "works," and also, in some manner not fully understood, definitely improved the performance of the speaker.

Obtaining Full Magnetic Values

It is useful to know how large in diameter a magnet steel of the cobalt type can be treated so as to get full magnetic values clear into the centre. Nine per cent. and 16 per cent. cobalt magnet steel of $\frac{5}{8}$in. and $\frac{7}{8}$in. round in lengths of about $4\frac{1}{2}$in. can be heat-treated satisfactorily to give full magnetic values; 35 per cent. cobalt steel would, however, only give full magnetic values if no point in the bar were more than, say, 9mm. from the surface for round bars and 7mm. for flat bars. The cost of finished magnets of these steels depends largely on the design required. In many instances the cost of the finished magnet far exceeds the cost of the material. It is possible to obtain these steels in half-round sections, but all would depend on the amount required, as in all probability special rolls would have to be put in to obtain the necessary half-round section, and no steel manufacturer would be anxious to do this in wartime. Cobalt magnet steels are less sensitive to grinding cracks than are the chromium or tungsten magnet steels. No detriment is caused to the steels by being cut off with an abrasive wheel.

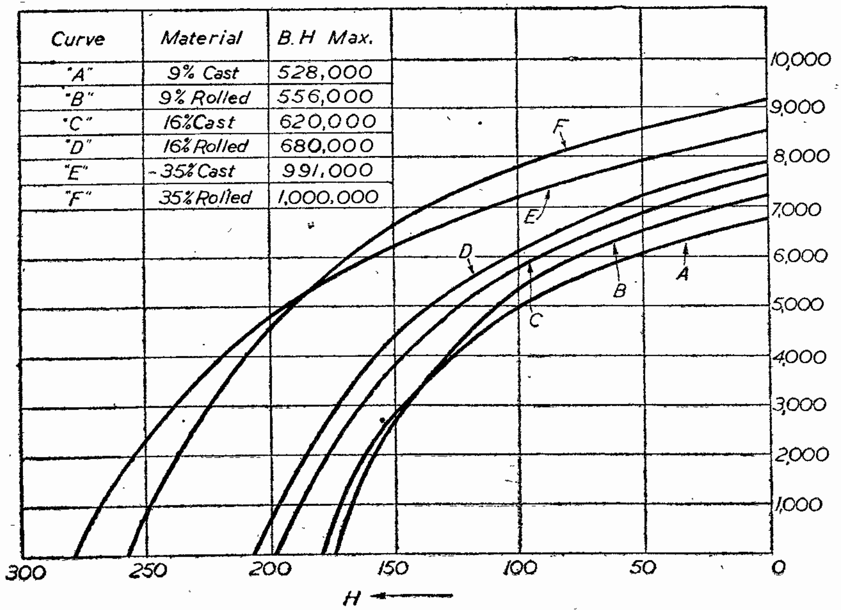


Fig. 2.—Demagnetising curves of cobalt steels in the cast and forged condition.

Cobalt super high-speed steels are definitely better than tungsten carbide for machining these steels, and they can, and should be, used for all three qualities of cobalt magnet steel. The machinability of these steels, incidentally, has no relation to their Brinell or Rockwell hardness.

Cost of Magnetic Energy

The cost of maintaining a certain magnetic energy is the sum of two quantities: (a) the cost of the magnet; (b) the cost of housing the magnet. The relative costs largely depend on the type of apparatus in which the magnet is used. In some instances the dimensions of the apparatus as a whole are determined by the dimensions of the magnet, so that a reduction in magnet dimensions may effect a considerable saving. In other instances, a reduction in the size of the magnet would not enable any reduction to be made in the size, and, consequently, the cost of the apparatus.

The ordinary moving coil instrument may be taken as an example. The dimensions of the case are generally governed by the necessity of providing an open scale, so that no reduction in overall dimensions could be effected by the use of a smaller magnet. In the case of a magneto the magnet used governs the size and shape of the machine, so that any reduction in the size of the magnet should bring about a corresponding reduction in the cost of housing it. Furthermore, an important point is not only the reduction in the size of the machine, but the reduction in weight. In some instances the results obtained from machines using 35 per cent. cobalt steel, and the still newer magnet alloys, could be obtained in no other way.

Cast or Forged Magnets?

In regard to the relative merits of cast and forged cobalt steel magnets an expert opinion is that with the lower cobalt chromium steels it is not possible to obtain such good magnetic results from cast magnets as from forged, and, moreover, the higher the cobalt content the greater the discrepancy between the magnetic results obtained from forged material and those obtained from cast material. It is not considered economical to make cast magnets from 16 per cent. cobalt steel. With the 35 per cent. cobalt steel cast magnets can, however, be produced with magnetic properties as good as, and sometimes better than, those of forged magnets.

Fig. 2 shows the demagnetisation curves of the three most widely used cobalt steels in the cast and forged condition. All the test pieces used were 5cms. × 0.9cms. With the 9 per cent. and 16 per cent. cobalt, the BH(max.) figures of 528,000 and 620,000, respectively, were not average figures, but the best that could be obtained. For average figures they were in the neighbourhood of 500,000 and 600,000. It will be seen that the BH(max.) figures for forged and cast 36 per cent. magnet steels are very close to one another. In general, higher remanence figures are obtained from forged than from cast magnets, and vice versa for coercive force. The probable explanation advanced is that with the cobalt chromium steels the "as cast" condition has a cored structure, which is extremely persistent, and difficult, if not impossible, to eliminate except by hot work. In consequence, conditions give rise to low remanence figures.

With the 35 per cent. material the same type of microstructure is not obtained as in the "as cast" condition. There is no heavy coring, and a quite short annealing at 750 deg. C. is all that is necessary. This small amount of annealing is necessary, as apart from the dangers of hardening a casting without its having been previously annealed, a definite improvement in the ultimate magnetic properties is thereby effected.

(To be continued.)

ITEMS OF INTEREST

Flash Lamp Bulbs Maximum Price Order

THE Board of Trade, after consultation with the Central Price Regulation Committee, have made an Order under the Goods and Services (Price Control) Act fixing the maximum price for flash lamp bulbs on sale to wholesalers, to retailers and to the public. The Order covers all types of bulb designed for use in battery lamps and torches, except those for police lamps, motor-car lamps and radio sets.

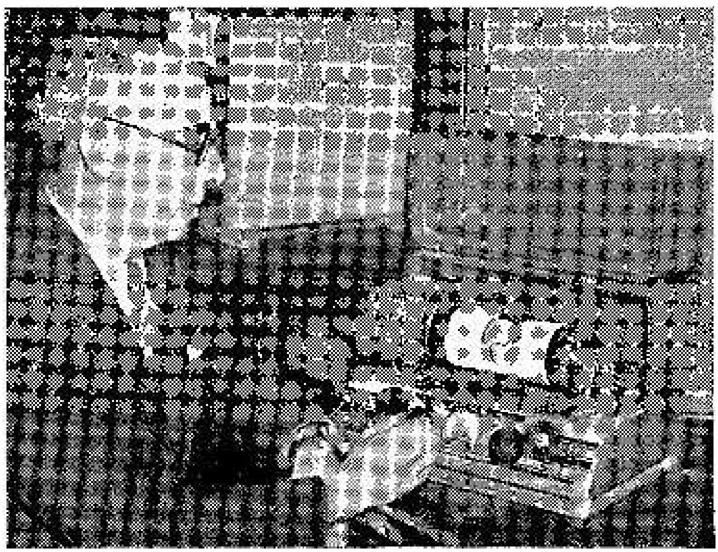
The retailers' margin will be $33\frac{1}{3}$ per cent. on returns, excluding purchase tax; and the wholesalers' margin will be 20 per cent. on returns. But the price to the public set out in the schedule to the Order includes purchase tax.

Prices have been divided into three groups, according to the origin of the flash lamp bulbs. The maximum retail price of the ordinary non-focusing bulb of 2.5 or 3.5 volts and 0.2 or 0.3 amps will be $5\frac{1}{2}$d. if of American or Canadian origin; $3\frac{1}{2}$d. if of British manufacture; for bulbs imported from elsewhere the maximum retail price will be $3\frac{1}{4}$d. each until June 30th, 1943, in order to allow time for the disposal of stocks bought at high prices; but *on and after July 1st*, 1943 the maximum retail price will be $2\frac{1}{2}$d. each.

The corresponding wholesale prices will be, for American or Canadian flash lamp bulbs, 25s. per 100; for those of British manufacture, 16s. 8d. per 100; and for those imported from elsewhere, 15s. 3d. per 100 until April 30th, 1943, *but 11s. 1d. per 100 thereafter.*

Where quantity discounts have been allowed on British produced flash lamp bulbs by manufacturers or wholesalers to particular customers within the last three months, they will be required by the Order to continue this practice.

The Order (S.R. & O., 1943, No. 247) came into force on April 26th, 1943; copies of it may be obtained, price 2d., through any bookseller or newsagent, or direct from H.M. Stationery Office, Kingsway, London, W.C.2.



A picture being transmitted by radio to Cairo, by Cable and Wireless, Ltd.

More Radio Plays

THERE is a marked increase in the interest taken by the public in broadcast plays. In July, 1941, listeners to plays represented 20 per cent. of the wireless audience. The figure has now risen to 31 per cent.

To meet this rapidly widening interest the Drama Department is to put more plays on the air. The range will provide for the tastes of all classes of theatre-lovers.

Alternating Current

A Survey of A.C. Theory and Its Application to Radio Engineering. By S. A. KNIGHT

Useful Trigonometrical Formulæ

1. $Sin^2 A + cos^2 A = 1$
2. $Sin (A+B) = sin A cos B + cos A sin B$
   $Sin (A-B) = sin A cos B - cos A sin B$
   $Sin 2A = 2 sin A cos B$
3. $Cos (A+B) = cos A cos B - sin A sin B$
   $Cos (A-B) = cos A cos B + sin A sin B$
   $Cos 2A = cos^2 A - sin^2 A$
   $= 2 cos^2 A - 1$
   $= 1 - 2 sin^2 A$
4. $Sin A + sin B = 2 sin \frac{1}{2} (A+B) cos \frac{1}{2} (A-B)$

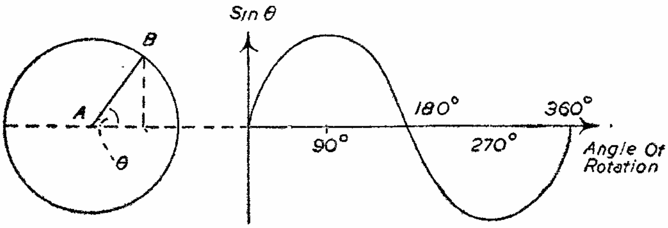


Fig. 1.—Tracing a sine curve made by the rotating arm AB.

Alternating Current

A GREAT many, it seems, while knowing their D.C. theory very well, fail to understand fully the theory of A.C., particularly in its application to radio circuits. Others, no doubt, would like a refresher on the subject. While, obviously, plain, straightforward D.C. knowledge is essential it must be remembered that it is the A.C. components of current and voltage which really matter in any radio design, and a good knowledge of the subject is as essential—if not more so—as the D.C. outlook. D.C. potentials are merely applied to make the functioning of valves and the like a practical possibility, the A.C. being the thing which—in effect—delivers the goods.

Any current which is constantly changing in direction is known as an alternating current, and if the variations and fluctuations occurring during a certain fixed period of time are plotted graphically along a time scale, a graph is obtained which is known as an A.C. waveform.

This waveform may be in the form of a pure sine wave or it may be as complex as can be imagined. If it is a sinsuoidal waveform then the matter can be dealt with quite simply by straightforward mathematical methods, and in the theory of alternating current it is assumed that all p.d's and currents are of a sinsuoidal nature. The theory can be extended to cover more complex waveforms, since any alternating current, however confused seeming, can be represented as a number of sine waves, but in the present article it will be assumed that all currents are of a sinsuoidal nature.

Consider first the sine curve of Fig. 1. The perpendicular dropped from the end of the unit rotating arm AB has a length which is equal to *sin θ*. If this value is plotted against the angle of rotation the sine curve depicted is obtained.

If now a rotating arm of magnitude $\hat{\imath}$ and angular velocity ω radians per second is considered as in Fig. 2, the following results are obtained:

The angle traced out in t secs $= \omega t$ radians

From the figure $i = \hat{\imath} \sin \omega t$

One complete cycle occurs in $2/$ seconds

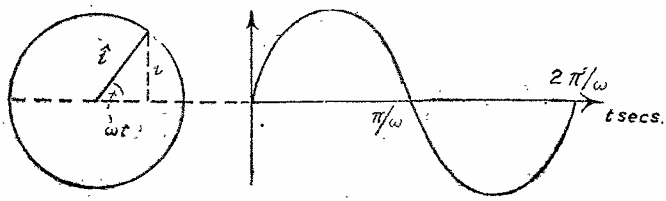


Fig. 2.—A rotating vector.

∴ Frequency = the number of complete cycles per sec.
$= \omega / 2\pi$

The above equation for the current can be re-written in this way:

$$i = \hat{\imath} \sin 2\pi f.t.$$

where $\hat{\imath}$ is the *peak* value of the current and i is the *instantaneous* value of the current.

