MAINS TRANSFORMER DESIGN— See page 474

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Edited by F. J. CAMM

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Practical Wireless and PRACTICAL TELEVISION

3D. EVERY WEDNESDAY

Feb 24th, 1940.

Contents

IN PEACE AND WAR men risk their lives that we may work and live . . . Here is the thrilling story of their exploits!

ROUND THE WORLD IN INDUSTRY

By Gerald Collins

DOWN in the depths a diver was facing death in its most terrible form—he had been boring a tunnel in the sea-bed when the walls collapsed and entombed him! Read how he faced the situation. . . . Read also of the photographer who went alone into the swirling gas of a gasholder to try to get pictures—of the lumberjack who swam under a mountain to dynamite a log jam—of the joke that sent a young man prospecting for gold where none existed, and how he made an amazing " strike."

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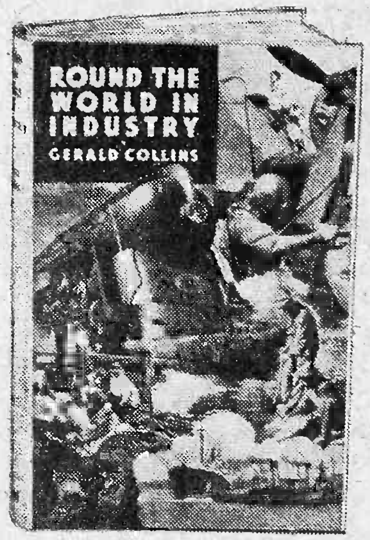

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The World's Proudest Train; Hunting for Seals; The Big Ships They Build in Britain; Cattle Raising and "Bronco Busting"; How a Diver Risks His Life Under the Sea; The Man Behind the Newspaper Pictures; Life of an Aeroplane Test-Pilot; Prospecting for Gold; The Watch on the World's Biggest Port; Black Diamonds from the Coalmines; the Life of the Lumberjacks; Work of the Motor-car Testers; Drilling for Oil; Stunting for the Films; Cables that Link the Nations; These Tunnellers are Human Moles.

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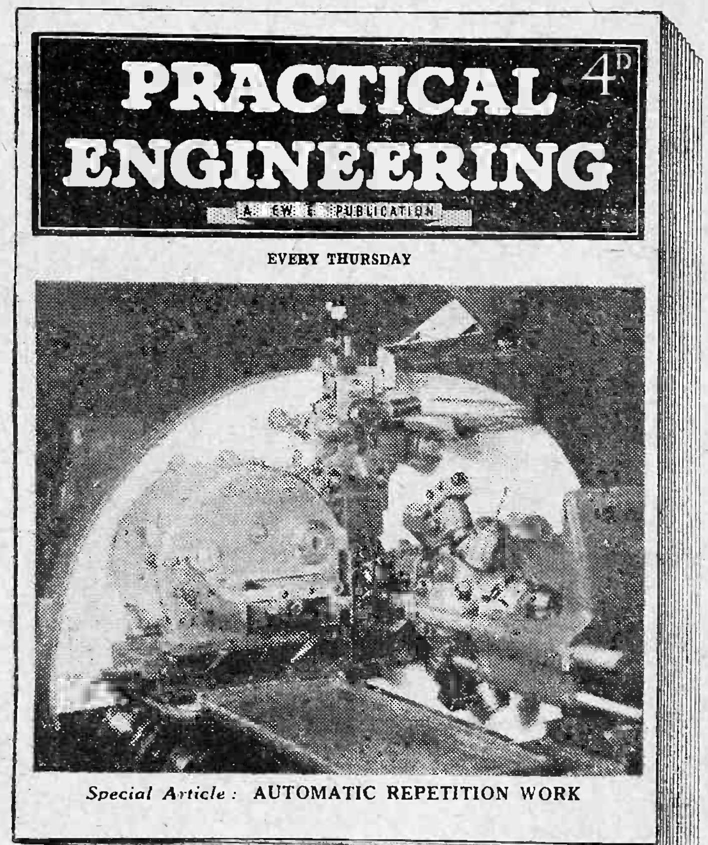

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EVERY WEDNESDAY
Vol. XV No. 388. Feb. 24th, 1940.
EDITED BY
F. J. CAMM
Staff:
W. J. DELANEY, FRANK PRESTON,
H. J. BARTON CHAPPLE, B.Sc.