Measurement of A.C.

There are three possible methods of doing this:—
(i) The Mean Half Cycle ($\bar{\imath}$)
(ii) The Crest Method ($\hat{\imath}$)
(iii) The R.M.S. Value (I)

1. The Mean Half Cycle

Instruments used for the measurements of the Mean half cycle value of A.C. are of the moving-coil type, in which a deflection of the needle is proportional to the current at any instant.

The average value of any sine wave over a complete cycle is zero, consequently in using such a measuring device the negative half-cycles must be suppressed or the current rectified so that the flow through the meter is always in the same direction.

2. The Crest Method

This is generally measured by such instruments as the valve voltmeter or the cathode ray tube.

3. The Root Mean Square Method

The types of instruments used in this case are of the hot wire or the moving iron variety, in which the deflection is equal to the square of the current.

In Fig. 3 a graph is plotted of $i = \hat{\imath} \sin \omega t$, and also by squaring the values for i a graph is drawn of $i^2 = \hat{\imath}^2 \sin^2 \omega t$.

The i^2 curve is seen to be a pure sine wave, moved through a quarter-cycle whose average value is $\hat{\imath}^2/_2$.

Consequently R.M.S. current $= \sqrt{\hat{\imath}^2/_2}$
$= \hat{\imath}/2 = 0.707\hat{\imath}$

∴ R.M.S. current = 0.707 crest current.

Similarly crest current = 1.414 R.M.S. current.

This result can be shown mathematically in this way:

$i = \hat{\imath} \sin \omega t$
$= i^2 = \hat{\imath}^2 \sin^2 \omega t$
Now $\sin^2 A = \frac{1}{2} (1 - \cos 2A)$
∴ $i^2 = \frac{1}{2} (1 - \cos 2 \omega t)$
$= \hat{\imath}^2/_2 - \hat{\imath}^2/_2 \cos 2 \omega t$

Now consider the mean value of this expression over a complete cycle:
(i) $\hat{\imath}^2/_2$ is a constant
(ii) $\hat{\imath}^2/_2 \cos 2 \omega t$ has a frequency which is twice the original, and over a complete cycle has an average value of zero.

∴ mean $i^2 = \hat{\imath}^2/_2$
∴ R.M.S. $= \sqrt{\hat{\imath}^2/_2}$

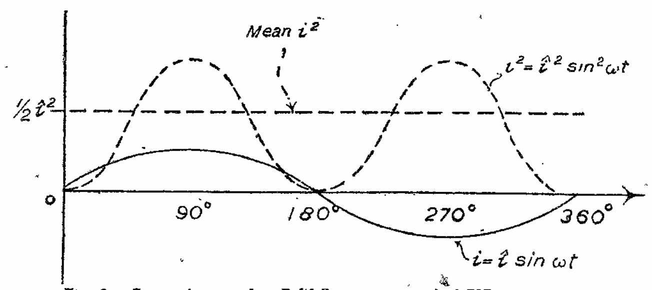


Fig. 3.—Curve showing that R.M.S. current equals 0.707 crest current.

Vector Representation

Consider Fig. 4, where two fixed arms of length A and B are rigidly attached together and are rotating in an anti-clockwise direction about the point P. Now, starting with arm A, assume that at the commencement of its rotation it is lying along the horizontal axis P_Q, and that during one complete revolution a curve is plotted to show how the length of the perpendicular dropped from the end of this arm varies with the time or angle turned through.

The result is, of course, the full line sine curve drawn on the diagram, where the maximum amplitude is seen to be equal to the length of A, and the frequency to be f cycles per second.

If now arm B is similarly considered, another sine curve can be plotted of the variations of the perpendicular dropped from the end of this arm to the horizontal P_Q, and this second curve is shown dotted in the diagram. As previously, this curve has a maximum amplitude equal to the length of the arm BP and a frequency again of f cycles per second.

It will now be seen that two curves have been obtained which have the same frequency in c.p.s. though occupying different positions along the time axis. In terms of this time axis, it is apparent that the second, or dotted, curve is always a certain distance behind the full line curve, since it reaches its maximum and zero positions a fraction of time after the full curve has reached its own corresponding positions of maximum and zero.

We say, therefore, that the two curves are in an out-of-phase condition and that the full curve always leads the dotted curve along the horizontal axis. When two curves reach their maximum and zero positions in the same instant of time they are said to be in phase; such a condition is shown later in Fig. 5. The statement that the full curve leads the dotted curve is consistent with the fact that the rotating arm A always leads the arm B by a fixed amount, in the figure by an angle ϕ.

Now, as most readers will realise, that merely to say that the full curve leads by a fraction of time the dotted curve is in a way incorrect. Such a lead in time will, of course, be a variable quantity with frequency, that is, if the speed of the rotating arms is doubled the time difference between the two sine curves will be halved. This difficulty is overcome, however, if the horizontal axis is considered in terms of the angle of rotation rather than the time occupied by the rotation; this angle is a constant for the two curves whatever the speed of rotation or frequency may be, and so this angle is employed to express the phase difference between the two waves. A study of Fig. 4 will show that the amount by which the full curve leads the dotted one is given by the angle ϕ; the angle of lead is therefore said to be equal to ϕ.

A problem now arises when we come to consider what will happen if it becomes necessary to add together the two sine curves already drawn. In D.C. we know that the sum of two currents flowing in a circuit will give us a third current; similarly with A.C. the sum of two currents will give a third, but the process of obtaining it is clearly not the simple one of arithmetical addition as it is for D.C. An obvious method of achieving the result is to add, point by point, along the graph the values of the two sine waves to give us the resultant third wave, but this method is cumbersome and tedious and has obvious limitations.

However, the problem is capable of a much easier solution. It is possible to show that if the two rotating arms are considered as vector quantities, and these are added vectorially by completing the parallelogram (parallelogram of forces), then the resultant, given by the line PC, is equivalent to a single rotating arm which will produce a sine curve representing the sum of the first two sine curves.

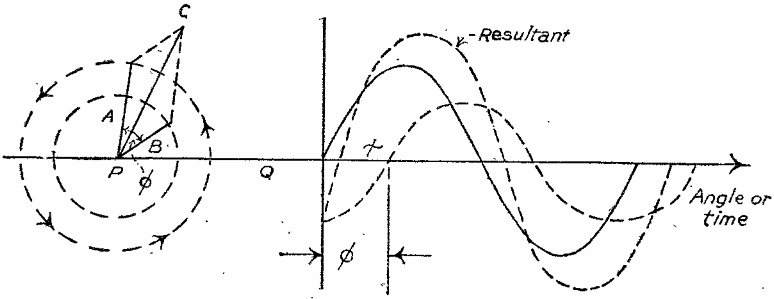


Fig. 4.—The representation of sine curves of different phase by rotating vectors.

In the figure this curve is drawn dashed; its maximum amplitude will be seen to be equal to the length of the resultant arm PC, and the angle by which it leads the dotted curve—arm B—is given by the angle $\propto$ This is an important result.

Therefore we know that any sinsuoidal alternating quantity may be represented as a rotating vector and that any number of sine curves of the *same* frequency may be added together simply by adding the vectors representing them. These vectors must, of course, be drawn such that the angle between them is equal to the phase angle between the sinsuoidal quantities, and also that the various vectors lead or lag on what is known as the Reference vector. This latter is better understood by referring again to Fig. 4. When we say that the full curve leads on the dotted curve by an angle ϕ, we would be equally correct in saying that the dotted curve lags on the full curve by the same angle ϕ. One sine curve lags on another when its maximum and zero positions are reached a fraction of time behind that of the other sine curve's maxima and zero positions, and the vector representation of the curve is behind that of the vector representation of the other curve.

(To be continued.)

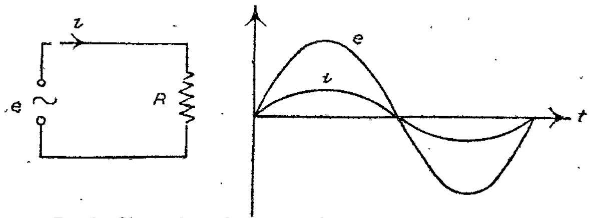


Fig. 5.—Phase relation between e and i in a purely resistive circuit.

REDUCED SURFACE LOSSES

IT is well known that high frequencies travel on the surface of a conductor, and in certain short-wave apparatus the coils and some other components are silver-plated to ensure high conductivity which will not be marred by oxidation. In some cases experimenters have attempted to obtain the desired effects by using ordinary brass or copper components and polishing with a chromium "plater" or similar liquid artificial plating chemical. The majority of these chemicals are, however, mercury in solution, and although when first applied they may fulfil the desired purpose, there is a risk of deleterious chemical action at a later date which will be worse than the trouble which it is intended to overcome. A better plan is to clean the parts very thoroughly and then paint with clear lacquer or celluloid in solution to prevent oxidation.

LUBRICATION

MANY moving parts in modern receivers are employed as conducting paths and thus in addition to good contact between the adjacent surfaces, it is essential to keep them clean and free from foreign matter. Switches, for instance, are a typical instance of a moving contact surface, and many amateurs clean these periodically by rubbing with emery or fine sandpaper. While this may be in order in some cases, the metal dust which is thereby obtained may find its way into some place where it will introduce trouble and the procedure is not therefore ideal. Special chemical cleaners are available for the purpose, and these should be used. Where lubrication is necessary colloidal graphite is a very good material to use, but it should be applied sparingly.

PRIZE PROBLEMS

Problem No. 444

JOHNSON built a three-pentode battery receiver using resistance-capacity coupling between the detector and output valves, with 72 volts on the screens of the H.F. pentodes and 120 volts on the screen of the L.F. pentode. Why were results unsatisfactory?

Three books will be awarded for the first three correct solutions opened. Entries should be addressed to The Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Envelopes must be marked Problem No. 444 in the top left-hand corner, and must be posted to reach this office not later than the first post on Monday, May 17th, 1943.

Solution to Problem No. 443

When Jones modified the wiring of his set he overlooked the fact that he had left the earthy-end of the wave-change switch still connected with the earth line. When, therefore, he used the medium wave-band the wave-change switch was closed and the moving arm of the potentiometer was short-circuited to earth, thus rendering the control inoperative.

Three readers successfully solved Problem No. 442, and books have accordingly been forwarded to them: R. S. Moore, 26, Chester Road, Akroydon, Halifax; K. Lewis, 105, Evington Road, Leicester; and D. Byrne, Sutton Bridge, Spalding, Lincs.

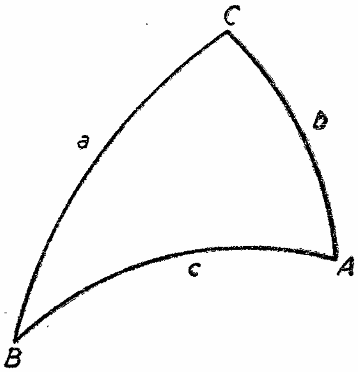
Directional Reception

Its Relation to Navigation

WHEN considering directional transmission and reception of radio signals, it must be remembered that electro-magnetic waves take the shortest path between two stations.

Thus, for maximum response in a receiver, the aerial must lie along the Great Circle path connecting the transmitter and receiver. Any deviation from this rule will result in a falling-off in performance.

Briefly, a Great Circle may be defined as "a circle on the surface of a sphere (e.g., the earth) whose *plane* passes through the centre of the sphere. [*Not strictly correct.*—ED.] It will thus be seen that the equator and



Spherical Triangle.

all the meridians are Great Circles, but that other parallels of latitude are not.

Taking the direction of two places from a Mercator's Projection can be very misleading. For instance, the direction of New York from London taken from a Mercator's Projection is S. 70° W. (approximate), whereas it will be shown that the direction of a Great Circle path from London to New York is N. 70° W., a difference of 40°.

An aerial array lined up along a bearing of S. 70° W. for perhaps an experimental pick-up of New York or other U.S.A. stations would result in inferior reception compared with one directed N. 70° W.

Calculation of Great Circle Bearings

In order to calculate the Great Circle bearing between two places it is necessary to consider them as being the two extreme points at the base of a triangle, the apex of which is the North Pole.

The three sides of the triangle will be (1) the distance from point A to the Pole, (2) the distance from point B to the Pole, and (3) the distance along the Great Circle arc between A and B.

In the figure, denoting the Pole by C, the angle we wish to find is the angle CAB.

When dealing with spherical triangles such as this, it must be borne in mind that the sides are measured in degrees, as they are themselves arcs of Great Circles, and not straight lines.

As the equator is at all points 90 deg. from the Pole, the angular distances CA and CB can easily be found by subtracting the latitudes of the places concerned from 90 deg.

It is also necessary to know the angle BCA, which is obviously merely the sum or difference of the longitudes of the places concerned, depending on whether they are on the same or different sides of the meridian of Greenwich.

Having found the two sides and the included angle as above, the angle CAB, which we will call "A," is calculated from the following formulæ:

$$\tan\frac{A+B}{2} = \frac{\cos\frac{a-b}{2}}{\cos\frac{a+b}{2}} \times \cot\frac{C}{2}$$

$$\text{and } \tan\frac{A-B}{2} = \frac{\sin\frac{a-b}{2}}{\sin\frac{a+b}{2}} \times \cot\frac{C}{2}$$

Thus, to find the Great Circle bearing of New York from London, we proceed as follows:

New York = lat. 43° N. $\therefore a = 90° - 43° = 47°$

London = lat. $51\frac{1}{2}$° N. $\therefore b = 90° - 51\frac{1}{2}° = 38\frac{1}{2}°$

New York = long. 73° W.

London = long. 0° $\therefore c = 73° \quad \frac{C}{2} = 36\frac{1}{2}°$

$$\frac{a+b}{2} = \frac{85\frac{1}{2}°}{2} = 42°\ 45'. \quad \frac{a-b}{2} = \frac{8\frac{1}{2}°}{2} = 4°\ 15'$$

For $\tan\frac{A+B}{2}$

$\frac{a-b}{2} = 4°\ 15' = \log\cos\ \bar{1}.9988$

$\frac{a+b}{2} = 42°\ 45' = \log\cos\ \bar{1}.8659$

(subtract) $= 0.1329$

$\frac{c}{2} = 36°\ 30' = \log\cot\ 0.1308$

$\log\tan\frac{A+B}{2} = 0.2637$

$\therefore \frac{A+B}{2} = 61°\ 25'$

For $\tan\frac{A-B}{2}$

$\log\sin\frac{a-b}{2} = \bar{2}.8698$

$\log\sin\frac{a+b}{2} = \bar{1}.8317$

(subtract) $= \bar{1}.0381$

$\log\cot\frac{C}{2} = 0.1308$

$\log\tan\frac{A-B}{2} = \bar{1}.1689$

$\therefore \frac{A-B}{2} = 8°\ 23'$

By adding $\frac{A+B}{2}$ and $\frac{A-B}{2}$ we obtain A, which equals 61° 25′ + 8° 23′ = 70° (approximate). Therefore, the true bearing is N. 70° W.

This method is perfectly general, except that it must be remembered that if one of the stations is south of the equator, the length of side *a* or *b* as the case may be will be 90° + lat., and in that case:

$\sin(90° + \text{lat.}) = \cos$ latitude.

and $\cos(90° + \text{lat.}) = \sin$ latitude.

Rectifier Circuits

Some Points in Design

IT is not generally realised that an electrical circuit which incorporates a rectifier, whether of the valve or metal type, is not always simple to design, and is apt to give somewhat unexpected results unless careful consideration is given to the characteristics of the rectifier and the load which is to be placed upon it. Three cases from the writer's own recent experience are illustrated in Figs. 1, 2 and 3. In the first two cases a metal rectifier was used, and in the third a vacuum type valve rectifier. The following explanation applies to both types, and with certain important reservations to gas-filled valves.

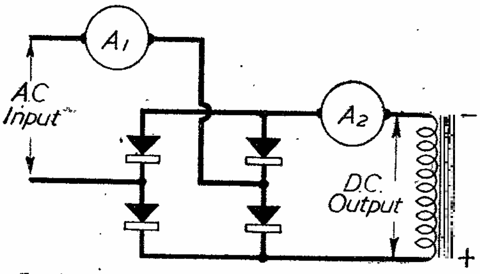


Fig. 1.—Schematic diagram of cut-in switch operating circuit.

Cut-in Switch

Fig. 1 is a wiring diagram of the operating circuit of a cut-in switch which was originally designed to operate at 0.250 amperes D.C. When it was adapted for working on A.C. a cheap, but fairly accurate, moving-iron ammeter was inserted in the A.C. side of the circuit (A1), and, to the surprise of the tester, it operated at 0.230 amperes without any alteration to the control spring. The ammeter was inserted in the D.C. side of the circuit (A2), and read, as at first, 0.250 amperes. Finally, two precisely similar ammeters were used, and there was no doubt that they registered two separate values for the current, differing by about 8 per cent.

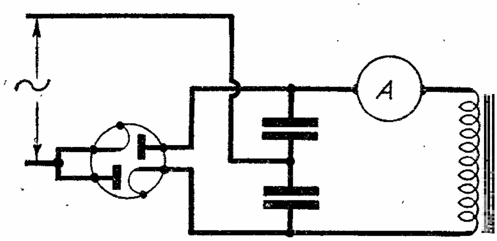


Fig. 3.—Voltage doubler with inductive load.

H.T. Supply Unit

Fig. 2 is the wiring diagram of an H.T. supply unit for operating a D.C. radio set from A.C. mains. The maker, an amateur, wound the transformer to give rather more than the actual voltage required, expecting to get a drop of potential across the rectifier and smoothing choke (not shown). To his surprise, far from there being a drop across the rectifier, the voltage rose from 146 v. on the A.C. side to 159 v. on the D.C. side, again measured by the same instrument, a high-grade dynamometer voltmeter of about 6,000 ohms resistance.

Voltage Doubler

Fig. 3 represents a voltage doubler rectifier-condenser assembly taken from an old radio set, which was intended to be used to supply D.C. to operate a small magnetic chuck or clutch. An ammeter was included in the D.C. side of the circuit when it was first tested, again a moving-iron instrument, to give a rough idea of the current taken, and when the supply was switched on the current was sufficiently heavy to damage the ammeter.

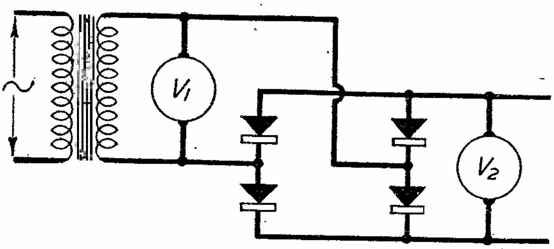


Fig. 2.—Schematic diagram of high-tension supply.

The first case is not difficult to understand. The load, the operating coil of the switch, was highly inductive, and this had a strong smoothing effect on the ripple on the applied voltage. This smoothing effect was brought about by an induced, out-of-phase current, which, added to the in-phase component, gave a direct current with

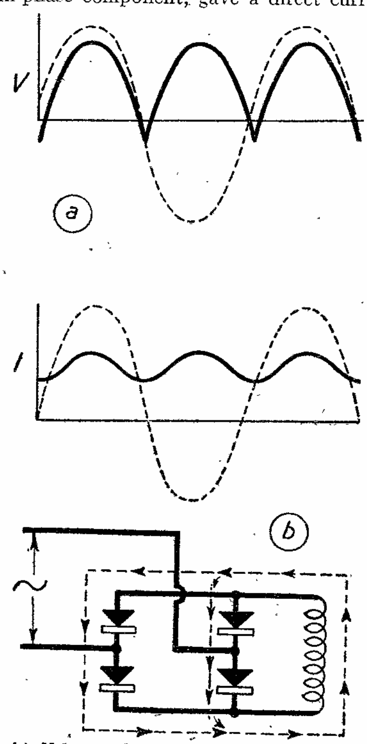


Fig. 4.—(a) Voltage and current waveforms in inductive load; (b) path of induced (out of phase) current.

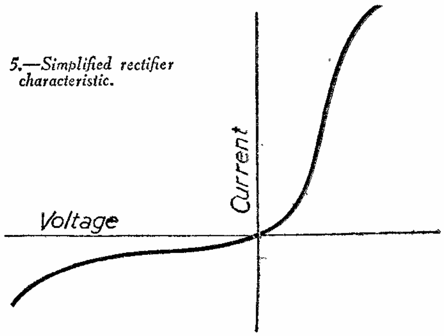


Fig. 5.—Simplified rectifier characteristic.

less variation than would have existed in a non-inductive load (Fig. 4a). Fig. 4b shows clearly that the rectifier offers two parallel low-resistance paths to a current flowing in a closed loop, which would be registered by ammeter A2 (Fig. 1), but not by A1. The writer's experience is that allowance should be made for this when designing such a circuit, and that a reasonably accurate allowance is to make the current in the A.C. side of the circuit lower than the operating current by about 10 per cent. If a temperature compensating, voltage calibrating, ballast or other resistance is to be included in the A.C. side of the circuit such an allowance is imperative.

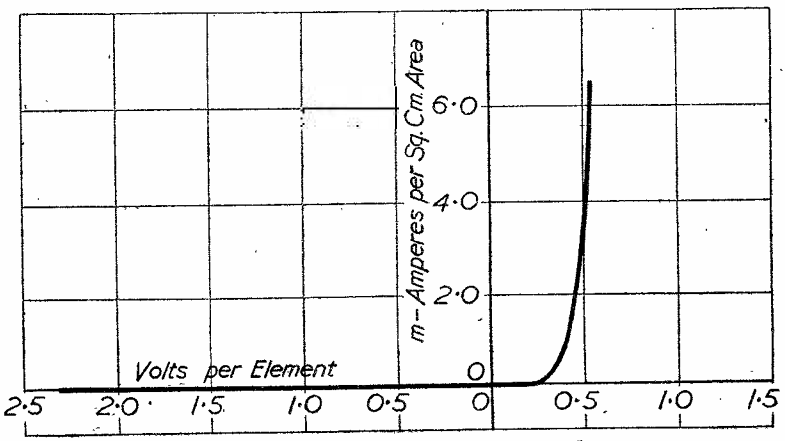


Fig. 6.—Actual rectifier characteristics.

Non-linear Voltage/Current Curve

The second case is not so easy to understand, as it is the result of the non-linear voltage/current characteristic curve of the rectifier, and to allow for it in design it is necessary to understand this completely. It is generally assumed that a rectifier offers very little resistance to the passage of an electric current in one direction, and very great resistance in the other; in fact, the ratio of the resistances is sometimes said to be of the order of 1,000 to 1. This is actually a very loose and misleading statement, as the resistance changes continuously. Fig. 5 is a very exaggerated curve, which should make this clear, but for the purpose of further investigation we shall take Fig. 6, which was obtained experimentally by the writer from a well-known proprietary brand of selenium rectifier.

This curve should show that while the leakage of current in the high-resistance direction is negligible, in the other direction there is a potential drop of about 0.5 volts per element practically irrespective of the load current. (In passing, it may be noted that with a gas-filled rectifying valve this effect is even more noticeable, as no appreciable current will flow until the striking voltage is reached, and with increasing load the potential drop may even decrease. We are not, however, considering these.) In Fig. 5 a rough geometrical construction is employed to show how this has the effect of distorting the wave-form of the resultant current, making it more peaky than a sine-wave, and having a correspondingly higher form factor.

Voltmeter Reading Divergencies

In Fig. 2 voltmeter V1, being a dynamometer instrument, indicated the R.M.S. voltage across the secondary of the transformer, or, more accurately, registered the current in its own coils, which was sinusoidal. Voltmeter V2 registered the current flowing through the rectifier and its own coils in series, which had practically the same average value, but, as we have seen, was not sinusoidal. Thus, the R.M.S. value registered by V2 was about 10 per cent. higher than that registered by V1.

The amount of the increase would be difficult to assess in advance, but, here again, the writer's experience is that 10 per cent. is a fair allowance to make when designing such a circuit.

Opposed Smoothing Effects

In the third case we again have a highly inductive load. It was assumed by the maker, skilled in his own branch of engineering but not in electrical work, that he would get the smoothing effects of both the condensers in the voltage doubler circuit and the inductive load, giving, he thought, practically perfectly smooth D.C. Actually, the circuit is such that the smoothing effects are opposed, and

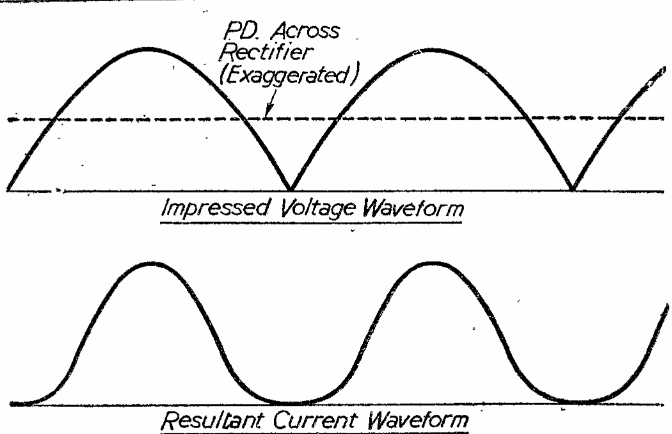


Fig. 7.—(Top) Impressed voltage waveform. (Bottom) Resultant current waveform.

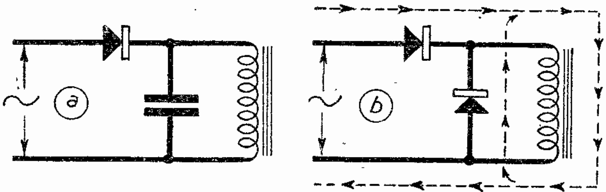


Fig. 8.—(a) Half-wave and capacity with inductive load. (See Fig. 3.)

by an odd mischance the values of the capacitances and inductances were such as to give an almost resonant circuit at the applied frequency, and, in spite of the heavy damping effect of the rectifier itself, a strong out-of-phase current was set up, damaging the ammeter and causing a chatter that was almost a buzz in the clutch.