ROUND THE WORLD OF WIRELESS

Valve Testers

MANY listeners use their receivers year after year and never give a thought to the question of valve life. Modern valves operate so well that in many cases they will give years of satisfactory reception, but if a valve which has been in use for a considerable time is checked properly it may be found that it has deteriorated and the replacement of a set of valves might rejuvenate many a receiver. The gradual deterioration is not noticed as a rule, and many receivers are thus failing to give the results of which they are capable. Many dealers have a small type of valve tester which, on plugging in a valve, indicates the condition of it—weak, good or replacement. This alone is sufficient, but the real experimenter or amateur serviceman is interested in ascertaining the exact characteristics of a valve and for this purpose a properly designed valve tester is necessary. This will give the various anode current readings with varying H.T. and G.B. voltages; will indicate the amplification factor, goodness factor and other details, but is obviously not a very simple instrument. A set of valveholders must be incorporated so that any desired type of valve may be instantly tested, and in this issue we describe the first part of such a combined instrument, which is built in three sections. Most of the necessary apparatus will be found in the average spares box and the complete installation will be found of great value to the serious experimenter.

G.E.C. and "Graf Spee"

AT the request of the British Embassy at Buenos Aires, the Anglo-Argentine General Electric Co., Ltd., has loaned a G.E.C. radio receiver to British sailors who are in hospital there recovering from wounds received while on board H.M.S. *Achilles* during the recent battle with the *Graf Spee*.

War Cabinet Speakers

THE Prime Minister will broadcast to the country on February 24th from Birmingham Town Hall, closing the series of speeches made up and down the country by members of the War Cabinet.

Command Performance for Children

THE Scottish Children's Theatre Company of Bertha Waddell will present a programme in Children's Hour on February 22nd. Their first performance was given in 1927 in a small Glasgow hall, but since then these entertainers have travelled all over the country, playing in schools, in colleges, theatres, halls and private houses. They have even been invited to Glamis Castle and Balmoral to give command performances before Princess Elizabeth and Princess Margaret Rose. Since the war broke out, Bertha Waddell's company has done special work among evacuated children.

A Play from Michael Arlen

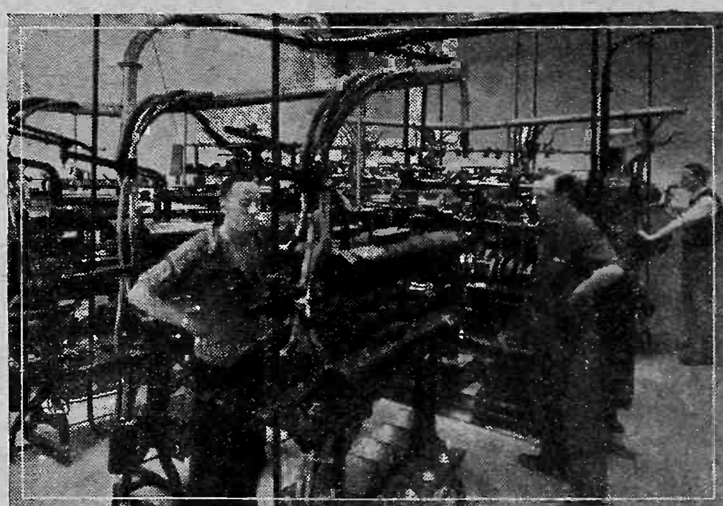
"RED ANTHONY," which listeners will hear on February 23rd, is a play adapted from Michael Arlen's story of the roistering gigantic Anthony Poole. Red Anthony tries to solve the mystery of how his brilliant brother came to kill himself by reconstructing the crime in his brother's own room. The mystery is solved at last in an exciting final scene. Hugh Stewart, who has adapted and dramatised this story for broadcasting, has succeeded in keeping much of the author's witty dialogue and sophisticated wisecracks.