A simpler circuit which would have given the same undesirable result is the half-wave and capacity, Fig. 8(a). The writer modified the circuit to the series-shunt system, Fig. 8(b), which worked quite well.

Finally, Fig. 9 illustrates the well-known D.C. selector circuit, much used in telephony, which was adapted by the writer to give what he believes to be a rather unusual effect. A friend wanted a cut-out switch for parallel battery charging, the rough specification being as follows. The operating coil was to be connected across the poles of the accumulators to be charged, was to break the charging circuit when the voltage reached 2.6, but restore when it fell to 2.2, and on no account to operate if the cell were accidentally connected in reverse. (Fig. 10.)

The "no-reverse" stipulation obviously called for a D.C. selector, in which the current would not flow in the wrong direction. So much had been decided when it was found that the relay which had been procured could be made to cut out at about 1.4 volts, but would not restore until the pressure had dropped to rather less than 1.0, and could not be made to give less lag without machining. The difficulty was overcome by building up a rectifier of simply two elements in series. The potential drop across the rectifier remained constant over a wide variation in the total voltage, and only a small resistance was required to set the two working voltages at the correct values. The rectifier thus had the effect of reducing the lag from about 30 per cent. to 15 per cent.

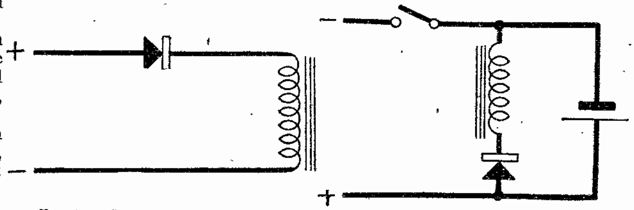


Fig. 9.—(Left) D.C. selector. Fig. 10 (Right).—Battery charging switch with rectifier as both D.C. selector and hysteresis lag reducer.

Gramophone Records Received

H.M.V.

FROM the *H.M.V.* new issues we select the following in the 12in. range:

Symphony in G Minor by the Hallé Orchestra, from the composition by E. J. Moeran, on *C*3319, 3320, 3321, 3322, 3323, and one side of 3324; Elgar's Pomp and Circumstance, by the Toronto Symphony Orchestra, on *C*3328; Four Bagatelles for the Piano composed by Alan Rawsthorne, played by Denis Matthews, on the other side of *C*3324; Tchaikovsky's Theme and Variations from Suite No. 3 in G, Op. 55, played by the Liverpool Philharmonic Orchestra, on *C*3338, 3339, and 3340; while among the 12in. Red Labels we select for especial mention the Sonata in F Major (F. Dur), K. 376, by Mozart, with Hephzibah at the piano and Yehudi Menuhin playing the violin, on *DB*3552 and 3553; the Serenade in G Major, Op. 10, by Dohnányi, played by Jascha Heifetz (violin), William Primrose (viola), and Emanuel Feuermann ('cello), on *DB*6143, 6144, and 6145; and "Kaaddisch," played by Yehudi Menuhin, accompanied by Marcel Gazelle and "Abodah," also played by Yehudi Menuhin, accompanied by Hendrik Endt, on *DB*6139.

In the 10in. range are "Yeah, Mam" and "Darling" (foxtrots), played by Joe Loss and His Orchestra on *BD*5794; "My Devotion" (foxtrot) and "Love Alone" (waltz from "The Belle of New York"), played by Joe Loss on *BD*5788; "We'll Smile Again" (foxtrot) and "Praise the Lord and Pass the Ammunition" (foxtrot), played by Joe Loss on *BD*5786; while the Hutch records include "My Devotion" and "Every Night About This Time" on *BD*2109, "Serenade in Blue" and "Nightingale" on *BD*1030, and "There are Angels Outside Heaven" and "My Heart and I" on *BD*1038; the delightful numbers "Love Me To-night" and "To-morrow," from "The Vagabond King," are sung by Anne Ziegler and Webster Booth on *DB*9311; while "Love is a Song," from the film "Bambi," and "We Mustn't Miss the Last Bus Home" are played by the R.A.O.C. Blue Rockets Dance Orchestra on *BD*5785; the latest swing music 1943 series, on *B*9307, includes "The St. James Infirmary Blues," played by Artie Shaw and His Orchestra; Hal McIntyre and His Orchestra tastefully record "I'll Keep the Lovelight Burning" and "South Bayou Shuffle" on *BD*7396; Maggie Teyte is at her best in the 10in. Red Label *DA*1830, singing "Ici-Bas," by Fauré, and "En Sourdine," by Hahn, on *DA*1830.

Decca

AMONG the *Decca* Records we select Nos. 13 and 14 of the Music While You Work series, "Sweet William" and "Marigold," by Billy Mayerl and His Forte Fingers, on *F*8250; "A Taxi Driver's Serenade," foxtrot, and "Praise the Lord and Pass the Ammunition," by Joe Loss, on *F*8245; "Idaho" and "Praise the Lord and Pass the Ammunition," a vocal by the Merry Macs, on *F*8249; "Constantly," from the film "The Road to Morocco," and "At Last," from "Orchestra Wives," sung with verve by Anne Shelton on *F*8247; while the 12in. Red Label *Decca* includes Rachmaninoff: 24 Preludes, No. 15, in E Minor (Op. 32, No. 4), by Moura Lympany, on *K*1209.

Regal and Brunswick

FROM the *Regal* range we select "The Baby Show" and "When the Water Works Caught Fire," sung by George Formby on *MR*3672.

From *Brunswick*, "The Road to Morocco" and "Moonlight Becomes You," sung by Bing Crosby on 03410—*A*.

Parlophone

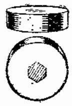
RICHARD TAUBER sings "Springtide," by Grieg, and "I Love Thee," by Grieg, on *R*020520, and "None But the Weary Heart" ("Goethe" Tchaikovsky), and "No More I'll be Singing," by Tchaikovsky, on *R*020518. These are, of course, Plum Labels. "I Cried for You" (foxtrot) and "You Made Me Love You" are recorded

(*Continued on page 306.*)

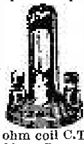
Electradix Bargains

★ METER MOVEMENTS ★
Moving Coil and Magnet Systems 10/- each.

MAGNETS. The Wonder Midget 2-oz. Permanent Magnet. Discs of Alni Steel. Tremendous magnetic force and only 1.3/16in. dia. × ⅜in. thick, with soft centre for drilling. One leaps off the table to meet another Uses: Any magnetic duty, metal separation, magnetic chucks and lifters. Cut-out core, polariser, solenoid cores, headphone re-magnetisers, etc., 2/6 each, or 4/6 pair. **A.C./D.C. Mains Magnets,** 2 wound poles.110 or 220 volts, 7 lb. lift, **5/6.** Small 12-volt solenoids, 2in. × ¾in. plunger, **6/6.**

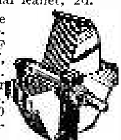


MORE RADIO SUNDRIES. Headphones, **12/6.** **Headbands,** Steel, double Brown's type, **2/6.** Single receivers, **4/6.** 1,000 ohm bobbins, **1/6.** Small high volt transformers, A.C mains to 1,000 volts, for neon ozonizers, C.R. tubes, condenser test, etc., 5-watts, **7/6.** Spare Crystal, 1/- tin. Perikon permanent, **2/6.** Carborundum, **7/6.** **Inter-Valve Transformers,** Ericsson type, **5/-.** **Loud Speaker Units,** magnetic type, **3/6.** **Telsen,** Telenor Dials, 4 control, **5/-.** 1 control, **2/6.** Slow Motion Dials, **4/6.** Instrument Fuses, 60 m/a, **4d.** **Panels,** cut square and finished, some drillings, ¼in. thick, 6¼in. × 13in., aluminium, **3/-.** Bakelite ditto, 6⅝in. × 7⅝in., **2/6.**



LIGHT RAY CELLS, Selenium Bridge in bakelite case. Raycraft Model, **21/-.** Electro-cell, self generating, light meter type, **35/-.** Raycraft Ray Set, with relay, **42/-.**

RELAYS. Telephone No. 6 twin bobbin polarised S.P. Change-over, 6 volts 25 m/a., **8/6.** No. A "on-off" S.P., 2 volts, **5/-.** Less contact blades 1,000 ohm coil C.T., **2/6.** Enclosed 10,000 ohm tele-type, **22/6.** For other Relays see special leaflet, 2d.



CONDENSERS. Solo High-grade Variable .0005 mfd. in original carton, logarithmic vanes. Formo F for oscillator and single tuning S/W, **4/6.** **Fixed Condensers,** 2 mfd. smoothers, G.P.O., **2/6.** Dubilier and T.C.C., .25 mfd., cased, **2/-.** H.T. Mica, .25 mfd. for 4,000 volts, **10/-.** Large 1 mfd. metal-cased, 2,000 volts, **10/6,** 1 mfd. oil-filled case, B.I., 6,000 volt condensers, **35/-.** 2 mfd., 4,000 volts, **45/-.**

Plugs and Sockets. Radio 2-pin socket and plug, **9d.** pair. Sockets mounted on panel, **4/6** doz. pairs. 5 pair socket strip panel and one plug, **2/-.** Model 5-pin plugs with panel socket and cords, compact type, **4/6** pair. 14-way plug and socket with cord, **7/6.** 4-way flex cord, 5ft., **2/3.**

HANDCOMS. Ex. Govt. All-metal Field or Pocket hand-telephone-microphone combinations. These are Microphone-Telephones of Transceivers for use with portable or fixed telephones. They are the famous No. 16 Handcom used in so many Field Sets. Sturdily built with mike finger switch and they are fine. As new, but no cord, **12/6.** For those able to refit there are a number less finger switch and cord for **7/6.**

PANEL SWITCH RHEOSTATS. "Off" and 0 to 1 ohm, 3 amps, 6 volts. Dimmers Charger Sub-circuit Regulators, Model Speed control, etc., 1 hole fixing and extra bracket for rack. Hollow knob has base or min. bulb to glow when "on." Makers, Aetna Co., U.S.A. New for **2/6.** Worth 5/-. 8 ohm enclosed resistors to extend range, **1/6.**

40 AMP RHEOSTATS. Large ironclad grid type with heavy 10-stud switch, drops 220 volt mains to 50 volts. Size : 33in. × 16in. × 14in., **£5 10/-.** 110-volt ditto, size 16in. × 14in. × 16in., **£2 10s.**

DYNAMO BARGAINS. We have a large stock of all sizes. Special Rotax 6 to 12 volts, 8 amps. D.C., 3rd brush, 8in. long, 4½in. diam., weight 11 lbs. Unused, **17/6.** L.T.-H.T. Double-current G.E.C. Dynamos, D.C. 6 volts and 600 volts, 2 coms., 17 lbs., **27/6.** Carr. paid Eng. and Wales.

Motor Generators and Rotary Convertors for radio. **Pumps.** Stuart Motor Pumps, centrifugal, 12v. D.C. **£4 4/-.** 230 volts A.C., **£6 6/-.** R Twin-piston pumps, without motors, **£3.** Motors on priority.

Tanks, etc. Open water tanks for engines, storage, fire, 14in. by 5ft., with fittings, **35/-.** Welded steel bottles for any pressure, pint size, 8¼in. × 2½in., **2/6.**

Vee Pulleys, turned steel for ½in. belt, 4in. outside, **4/6.** Endless Belts, rubberized, **7/6.**

Please add postage for all mail orders. Send stamped envelopes for replies to all enquiries.

ELECTRADIX RADIOS

Electradix House, 214, Queenstown Road, Battersea, London, S.W.8.

Telephone : Macaulay 2159.

WEBB'S Radio

We can supply most things in RADIO including the WEBB'S tradition of technical guidance.

Useful close tolerance Silver-mica Condensers, all 1/- each :—

.000025	Plus or Minus	10 per cent.
.000050	,, ,,	10 ,,
.000077	,, ,,	2 ,,
.0001	,, ,,	1 ,,
.0002	,, ,,	10 ,,
.000305	,, ,,	2 ,,
.0005	,, ,,	5 ,,
.001	,, ,,	5 ,,
.001505	,, ,,	1 ,,
.002	,, ,,	1 ,,
.003750	,, ,,	5 ,,
.005	,, ,,	5 ,,

Midget Mica Trimmers

40 PF, 250 PF, 450 PF, 100 plus 100 PF ... ... all 1/- each

Tuning Condensers

Wavemaster Ceramic end plate.
.0001, .00016, .0002 ... all 5/- each
Cyldon, Ceramic end plate .000025 3/6 ,,
Eddystone 15 mmfd. Microdenser 3/6 ,,
3 gang .00045 with trimmers ... 7/6 ,,

All values ½ and 1 watt Resistors 6d. and 1/-

Baseboard, British Valveholders

Skeleton low loss construction on pillars, 4, 5 and 7 pin ... ... 1/- each

Vibrator Packs

Mallory VP553, with valve rectifier complete, unused. 6v. input to 125/200 volts 100 m/a. D.C. 4 10 0

L.F. Smoothing Chokes

Ideal for initial smoothing for receivers, etc. Inductance 70 h. at zero D.C., 45 h, at 10 m/a., 28 h. at 25 m/a. D.C. 8/6 each

Visitors may inspect the famous EDDYSTONE '358X' communications receiver with the phenomenal range of 31,000 kc/s to 90 kc/s. All Eddystone Components generally available, though OFFICIAL requirements must take priority.