Uncle Remus

FIRST of what is sure to be an intriguing series is in preparation for broadcasting on February 22nd. This is called "Uncle Remus." The broadcasts will be founded on a group of stories under the same title by Joel Chandler Harris, which has gained an immortal status in America, if not quite so well known in this country.

Uncle Remus, an old darkie who lived in Georgia, had innumerable fascinating legends to tell of a host of queer and kindly animals living in the dark African jungle. In these broadcasts listeners will soon become acquainted with the Tar Baby, Brer Rabbit, Brer Possum, Brer Terrapin and many other delightful creatures. Altogether the series presents remarkable opportunities for radio production.

The distinguished negro actor and singer, Robert Adams, will play Uncle Remus. James Dyrenforth will adapt the stories for radio and David Porter will produce. Henry Reed will be responsible for the music, which will be after the style of the scores which he wrote for "Æsop's Fables."



Some of the electric ovens used for the process of enamelling copper wires.

Edward Isaacs

EDWARD ISAACS, the well-known Manchester musician, is all the more remarkable because he is completely blind. He was a student of the Royal Manchester College and protégé of Charles Hallé, studying in Germany and Austria after leaving Manchester. He was one of the founders of the Midday Society Concerts in Manchester. On February 23rd he will broadcast a Bach recital.

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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.

THE POWER AMPLIFIER IN PRACTICE

(Continued from previous page)

the screen or anode stopper is to carry substantial current. Often a screen stopping resistance is preferable to a resistance in the anode lead.

Suitable values may be from 5,000–50,000 ohms for the grid stopper and 50–100 ohms for the screen stopper.

Parasitic oscillation or "squegger" may cause a flash-over between the valve pins if of high enough H.F. voltage, particularly if the grid and anode leads of the valve follow parallel paths, in which the conditions are closely similar to those of an ultra-short-wave self-oscillator. Precautions as above are therefore the first essential.

Distortion

The next point to consider in our choice of triode or pentode is the much discussed one of *distortion*, or percentage of harmonic content superimposed on the waveform most commonly introduced with pentodes is introduction of "odd" harmonics such as 3rd, 5th, etc., which rapidly become much more unbearable to the ear as the percentage increases, and moreover cannot be balanced out on a push-pull circuit. It is to reduce those harmonics, among other reasons, that circuits called "*Negative or Reverse Feedback*" are employed, and many varieties of the basic principle involved in this are used in practice.

Negative Feedback

"Negative feedback" is simply a reversal of our old friend of the early days of knob-twiddling wireless which we called "reaction" and which was in effect "positive feedback" applied to H.F. circuits. "Re-generation" or positive feedback now becomes in our audio frequency amplifier "de-generation," and just as reaction *increased* the sensitivity of our H.F. stage, so negative feedback *decreases* the amplification of our output stage.

This decrease in sensitivity of course nance at certain frequencies. The whole subject is one of wide scope and space does not permit further discussion here.

"Matching" of Output Circuit

We must now turn to what is probably the most important aspect of a successful output stage—namely, correct "*matching*" to the "load" or loudspeaker.

It is seldom that the loudspeaker can be connected with its "speech" winding directly in series with the output valve anode circuit. For one thing, heavy direct currents are undesirable, and—most important—it is unlikely that the relative impedance of the valve and loudspeaker winding are such as to produce the maximum transfer of audio-frequency power, or the minimum distortion of the waveform. Further, it is often assumed that the loudspeaker behaves as a resistance load—constant at all frequencies, and that all that had to be done was to calculate the ratio of valve load to loudspeaker resistance, take the square root and wind a transformer with a turn ratio corresponding to the result of this arithmetical exercise.