Additional charge of 1/- for postage and packing on orders below 10/-.

WEBB'S RADIO, 14, Soho St., Oxford St., London, W.1. *Telephone : Gerrard 2089*

Note our revised SHOP HOURS :— 10 a.m. to 4 p.m. Sats., 10 a.m. to 12 noon

---

GALPINS

ELECTRICAL STORES

"FAIRVIEW," LONDON RD., WROTHAM, KENT.

Please Note Change of Address

This business is now transferred permanently to the above address, where all mail orders will receive strict personal attention.

TERMS CASH with ORDER. No C.O.D.

Regret no Orders can be accepted from Eire or Northern Ireland.

ELECTRIC LIGHT CHECK METERS, well-known makers, first class condition, electrically guaranteed, for A.C. mains 200/250 volts 50 cy. 1 phase 5 amp. load, **10/-** each ; 11 amp. load, **12/6,** carriage 1/-.

1 K.W. TRANSFORMER, input 100 volts at 100 cycles, single phase, output 10,500 volts, centre tapped to earth. Price **£4/10/-,** carriage forward.

1 K.W. ELECTRIC FIRE Element, size 16in. x 1⅝in. x 1in., for 220 v. mains A.C. or D.C., as new, **6/-** each, post free.

ROTARY CONVERTER, D.C. to D.C. Input 12 v.; output 1,100 v. at 30 m/a. Ex R.A.F., condition new. Price **50/-,** carriage paid.

ROTARY CONVERTER, D.C. to D.C., input 48 volts; output 2,500 volts at 1 kW., condition as new. Price **£10,** carriage paid.

½ WATT WIRE END Resistances, new and unused, assorted sizes (our assortment), **5/6** per doz., post free.

ROTARY CONVERTERS, D.C. to D.C., permanent magnet fields, small size, windings not guaranteed, ball bearing, contained in cast alli. box, size 12in. x 4in. x 4in. Price **15/-,** carriage paid.

SOLID BRASS LAMPS (wing type), one-hole mounting, fitted double contact small B.C. holder and 12-volt 16 watt bulb, **3/6** each, post free, or **30/-** per doz., carriage paid.

HEADPHONES, 120 ohm, secondhand, complete with headband and cords, in perfect working order, price **7/6** per pair, post free.

INSTRUMENT METAL RECTIFIERS by famous maker, 10 m/a. full load, convert your D.C. motor to A.C. working. Price **15/-** each, post free.

TUNGSTEN CONTACTS, 3/16in. dia. a pair mounted on spring blades; also two high quality pure silver contacts 3/16in. dia., also on spring blades, fit for heavy duty, new and unused; there is enough base to remove for other work. Price the set of four contacts, **5/-,** post free.

220 VOLT DYNAMO, 9 AMP. output by Lancaster Dynamo Co. Shunt wound, speed 1,500 r.p.m. Condition as new. Price **£10,** carriage paid.

POST OFFICE RELAYS, small type, high resistance, twin blade, very low m/a. operation, as new. Price **7/6** each, post free.

VOLTMETERS, 2½in. dia., panel mounting, moving-coil, modern type by famous makers, range 0-120 volts, F.S.D. very low. Price **32/6,** post free.

AMPMETERS, description as above, range 0-1½ amps. Price **25/-,** post free.

KLAXON MOTORS, 220 v. D.C. 1/10 H.P., shunt wound, ball bearing, fitted reduction gear giving speed of 700 r.p.m., high-grade job, condition as new. Price **50/-** each, carriage paid.

D.C. MOTOR, shunt wound, condition as new, high grade, ball bearing, 1/8 H.P., can be supplied in 110 or 220 v. as ordered. Price either voltage, **40/-,** carriage paid.

Open to Discussion

The Editor does not necessarily agree with the opinions expressed by his correspondents. All letters must be accompanied by the name and address of the sender (not necessarily for publication).

An Appreciation from Palestine

SIR,—It is a long time since I wrote to you last, but with the new improvements, and with respect to the excellent material published in your excellent paper, I must let you know how much I appreciate your efforts to give us all the latest "dope" on everything in Wireless.

Your articles on mathematics are, I know, of special interest to many readers, including myself. And now a few remarks with respect to certain subjects. What about publishing more information on television? Surely, when the Alexandra Palace transmissions were closed down some more experiments were carried on in this science, and I certainly want to hear more about it. Further, I should like to see published a few constructional articles on small short-wave receivers, A.C. or battery operated, using the latest circuits; I know there are many improvements.—R. SOKOLOVSKY (Haifa, Palestine).

S.W. Converter

SIR,—During the past week or so I have been listening with a home-built S.W. converter, a diagram of which is appended. The component values are fairly critical. It was built on a midget A.C.-D.C. chassis and used in conjunction with a 6-valve commercial superhet. The coils are Premier, three in all (13-50 metres).

Some of the stations received are: WGEO, WLWO, WHL6, WBOS, WRUW, and CRL8, the latter being from Rio de Janeiro on 26.5 metres. On and after February 15th this station will operate on 31.56 metres. It is beamed to Europe, and the programmes are in English.—D. M. WEBBER (South Brent).

A Modified Corona A.C.4

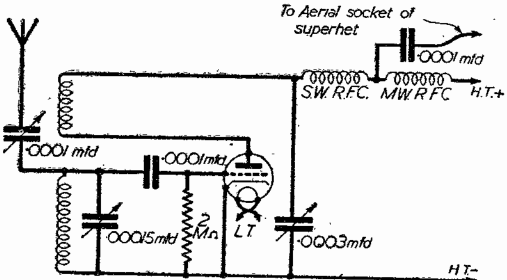
SIR,—You have so often impressed upon your readers how advisable it is in their own interests not to depart in any way from the specification of any of your pre-war receivers, that my experiences in taking liberties with one of your designs may be of interest. I may say that my receiver in its present state entirely satisfies me. It started off as the Corona A.C.4. In the first instance I built the receiver on a separate aluminium chassis. The reason for this was that I already had a power pack consisting of an H.T.9 metal rectifier; Heayberd transformer and condensers for voltage-doubler circuit. My speaker was practically new, and of the mains-energised type with a resistance of 2,500 ohms. So rather than go to the expense of purchasing a P.M. unit I used the field as a smoothing choke, with an 8 mfd. electrolytic either side of the field. I suppose the valves are being under-run as far as H.T. goes, but I think that is all to the good, as they are still in commission, and it certainly made no difference that I can see as to reproduction, which is really good. The valves are Hivac V.M. H.F. pen. detector, Osram M.H.4, 1st L.F. an Osram MHL4, and the output valve P.X.4. The rest of the components I obtained from one of the surplus dealers, and so far I've had no trouble. But on going home in 1940 I found that the coils were giving trouble, so I took them out and replaced them with a Varley B.P.114 unit; but that was unsatisfactory as a foreigner kept butting in on a London station. So I cast around and secured a Telsen 477 coil unit. That cured the trouble and is still functioning. There was a low hum from the beginning, so being rather critical I thought I'd try and get rid of it. I tried all sorts of things, such as extra smoothing and checking earth points. But it wasn't until I fed the output valve from a separate 4v. 1 amp. winding that I finally succeeded. Then it was so silent that I had to wire a 6v. .3a. dial lamp across the heaters so that I should know if it was switched on or not. I congratulate you on such a completely satisfactory design, for with the exception of valves, coils and power pack it is built as specified.—L. N. HALLIDAY (London, E.C.).

Station WDL

SIR,—With regard to the letter from G. A. Lockie, of Kelso, in the April issue of PRACTICAL WIRELESS, I should like to inform him that I, too, have heard the American station WDL of the 30 metre band on 322 metres. I have listened to this station several nights running last month, and it sometimes comes in very strong. Sorry I can't identity the transmission further.—C. N. WILLIAMS (Bedford).

Our Serial Articles

SIR,—As a regular reader of PRACTICAL WIRELESS I would like you to know how much I enjoy the



Circuit diagram of a S.W. convertor, by D. M. Webber.

series of articles Elementary Electricity and Radio and Radio Examination Papers. The RX. here is a commercial communications set and all continents have been received at good strength at one time or another. Like your correspondent in the April issue, I am interested in commercial C.W. stations and can copy them fairly well. If D. B. Taylor (Hale) gets in touch with me through your paper I will send him a list of the Z abbreviations ZHC, ZRK, ZOK, etc., which he wanted to know about, and also a list of Press stations.—THOS. WILSON (Kirkconnel).

Replies to Queries

RULES

We wish to draw the reader's attention to the fact that the Queries Service is intended only for the solution of problems or difficulties arising from the construction of receivers described in our pages, from articles appearing in our pages, or on general wireless matters. We regret that we cannot, for obvious reasons :—

(1) Supply circuit diagrams of complete multi-valve receivers.

(2) Suggest alterations or modifications of receivers described in our contemporaries.

(3) Suggest alterations or modifications to commercial receivers.

(4) Answer queries over the telephone.

(5) Grant interviews to querists.

A stamped, addressed envelope must be enclosed for the reply. All sketches and drawings which are sent to us should bear the name and address of the sender.

Requests for Blueprints must not be enclosed with queries, as they are dealt with by a separate department.

Send your queries to the Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. The coupon on page iii of cover must be enclosed with every query.

Earth Connection

"I took some pains to make a really good earth connection when I moved into my present house. I used a roll of new galvanised iron, and soldered the connection to it. This was buried end on in the ground and is at least 18in. deep. I noticed the other day that the lead had come off, and when I fixed it on again there was no improvement in reception. The connection is good and the lead is not broken. Can you suggest the cause of the failure of the earth to give improved results?"—B. M. (Leicester).

ALTHOUGH the earth connection may be well made and soldered you must bear in mind that it is essential for the buried mass of metal to make good contact with the actual earth. Your earth may be in a dry condition and this could cause the inefficiency. Thoroughly moisten the earth surrounding the plate and you should note some improvement. On some circuits, of course, an earth does not greatly affect results.

Using a Pentode

"Wishing to obtain more volume from my home-made Det. L.F. Power set, I fitted a pentode, but am now troubled by the high-pitched tone. Also, I thought the volume would be much more than it is. Will you kindly examine the enclosed circuit and advise me on the best course to adopt?"—A. H. R. (Preston).

THE circuit is quite correctly wired and consists of a perfectly standard arrangement. The high-pitched tone is always experienced when using an uncorrected output circuit with a pentode, and you should fit a tone corrector across the loud-speaker terminals. The usual .01 mfd. fixed condenser, in series with a 10,000 ohm variable resistor, will be found satisfactory. Furthermore, your loud-speaker may not be matched to the pentode, and this point must receive attention, as a much higher impedance is required than was formerly needed for the power valve. There is a possibility that the additional anode current required for the pentode is resulting in overloading of your mains unit, and this point also should be checked.

Pick-up Leads

"I have been trying to get my radiogram working but cannot make certain regarding the pick-up connections and most suitable arrangement for this component. I have tried short and long leads and there appears to be no difference in results, but there is a faint background whistle all the time. I do not get this on radio reception, and the quality on gramophone is not so good as radio. Can you suggest anything?"—C. J. (London).

THE fact that you mention a faint whistle leads us to suppose that you have not broken the grid circuit when connecting the pick-up, although you give no details at all concerning the circuit arrangements of the complete apparatus. You are probably including the pick-up in the grid circuit in addition to the normal tuning coil, and thus are getting a certain amount of H.F. inter-action due to coupling between the present H.F. circuit and tuning coils and the long pick-up leads. The grid circuit should be broken and a change-over switch fitted so that the tuned circuits are cut out, whilst the pick-up is in use. It may be found worth while also to reverse the connections to the secondary terminals of the L.F. transformer.

Speaker Cabinet

"I have recently made up a fair-sized box in which to place the speaker. The size is approximately 2ft. cube. I find, however, that there is an unpleasant bass resonance, and I wonder if you can tell me how to overcome this. I want the box back closed in to keep out dust, and the speaker sounded all right before putting it in the box."—R. H. D. (Pinner).

ALTHOUGH the speaker may have sounded good when standing alone, it may have a prominent bass resonance. This would not be very noticeable without a baffle. An enclosed box will, however, give rise to resonance and special precautions must be taken. The sides of the cabinet should be lined with thick felt, or the entire inside filled with kapok or similar material, leaving a space round the speaker to prevent the cone movement from being restricted. It may be necessary to cut holes in the back of the cabinet and cover these with gauze or other dust-proof material.

Trimming Necessary

"I have a commercial superhet, and there has developed a peculiar fault. When tuned direct to a station according to the scale there are very weak signals. As soon as I detune slightly the signals increase in volume but suddenly cease as though there is a short-circuit across the condenser. Can you explain this?"—S. B. (Morecambe).