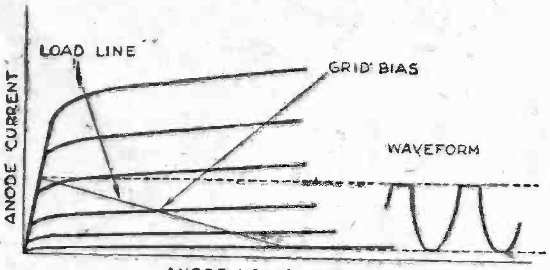

Fig. 12. (Left)—Form of distortion with pentode, resembling current distortion.

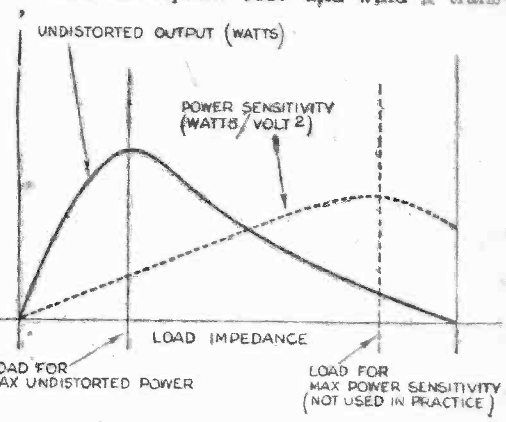

Fig. 13.—Curves showing how undistorted output varies with the load for a given pentode valve.

of the input signal by the complete output stage. To be comprehensive, this must also take into account the characteristic of the loudspeaker, which may vary over a very wide range depending on the nature of its design.

When a triode valve is used, the most common form of distortion is that caused by the introduction of second harmonic, or the "octave" of the original frequency. Fortunately, the ear can stand a good deal of this form of distortion before it becomes distressing, but as the degree of second harmonic introduced may vary widely over the frequency scale, increasing as the load impedance becomes reduced at the lower audio frequencies, an unpleasant result often occurs when music is being received, consisting of a mixture of very low and high frequencies simultaneously. The provision of a push-pull circuit with triodes may be designed practically entirely to overcome this defect, and hence the popularity of the push-pull triode output stage for "quality" amplifiers.

The design of a power triode for minimum second harmonic content does not, however, lend itself to the use of indirectly heated cathodes, for the reason that a large surface area for electron emission, such as obtaining with a tubular cathode of diameter approaching that of the grid, leads to lack of grid control as the anode voltage is increased. This leads to what is known as a "taily" characteristic, decreased output, and increased second harmonic, unless a very expensive electrode design is adopted.

Most power triodes, therefore, are found to have directly heated filaments. The application in a push-pull circuit, however, largely overcomes this disability, and the pentodes wired as triodes are often so used. In many cases the benefits of an indirectly heated cathode in simplification of automatic bias arrangements, hum reduction, etc., point to the use of a pentode or tetrode (in which the effect described above is not of prior importance). The form of distortion tends to bring the effective gain of an output pentode down to that possible with a triode, the amount of decrease in sensitivity depending on the percentage of the amplified voltage which is fed back into the input in reversed phase.

A set of curves (Fig. 9) shows clearly how the introduction of feedback affects the input required to produce a given output power, and the distortion. The circuit used to produce these results is shown in Fig. 10. The example is for a battery amplifier, but would apply equally—and possibly with more force—to a mains driven amplifier (Fig. 11).

Feedback circuits are also used to improve frequency response, and reduce objectionable effects of loudspeaker reso-

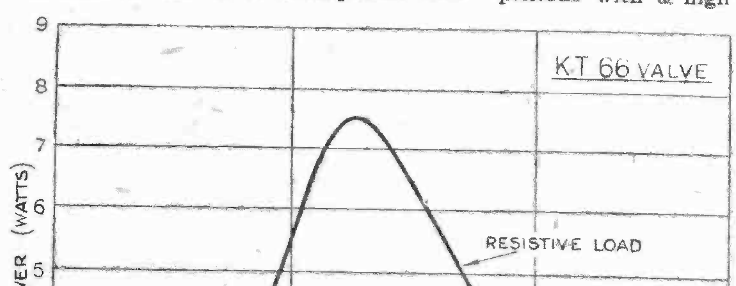

Fig. 14.—Curves taken of measured output voltage and varying load impedance.