THE trouble may be that the circuit is in need of retrimming. When a superhet is not trimmed properly there is sometimes instability. As you detune the circuits are gradually brought into resonance, giving the increased volume, and then oscillation takes place, resulting in absence of signals. We advise you to have the set inspected by an engineer who is familiar with the particular make.

Record Wear

"I am using a fairly well-known make of gramophone pick-up, although it is a fairly old model. I find that my records begin to sound scratchy after only a comparatively few playings and I wonder if you can say the reason for this and how the noise can be avoided?"—R. W. (Caterham).

THERE can be two reasons for the noise. It is undoubtedly due to wear on the grooves and this may be caused by a pick-up in which the needle movement is not sufficiently free, or by undue weight on the record. In the former case, the trouble may have arisen owing to perishing of the rubber surrounding the armature. This may have hardened and thus is holding the needle rigid. If the pick-up is bearing too heavy on the disc it should be counter-weighted by fixing an arm to the carrier arm, and putting a weight at the far end to take off the pick-up weight. We presume, of course, that the pick-up is properly mounted, as it is essential to see that it tracks correctly, otherwise the record will be damaged.

Metal Rectifier

"I have an old metal rectifier which has apparently been dismantled from a set. There are three tags on this and I should be glad if you could tell me what type of instrument this is. Am I right in assuming that it is a voltage doubler, and if so, which are the A.C. terminals?"—P. F. (Kingston).

IT is not possible to state definitely what type of instrument this is, and you should communicate with the makers. Special rectifiers have been made from time to time for set makers, and these may not be standard. Usually, three terminals would indicate a component for voltage doubling, one terminal being A.C. and the others positive and negative.

H.F. Instability

"I recently built a four-valve receiver with an H.F. Pentode H.F. stage, transformer-coupled to the detector. I am experiencing severe H.F. instability, which all my tests and trials have failed to obviate. I have modified the screen voltage, changed decoupling values and screened various parts without avail. I wonder if you could suggest anything which I have not tried, but which would prevent this trouble?"—C. J. (Reading).

THE instability may be due to the particular H.F. coupling provided in the transformer, provided that all other tests and modifications have been correctly carried out. We therefore suggest that you shunt the primary of the H.F. transformer with a fixed resistance—the most effective value being found by trial. An alternative scheme would be to reduce the coupling between primary and secondary, which is presumably too tight now.

GRAMOPHONE RECORDS RECEIVED

(*Continued from page 302*)

by Harry James and His Orchestra on *R*2869; "My Melancholy Baby" and "Mean to Me," by Teddy Wilson and His Orchestra, on *R*2868; "Ain't Misbehavin'" and "Boogi," by Harry Parry and His Radio Rhythm Club Sextet, on *R*2860; "The Taxi War Dance" and "Twelfth Street Rag," by Count Basie and His Orchestra, on *R*2862; Geraldo and His Orchestra record "Der Fuehrer's Face" and "My Devotion" on *F*1960, "You Can't Say No to a Soldier" and "I'm Old Fashioned" on *F*1970, and "I Met Her on Monday" and "Every Night About This Time" on *F*1964; Ivor Moreton and Dave Kay record "Tin Pan Alley Medley, Nos. 52 and 54," on *F*1972 and *F*1958; "Santiago" and "Coon Town Caravan" is recorded by Joe Daniels and His Hot Shots on *F*1969; "We'll Smile Again" and "Ol' Banjo," by Carter and Evans (Two Voices and a Piano), on *F*1962; "Three Minutes of Heaven" (foxtrot) and "Fox Trot Medley" on *F*1959.

Columbia

THE following are 10in. records: "Will o' the Wisp" and "Daybreak," sung by Turner Layton on *FB*2886; "Serenade in Blue" and "Praise the Lord and Pass the Ammunition," played by Carroll Gibbons and the Savoy Hotel Orpheans on *FB*2867; "Yankee Doodle Boy" and "Mary's a Grand Old Name," from the film "Yankee Doodle Dandy," and "Moonlight Becomes You," from the film "The Road to Morocco," on the reverse side, played by Carroll Gibbons and the Savoy Hotel Orpheans, on *FB*2889; "Crazy Rhythm" and "St. Louis Blues," played by Felix Mendelssohn and His Hawaiian Serenaders on *FB*2882. The following are all played by Victor Silvester and His Ballroom Orchestra: "All I Need is You" (quickstep) and "I'll Come to You" (waltz) on *FB*2891; "Constantly" (quickstep) and "My Devotion" (slow foxtrot) on *FB*2883; "9.20 Special" (quickstep) and "Serenade in Blue" on *FB*2884; "I Had the Craziest Dream" and "There Will Never be Another You" on *FB*2910. "No, No, No, No, Columbus," from "Best Bib and Tucker," by Tommy Trinder, with Edmundo Ross and His Rumba Band, and "Der Fuehrer's Face," from the film of the same name, by Tommy Trinder, with Jan Ralfini and His Squad of Swing and Hammond Organ, on *F*2885; "Romanesca" and "My Serenade," sung by Monte Rey on *FQ*2881; "Carroll Calls the Tunes" (No. 24), Parts 1 and 2, with Carroll Gibbons at the piano, on *FB*2912; "The Glory of the Sea" and "The Holy City," sung by Delya, with organ and piano, on *FB*2906; "Romantic Waltzes, Parts 1 and 2," played by Felix Mendelssohn and His Hawaiian Serenaders; "The Blue Danube—Waltz, Parts 1 and 2," a piano duet by Rawicz and Landauer, on *DB*2108; "Rhapsody in Blue, Parts 1 and 2," a piano duet by Rawicz and Landauer, on *DB*2104; "Dance of the Comedians" and "Perpetuum Mobile," played by the Orchestra of H.M. Royal Marines on *DB*2095; "The Night has Eyes" and "Ghosts of Old Vienna" by Albert Sandler Trio on *DB*2105. In the 12-in. series there is "Barcarolle in F Sharp, Parts 1 and 2," a pianoforte solo by Louis Kentner, on *DX*1112; "Let the Bright Seraphim, Parts 1 and 2," by Handel, sung by Isobel Baillie, accompanied by the Hallé Orchestra, on *DX*1113; "Aïda," Act 2, "The Grand March," by Verdi, played by the Columbia Symphony Orchestra on *DX*1111; "Stenka Razine, Symphonic Poem, Parts 1, 2, 3 and 4," by Glazounov, played by the Liverpool Philharmonic Orchestra on *DX*1107 and 8; "Variations of a Theme of Joseph Haydn, Parts 1, 2 3 and 4," played by the Hallé Orchestra on *DX*1105 and 6.

MATRICULATION
brings Success & Security

Whatever your age, you can now study for the all-important Matriculation Examination at home on "NO PASS—NO FEE" terms.

"**MATRIC**" is the accepted passport to all careers, and opens up opportunities which would otherwise be completely closed to you.

Ensure the **success** and **security** of you and yours through post-war difficulties by writing for our valuable "**Guide to Matriculation**" immediately—**FREE.**

B. T. I. (Dept. 113),
356, Oxford Street, London, W.1.

RADIO SERVICE

REWINDS.—Mains 25/-, and Output Transformers 6/-, Fields, Coils, Pick-ups promptly executed.

VALVES.—Good selection—we may have the one you want. Brand new in Makers' cartons, plus tax—postage and packing, 1/-. Send S.A.E. to **A.R.D.S. Co., 261/3/5, Lichfield Road, Aston, Birmingham, 6.**

'Systematic Radio Servicing'

A practical method by J. Bull, also a Catalogue of Radio Service Aids, including "History of Faults," "Job Cards" which almost repair the sets, "Valve Base Data Cards," and perhaps the most important, details of a Rectifier which will replace any of the popular Universal valves, 1D5, etc. Price 1/7, post free.

V.E.S.(P), Radio House, Melthorne Drive, Ruislip.

TESTOSCOPE

Makes 30 important tests, 100 to 750 volts. A.C. or D.C. Ideal for Radio Engineers. *From Wholesalers or direct. Send for leaflet "A.24."*

RUNBAKEN - - MANCHESTER - - 1
Tel. ARD. 3507-8.

MORSE CODE TRAINING!

The Candler System of Morse Code Training is carried out in your own home. It is definitely the quickest, easiest way of becoming a skilled wireless telegraphy operator.

Numerous Candler trained operators are serving in the Army, Navy and Royal Air Force.

Write now for a copy of the

FREE "BOOK OF FACTS"

it gives full details of the courses for Beginners and Operators.

CANDLER SYSTEM CO.
(5.L.O.), 121 Kingsway, London, W.C.2
Candler System Co., Denver, Colorado, U.S.A.

Classified Advertisements

LITERATURE, MAPS, etc.

RADIO SOCIETY OF GREAT BRITAIN invites all keen experimenters to apply for membership. Current issue "R.S.G.B. Bulletin" and details, 1/-.

AMATEUR Radio Handbook (300 pages), paper cover, 4/- : cloth, 6/6. Radio Handbook Supplement (140 pages), paper cover, 2/9 ; cloth, 5/-.—16, Ashridge Gardens, London, N.13.

WEBB'S Radio Map of the World. Locates any station heard. Size 40in. by 30in, 4/6, post 6d. On linen, 10/6. post 6d.—Webb's Radio, 14, Soho Street. London. W.1. GERrard 2089.

7,000 Members of the Scientific Book Club believe that Knowledge is Power. Are you a member ? Particulars from 121, Charing Cross Road, London, W.C.2.

SHORT of Stock ? Make and sell your own Torch Battery, Cigarette, Pipe and Gas Lighters. No awkward wheels, wicks, flints to fit. Materials obtainable. Reliable. Lasts 6 months. Diagram and full instructions, 2/9. Element included free.—P. W. Barham, "Hilltop," Bradmore Green, Coulsdon. Surrey.

MORSE & S.W. EQUIPMENT

FULL range of Transmitting Keys, practice sets and other equipment for Morse training.—Webb's Radio, 14, Soho Street, London, W.1. 'Phone : GERrard 2089.

"**H.A.C.**" Short-wave Receivers. Famous for over ten years. Improved one-valve model now available. Complete kit of components, accessories, with full instructions—only 16s., postage 6d. Easily assembled in one hour. S.A.E. for free catalogue.—A. L. Bacchus, 109, Hartington Road, London, S.W.8.

RECEIVERS AND COMPONENTS

FRED'S RADIO CABIN,
COMPARE OUR PRICES.

FUSES, glass 1¼ inches long, 2 amp., 3/- doz.

MAINS DROPPERS, 0.2 amp.. Pye, **3/6.** Also .3 amp. 660 ohms tapped and 1,000 ohms tapped, **4/-** each.

PUSH BUTTON, 6-way, no knobs—a really fine job, **2/6** each. New.

CONDENSERS. "Plessey" 4-gang screened 6¼in. x 3¼in., **4/6.** 3-gang, 6¼in. x 3¾in., unscreened, **2/6.** All brand new and include trimmers.

"**HENLEY**" Electric Soldering Irons, new. Straight bit, **13/6** each. Resin-cored solder, **4/-** lb. reel.

METAL Spade Tags, **3d.** dozen.

SLEEVING. **3½d.** per yard length. 1 doz. lengths, **3/-.** Braided sleeving, **8d.** per yard length, **7/-** doz. lengths.

T.C.C. Tubulars, 0.1 mfd., **7d.** each, **6/6** doz., also .01 mfd. at **6d.** each, **6/-** doz.

CONNECTING WIRE. Heat resisting, tinned copper, as used by Government, **6d.** coil of 12 ft.

TRIMMERS, 50 m.mfd., **3d.** each. Also 250 m.mfd., **3d.** each.

VOLUME CONTROLS, few only, various sizes, some with switch, second-hand, **1/-** each.

SOLDERING TAGS. 2 B.A., **4/-** gross.

T.C.C. TUBULARS, brand new 25 mfd. 25v., **1/3** ; 25 mfd. 50v., **1/6** ; 50 mfd. 12v., **1/3** ; 50 mfd. 25v., **1/3.**

DUAL RANGE COIL, with variometer tuning, fully screened in copper can, **2/3** each. No circuits.

SPEAKER GRILLES, 7in. x 3½in. Chromium-plated, cheap to clear, **1/6** each.

SOLDER, 1lb. reels, fine all-tin instrument solder, **3/6** lb.

WIRE. Silk-covered, 2 oz. reels, 26 to 40 gauge, **1/3** reel.

CRYSTAL DETECTOR, New type on ebonite base, **2/6** each.

CRYSTAL and Catswhisker in metal box, **6d.** each.

METER Resistances, wire wound, 50-120, 500, 1,000 ohms, **1/-** each.

TELSEN Illuminated disc drives. useful for short waves, **2/6** complete.

LITZ WIRE, 2oz. reels, 38-40, 20-40, 9-45, 4-36, 4-35, 4-34, 4-31, 4-30, 4-28, 2-32, 2-30, 2-26, **1/6** per reel.

ROTARY SWITCHES, double pole, double throw, ebonite, **9d.** each.

(Continued on page 308.)

YOU MUST KNOW "MATHS"

If you wish to understand radio, or any other technical subject thoroughly, you must know mathematics.

Our method of Home Study tuition is an outstanding success. Hundreds of students owe their progress and increased earnings solely to our training.

Trained men get good jobs. Even if you are now in the Forces, or on work of National importance, you should think of your future. There will be splendid opportunities for men who have studied radio or mathematics, and now is the time to start learning.

Post coupon for free details of our Home-Study Courses in Mathematics, Radio Calculations, Radio Reception and Transmission, and Television.

T. & C. RADIO COLLEGE,
2, THE MALL, EALING, W.5
★ *Please note new address* ★

(Post in unsealed envelope. 1d. stamp.)
Please send me free details of your Home-Study Mathematics and Radio Courses.

NAME ....

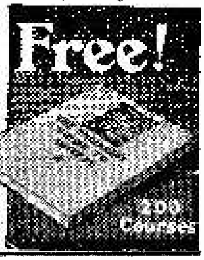
ADDRESS ....

P. 40..............................

The Best Qualification in Wireless!

The City & Guilds RADIO COMMUNICATION Diploma

Recognised throughout the Wireless Industry as a direct qualification for technical posts and has the active support of the greatest Radio concerns such as Cable and Wireless Ltd., the G.P.O., etc. Write to-day for **The Engineer's Guide To Success,** which gives full particulars of **C. & G. Radio, A.M.I.E.E., A.M.I.Mech.E., A.F.R.Ae.S.,** etc., in which exams T.I.G.B. home-study students have gained 32 FIRST PLACES and hundreds of passes. Training until successful guaranteed.



The Technological Institute of Gt. Britain, 211, Temple Bar House, London, E.C.4

COPPER PLATES, 3in. x 8in. approx. 16 gauge, 1/- per piece.
SHORT WAVE CHOKES, 1/3 each.
CLARION SLOW MOTION ILLUMINATED DISC DRIVES, useful for short waves, 2/6.
ENAMELLED COVERED WIRE, 50 ft. 24 gauge, **9d.** a coil.
COTTON COVERED ¼ LB. REELS of 24 to 40 gauge, 2/6 a coil.
Postage must be included. No C.O.D.
FRED'S RADIO CABIN FOR BARGAINS, 75, Newington Butts, S.E.11. Rodney 2180.

EVERYTHING FOR THE SERVICEMAN AND EXPERIMENTER

VALVES. Comprehensive selection of British and American valves. American midget octals a speciality.
VALVEHOLDERS. Chassis mounting. Ceramic 5- and 7-pin, 1/3. Amphenol American octal, 1/3 ; Mazda octal, 1/- ; Paxolin Mazda octals. American octals, English 7-pin, 9d. ; English 5-pin, heavy quality, 1/-.
SWITCHES. Rotary wavechange midget switches, 2-way, 2-pole (DPDT), 2-way, 1-pole (SPDT). Switch for tone control circuits, etc., 3-way, 2-pole shorting. All at 3/6 each.
CONDENSERS. Mica wire ends, .00015 mfd., .0023 mfd., 6d., 5/- doz. .01 mfd., 1/-. Tubular, .1 mfd., .01 mfd., 9d., 8/- doz. Electrolytic (cardboard), 50+100 mfd., 10v. wkg., 15v. surge, 2/6.
KNOBS. Handsome knobs, milled edge, 2½ inch diameter, 1/6. Black pointer instrument knobs, 1/3.
PAXOLIN panels, Sockets marked A.E. GRAMO., 6d. ; ext. L.S. 4d.
SAFETY FUSE, Baseboard holder, fuse bulb, new boxed for battery sets, 1/3.
DROPPER resistances, Speakers, Volume controls, etc., etc.
Service dept. for the repair of British and American Receivers.
Stamped envelope with all inquiries, please. Postage on all orders.
O. GREENLICK, 34, Bancroft Road, Cambridge Heath Rd., London, E.1. (Stepney Green 1334.)

COULPHONE Radio, New Longton, Nr. Preston. Brand new goods only. P.M. Speakers with transformer, 8in. Rola and Celestion, **24/6.** 5in. Rola, **22/6.** Electrolytics, 50 mfd. 50 v., **3/3.** Erie 1 watt resistors, all value **9d.** each. Push-back wire, 100ft. coils, **6/-.** Barreter resistors, **6/-.** Parafeed L.F. Transformers, 4 : 1, **4/9.** Tinned copper wire, ½lb. reel, **2/3.** Mains Transformer, 350-0-350, 120 m.a., 4 v. 6 a., 4 v. 2.5 a., **28/6.** Resin-cored solder, 1lb. reels, **4/6.** Output Transformer Power-Pen, **7/6.** Tungsram Valves. Stanelco Electric Soldering Irons, **21/-.** Tubular and Mica Condensers. Systoflex, **3d. yd.** Switch cleaner, **2/3** bottle. S.A.E. for stock list.

PERMANENT CRYSTAL DETECTORS Tellurium-Zincite combination. Complete on base. Guaranteed efficient, **2/6** each. Wireless crystals with silver cats-whisker, **6d.** B.A. thread screws and nuts. One gross assorted useful sizes, **2/6.** Reconditioned headphones, 4,000 ohms, **12/6** pair. Postage extra. Post Radio Supplies, 67, Kingscourt Road, London, S.W.16

VALVES. B.V.A. and American. List plus tax. Include PenA4, AC/TP, 35Z5, 25Z6, 50L6, 5Z4G, U50, 80, 6A7, 6A3G, 25L6, 1A7G, Pen4DD.—L. W. Lawrence, Station Street, Saffron Walden, Essex.

MILNES Units, 140 volts, another 120. Quantity Radio parts. Details, Stamp.—W. Dunnington, Heck, Snaith, Goole.

RADIO Valves and Service Material supplied. Cored solder 5s. one pound reel ; Tinned Copper Wire (22 s.w.g.) 2s. 6d. half pound reel ; etc., etc. Cash with order or C.O.D. Printed list and samples 6d. postal order. List only 2d. stamp.—J. Wm. Charge, 34, Wimborne Drive, Pinner, Middlesex.

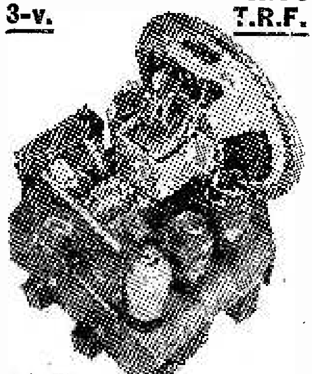
SOUTHERN Radio's Wireless Bargains :—
GROSS Assorted Screws 6/-.
GROSS Soldering Tags including Spade Ends, 6/-.
PHILCO 3-point Car Aerials. Make excellent short-wave and home aerials. Complete with fixing bolts, etc., 7/6.
LIMIT Tone Arms. Universal fixing for all types of sound box and pick-up heads, 10/-.
ACE " P.O." Microphones, complete with Transformer. Ready for use with any receiver. 7/-.
ERIE Resistances. 100 assorted resist-

(Continued in column 3.)

F. H. WILSON

A.C. & BATTERY CONSTRUCTORS' KITS

3-V. T.R.F.



A.C. Kit Assembled.

When assembled these Kits give excellent reproduction on Medium and Long Waves. Supplied complete with chassis 8in. x 6½in. x 2¼in., Valves, M.C. Speaker, and wiring diagram. (Regret, no cabinets.) 3 controls.
A.C. 3-V. (+RECTIFIER) KIT. V.M.H.F. Pen., Triode, L.F. Pen., Rectifier, M.C. Speaker. Price **£9 9s.** Post 1/1, plus 3/6 packing (returnable).
BATTERY 3-V. KIT. V.M.H.F. Pen., Triode Detector and Output Tetrode, P.M. Speaker. Price **£6 10s.** Post 1/1, plus 3/6 packing (returnable).
Orders executed in rotation. Delivery approx. one month. No C.O.D.
STANDARD 3-GANG .0005 CONDENSER, with trimmers, new, boxed. **7/6.**
2-GANG CONDENSER .0005, with trimmers, **7/6.**
A. & H.F. COILS, dual ranges reaction, coloured wires, circuit. **8/6** per pair.
NEW STEEL CHASSIS, undrilled, painted grey, 10 x 8 x 2½, **7/6** ; 8 x 6, **4/6.**
10-WATT WIRE WOUND RESISTORS, 2,000, 500, 150 ohms. **2/6** each.
SCREENED CABLE, Twin. **1/9** per yd.
MICA CONDENSERS, .001, 2,200v. test, **1/6** ; .0001, **1/-** ; .01, **1/6.**
TWIN PADDERS, ceramic 300-600 m.mfd. **1/6** each.
YAXLEY TYPE 3-bank, 2-pole, 4-way, with screening shield, complete, new, **7/6** each.
YAXLEY TYPE 2-bank, 2-pole, 3-way (shorting switch), **5/6** each.
OUTPUT SPEAKER TRANSFORMERS, heavy duty, aluminium shroud, chassis mounting, **10/-.** T.C.C. Electrolytic dry-can, 2 x 3 mfd. 300 volt working. 20 mfd. 30 volt working. 50 mfd. 25 volt working. Coloured wires, chassis mounting, **9/6** each.
MICROPHONE TRANSFORMER. Ratio 100-1, **8/6** each.
Licence to export to Northern Ireland and Irish Free State. Please add postage for enquiries and mail orders.

51-52 CHANCERY LANE, LONDON, W.C.2. Telephone: Holborn 4631

ances, ¼, ½, 1 and 2 watt. Sizes from .8 ohm upwards. Brand new with wire ends. 100 for 30/-.
SPECIAL Assorted Parcel for Servicemen. 100 Erie Resistances, assorted sizes from .8 ohms upwards, ¼, ½, 1 and 2 watt ; 24 Assorted Tubular Condensers, .01, .05, .1, etc., up to 6 mfd. 50 volt ; 6 Reaction Condensers ; 12 Lengths Sleeving ; 75ft. push-back wire ; Soldering Tags, screws and wire. All brand new, 65/-.
POWERFUL Circular Magnets, 1¼ inches diameter by ⅜ inch thick, 1/6 each, 15/- per dozen.
TUNGSRAM H. R. 210 Valves. General Purpose Battery type, 4/9.
CRYSTALS (Dr. Cecil) 6d. each, 5/6 per dozen ; with cats-whisker, 9d. each, 8/- dozen. Complete Crystal Detectors, 2/6 ; 75 feet Covered Wire for Aerials, etc., 2/6 ; 25 yds. Push-back Wire, 5/- ; Crystals Cups, 6d. each, 5/- dozen ; Telsen Reaction Condensers (.0001), 1/9 each, 18/- dozen ; Telsen Large Disc Drives, complete with escutcheon, knob, etc., type W184, 3/- each, 30/- dozen ; Insulated Sleeving, Assorted yard lengths, 4/- per dozen ; Single Screened Wire, 12 yds. 10/- ; M.E.S. Holders (miniature screw bulb holders), metal, 7½d. each., 6/- per dozen. Many other Bargains for Callers.
SOUTHERN Radio Supply Co., 46, Lisle Street, London, W.C. Gerrard 6653.

RELIANCE RADIO SERVICE,
8, Kennington Park Road, S.E.11.
'Phone : REL. 2331.

ROLA PERMANENT MAGNET SPEAKERS. All less Transformer. 5in, **21/-.** 6in. **23/-.** 8in. **27/6.**
LINE CORD. 3-way. 350 ohms with 2-pin plug complete, **12/9.** 550 ohms with 2-pin plug complete, **20/-.**
FLEX, TWIN. Red and black, heavy duty, **1/-** per yard. 10yd. lengths. Mains Lead, twin, suitable for any set, 6ft. long, with plug, **3/-.**
T.C.C. TUBULAR CONDENSERS. .0001 mfd., .0002 mfd., .0003 mfd., .0005 mfd., .005 mfd., .02 mfd., .001 mfd., all 350 volt working **6d.** each, **5/6** doz. .1 mfd., 350 volt working, **8d.** each, **7/6** doz. 25 mfd., 25 volt working, **1/6** each. 50 mfd. 12 volt. working, **1/3** each. 50 mfd., 25 volt working, **1/9** each. 25 mfd., 50 volt working, **1/9** each. 8 mfd., 125 volt working, **3/6.**
ASSORTED TUBULAR CONDENSERS. Our selection, **2/6** per doz.
CELLULOID TUNING DIALS. Oval type with fixing bracket. 2 wave-band, 2 colours, **1/-** each.
2-PIN 5 AMP. MAINS PLUGS. Superior quality, **1/3** each. Howard Jones 5-pin American Plugs, **1/6** each.
RESIN CORE SOLDER. 1 lb. reels, best make, **4/6** reel. In 1yd. lengths, **4d.** per yd.
VALVE HOLDERS. U.S. type. 7-, 6-, 5-, and 4-pin **7d.** each. English type, 7-pin, and Mazda Octal, also International Octal, **8d.** each.
2-WATT ERIE RESISTORS. 300 ohms, 500,000 ohms, 500,000 ohms, 5,000 ohms, 700,000 ohms, **1/-** each.
PILOT BULBS. Osram gas-filled, 6.3 volt .3 amp., **9d.** each, **8/6** per doz.
VIBRATORS. 4-pin Philco type, 6 and 12 volts, **10/-** each.
CRYSTAL SETS. Complete with permanent detector. All you need are 'phones, aerial and earth. Perfect reception, **12/6** each.
MICROPHONES. Table model complete with transformer. Transverse current type, **7/6** each.
All Orders should include postage. Regret no C.O.D. Customers in Eire should add 10% to the above prices to cover extra cost of post and packing.
RELIANCE RADIO SERVICE,
8, Kennington Park Road, S.E.11.

TUITION

LEARN MORSE CODE the Candler way. See advertisement on page 307.

" RADIOLOCATION."—Students of both sexes trained for important war-time Radio Appointments. Also for peace-time careers in all branches of Radio and Television. Boarders accepted. Low inclusive fees. College in ideal peaceful surroundings. 2d. stamp for Prospectus.—Wireless College, Colwyn Bay.

PRACTICAL Postal Radio Courses, coaching for I.P.R.E. exams. and post-war appointments ; booklet, stamp.—Secretary, I.P.R.E., Bush House Walton Avenue, Henley-on-Thames

Practical Wireless

BLUEPRINT SERVICE

PRACTICAL WIRELESS — *No. of Blueprint.*

CRYSTAL SETS

Blueprints, 6d. each.

1937 Crystal Receiver	PW71
The "Junior" Crystal Set	PW94*

STRAIGHT SETS. Battery Operated.

One-valve : Blueprints, 1s. each.

All-Wave Unipen (Pentode)	PW31A
Beginners' One-valver	PW85*
The "Pyramid" One-valver (HF Pen)	PW93*

Two-valve : Blueprint, 1s.

The Signet Two (D & L F)	PW76*

Three-valve : Blueprints, 1s. each

Selectone Battery Three (D, 2LF (Trans))	PW10
Summit Three (HF Pen, D, Pen)	PW37
All Pentode Three (HF Pen, D (Pen), Pen)	PW39
Hall Mark Cadet (D, LF, Pen (RC))	PW48
F. J. Camm's Silver Souvenir (HF Pen, D (Pen), Pen) (All-Wave Three)	PW49
Cameo Midget Three (D, 2 LF (Trans))	PW51
1936 Sonotone Three-Four (HF Pen, HF Pen, Westector, Pen)	PW53
Battery All-Wave Three (D, 2 LF (RC))	PW55
The Monitor (HF Pen, D, Pen)	PW61
The Tutor Three (HF Pen, D, Pen)	PW62
The Centaur Three (SG, D, P)	PW64
F. J. Camm's Record All-Wave Three (HF Pen, D, Pen)	PW69*
The "Colt" All-Wave Three (D, 2 LF (RC & Trans))	PW72*
The "Rapide" Straight 3 (D, 2 LF (RC & Trans))	PW82*
F. J. Camm's Oracle All-Wave Three (HF, Det, Pen)	PW78
1938 "Triband" All-Wave Three (HF Pen, D, Pen)	PW84
The "Hurricane" All-Wave Three (SG, D (Pen), Pen)	PW89
F. J. Camm's "Push-Button" Three (HF Pen, D (Pen), Tet)	PW92*

Four-valve : Blueprints, 1s. each

Beta Universal Four (SG, D, LF, Cl. B)	PW17
Nucleon Class B Four (SG, D (SG), LF, Cl. B)	PW34B
Fury Four Super (SG, SG, D, Pen)	PW34C
Battery Hall-Mark 4 (HF Pen, D, Push-Pull)	PW46
"Acme" All-Wave 4 (HF Pen, D (Pen), LF, Cl. B)	PW83
The "Admiral" Four (HF Pen, HF Pen, D, Pen (RC))	PW90*

Mains Operated

Two-valve : Blueprints, 1s. each.

A.C. Twin (D (Pen), Pen)	PW18*
A.C.-D.C. Two (SG, Pow)	PW31*
Selectone A.C. Radiogram Two (D, Pow)	PW19

Three-valve : Blueprints, 1s. each.

Double-Diode-Triode Three (HF Pen, DDT, Pen)	PW23*
D.C. Ace (SG, D, Pen)	PW25
A.C. Three (SG, D, Pen)	PW29
A.C. Leader (HF Pen, D, Pow)	PW35C*
D.C. Premier (HF Pen, D, Pen)	PW35B
Unique (HF Pen, D (Pen), Pen)	PW36A
Armada Mains Three (HF Pen, D Pen))	PW38
F. J. Camm's A.C. All-Wave Silver Souvenir Three (HF Pen, D, Pen)	PW50*
"All-Wave," A.C. Three (D, 2 LF (RC))	PW54*
A.C. 1936 Sonotone (HF Pen, HF Pen, Westector, Pen)	PW56
Mains Record All-Wave 3 (HF Pen, D, Pen)	PW70

Four-valve : Blueprints, 1s. each.

A.C. Fury Four (SG, SG, D, Pen)	PW20*
A.C. Fury Four Super (SG, SG, D, Pen)	PW34D
A.C. Hall-Mark (HF Pen, D, Push-Pull)	PW45*
Universal Hall-Mark (HF Pen, D, Push-Pull)	PW47

SUPERHETS.

Battery Sets : Blueprints, 1s. each.

F5 Superhet (Three-valve)	PW40
F. J. Camm's 2-valve Superhet	PW52

Mains Sets : Blueprints, 1s. each.

A.C. £5 Superhet (Three-valve)	PW43
D.C. £5 Superhet (Three-valve)	PW42
F. J. Camm's A.C. Superhet 4	PW59*
F. J. Camm's Universal £4 Superhet 4	PW60
"Qualitone" Universal Four	PW73*

Four-valve : Double-sided Blueprint, 1s. 6d.

Push Button 4, Battery Model Push Button 4, A.C. Mains Model	PW95*

SHORT-WAVE SETS. Battery Operated.

One-valve : Blueprint, 1s.

Simple S.W. One-valver	PW88*

Two-valve : Blueprints, 1s. each.

Midget Short-wave Two (D, Pen)	PW38A
The "Fleet" Short-wave Two (D (HF Pen), Pen)	PW91*

Three-valve : Blueprints, 1s. each.

Experimenter's Short-wave Three (SG, D, Pow)	PW30A*
The Prefect 3 (D, 2 LF (RC and Trans))	PW63*
The Band-Spread S.W. Three (HF Pen, D (Pen), Pen)	PW68*

PORTABLES

Three-valve : Blueprints, 1s. each.

F. J. Camm's ELF Three-valve Portable (HF Pen, D, Pen)	PW65
Parvo Flyweight Midget Portable (SG, D, Pen)	PW77*

Four-valve : Blueprint, 1s.

"Imp" Portable 4 (D, LF LF (Pen))	PW86*

MISCELLANEOUS

Blueprint, 1s.

S. W. Converter-Adapter (1 valve)	PW48A*

AMATEUR WIRELESS AND WIRELESS MAGAZINE

CRYSTAL SETS.

Blueprints, 6d. each.

Four-station Crystal Set	AW427
1934 Crystal Set	AW444
150-mile Crystal Set	AW450*

STRAIGHT SETS. Battery Operated.

One-valve : Blueprint, 1s.

B.B.C. Special One-valver	AW387

Two-valve : Blueprints, 1s. each.

Melody Ranger Two (D, Trans)	AW388
Full-volume Two (SG det. Pen)	AW392
A Modern Two-valver	WM409*

Three-valve : Blueprints, 1s. each.

£5 5s. S.G. 3 (SG, D, Trans)	AW412*
Lucerne Ranger (SG, D, Trans)	AW422*
£5 5s. Three De Luxe Version (SG, D, Trans)	AW435*
Transportable Three (SG, D, Pen)	WM271
Simple-Tune Three (SG, D, Pen)	WM327
Economy Pentode Three (SG, D, Pen)	WM337
"W.M." (1934 Standard Three (SG, D, Pen))	WM351*
£3 3s. Three (SG, D, Trans)	WM354
1935 £6 6s. Battery Three (SG, D, Pen)	WM371
PTP Three (Pen, D, Pen)	WM389
Certainty Three (SG, D, Pen)	WM393
Minitube Three (SG, D, Trans)	WM396*
All-wave Winning Three (SG, D, Pen)	WM400

Four-valve : Blueprints, 1s. 6d. each.

65s. Four (SG, D, RC, Trans)	AW370
Self-contained Four (SG, D, LF, Cl. B)	WM331
Lucerne Straight Four (SG, D, LF, Trans)	WM350
£5 5s. Battery Four (HF, D, 2LF)	WM381*
The H.K. Four (SG, SG, D, Pen)	WM384
The Auto Straight Four (HF, Pen, HF, Pen, DDT, Pen)	WM404*

Five-valve : Blueprints, 1s. 6d. each.

Super-quality Five (2 HF, D, RC, Trans)	WM320
Class B Quadradyne (2 SG, D, LF Class B)	WM344
New Class B Five (2 SG, D, LF Class B)	WM340

Mains Operated.

Two-valve : Blueprints, 1s. each.

Consoelectric Two (D, Pen) A.C.	AW403
Economy A.C. Two (D, Trans) A.C.	WM286

Three-valve : Blueprints, 1s. each.

Home Lover's New All-Electric Three (SG, D, Trans) A.C.	AW383*
Mantovani A.C. Three (H.F. Pen, D, Pen)	WM374
£15 15s. 1936 A.C. Radiogram (HF, D, Pen)	WM401

Four-valve : Blueprints, 1s. 6d. each.

All Metal Four (2 SG, D, Pen)	WM329
Harris' Jubilee Radiogram (HF, Pen D, LF, P)	WM386

SPECIAL NOTICE

THESE blueprints are drawn full size. The issues containing descriptions of these sets are now out of print, but an asterisk beside the blueprint number denotes that constructional details are available, free with the blueprint.

The index letters which precede the Blueprint Number indicates the periodical in which the description appears: Thus P.W. refers to PRACTICAL WIRELESS, A.W. to *Amateur Wireless*, W.M. to *Wireless Magazine*.

Send (preferably) a postal order to cover the cost of the Blueprint (stamps over 6d. unacceptable) to PRACTICAL WIRELESS Blueprint Dept., George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.

SUPERHETS

Battery Sets : Blueprints, 1s. 6d. each.

'Varsity Four	WM395*
The Request All-Waver	WM407

Mains Sets : Blueprints, 1s. each.

Heptode Super Three A.C.	WM359*

PORTABLES

Four-valve : Blueprints, 1s. 6d. each.

Holiday Portable (SG, D, LF, Class B)	AW393
Family Portable (HF, D, RC, Trans)	AW447
Tyers Portable (SG, D, 2 Trans)	WM367

SHORT-WAVE SETS. Battery Operated

One-valve : Blueprints, 1s. each.

S.W. One-valver for America	AW429*
Roma Short-Waver	AW452

Two-valve : Blueprints, 1s. each.

Ultra-short Battery Two (SG, det Pen)	WM402*
Home-made Coil Two (D, Pen)	AW440

Three-valve : Blueprints, 1s. each.

Experimenter's 5-metre Set (D, Trans, Super-regen)	AW438
The Carrier Short-waver (SG, D, P.)	WM390

Four-valve : Blueprints, 1s. 6d. each.

A.W. Short-wave World-beater (HF, Pen, D, RC, Trans)	AW436
Standard Four-valver Short-waver (SG, D, LF, P)	WM383*

Superhet : Blueprint, 1s. 6d.

Simplified Short-wave Super	WM397

Mains Operated

Two-valve : Blueprints, 1s. each.

Two-valve Mains Short-waver (D, Pen) A.C.	AW453*

Three-valve : Blueprints, 1s.

Emigrator (SG, D, Pen) A.C.	WM352

Four-valve : Blueprints, 1s. 6d.

Standard Four-valve A.C. Short-waver (SG, D, RC, Trans)	WM391*

MISCELLANEOUS

S.W. One-valve Converter (Price 6d.)	AW329
Enthusiast's Power Amplifier (1/6)	WM387*
Listener's 5-watt A.C. Amplifier (1/6)	WM392*
Radio Unit (2v.) for WM392 (1/-)	WM398*
Harris Electrogram battery amplifier (1/-)	WM399
De Luxe Concert A.C. Electrogram (1/-)	WM403*
New Style Short-wave Adapter (1/-)	WM388
Short-wave Adapter (1/-)	AW456
B.L.D.L.C. Short-wave Converter (1/-)	WM405
Wilson Tone Master (1/-)	WM406
The W.M. A.C. Short-wave Converter (1/-)	WM408*

FREE ADVICE BUREAU COUPON

This coupon is available until June 12th, 1943, and must accompany all Queries and Hints.

PRACTICAL WIRELESS, JUNE, 1943.

Published on the 7th of each month by GEORGE NEWNES, LIMITED, Tower House, Southampton Street, Strand, London, W.C.2, and printed in England by THE NEWNES & PEARSON PRINTING CO., LTD., Exmoor Street, London, W.10. Sole Agents for Australia and New Zealand: GORDON & GOTCH, LTD. South Africa: CENTRAL NEWS AGENCY, LTD. Subscription rates including postage: Inland 10s. 6d. per annum; Abroad 10s. per annum. Registered at the General Post Office for the Canadian Magazine Post.