An additional assumption often made is that the full output of a valve under Class A or AB1 conditions, with any anode load, is given by applying a grid voltage input just insufficient to cause flow of positive grid current.

While these assumptions may apply to some extent in the case of triode valves, they cannot do so in the case of pentodes or tetrodes.

Fig. 12 shows a family of curves for a pentode with a high impedance load-line superimposed. In this case, although the grid swing is restricted such as to avoid positive grid current, the "crowding up" of the grid voltage curves at the region of low anode voltage produces a form of distortion which is indistinguishable from grid-current distortion. The extent of grid swing is, therefore, quite useless as a guide in assessing the undistorted output in this class of valve. The "optimum load" becomes a factor of the highest importance, and hence the necessity for accurate

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ON YOUR WAVELENGTH

By Thermion

The Effect of the War

THE war has had its inevitable effect on the design of commercial radio receivers, and also upon the prices of them. Many models, it will be observed, have been withdrawn, whilst some of those remaining have been advanced in price. The usual release of new models which normally takes place in the spring is this year on a greatly reduced scale.

An examination of the programmes which have been sent to me so far indicate that manufacturers have used their ingenuity in making the best possible use of materials which, in most cases, are now only available under the permit system. Munitions are absorbing a great deal of the materials which are used in the manufacture of wireless sets, especially aluminium and the non-ferrous metals. Thus, the wireless trade must face the fact that as the war goes on the supply to them will be even more restricted than it is now.

One of the things you will notice about the new 1940 receivers is that they are getting smaller. I do not think that this is entirely due to the desire to economise in material, but because it has been found that greater efficiency can result from the use of less material. Portables figure largely in the lists. This is understandable when we remember the large numbers of people who are evacuated, the large numbers of A.R.P. workers, and the enormous number of people who have joined the Forces and desire to have radio wherever they may be located. Undoubtedly, there is more listening being done to-day than ever before, not only because the public is compelled to spend most of its evenings indoors during the black-out, but also because they are taking a keen interest in the News Bulletins.

There has been a distinct shortage of portables and long delay in delivery. The trade is, however, catching up. There are several sets of the mains-battery type, which will operate either on batteries or on A.C./D.C. mains.

Push-button sets, as I forecast when they were first introduced, are not so popular, and I do not think that they will remain as part of British design. There will not, of course, be a Radio Show this year, and so the new releases will be launched in the ordinary way by press announcements and by local displays.

War Fun

THE good humour of the British soldier is proverbial, and in each successive war it wins the admiration of a world astonished that in face of dangers, privations and discomforts, Tommy is always ready to crack a joke himself and to laugh at those of his fellows.

This incurable sense of fun and the lighter side of war generally are admirably illustrated in a new publication called *War Fun*, which is now obtainable through all newsagents and bookstalls, price 6d. The jokes reproduced are by the most famous artists of the day—Bert Thomas, Lees. Wallis Mills, A. C. Barrett, Treyer Evans, G. S. Sherwood, Peter Probyn, Hynes, Batchelor, and Arthur Ferrier, to name but a few.

This book of "war jokes" is a unique record of the British sense of humour in war-time. It will be appreciated in every home and every mess, either here or overseas.

What's In a Name?

WHY all the fuss about the identity of "Onlooker"? He gave us a good talk, was interesting and to the point, even if he had a rather "bedside" manner. Surely it is not of the slightest importance to us what may be the name of the gentleman? For all I know, the "talk" might have been written by Winston Churchill and delivered by an announcer or an actor. All that matters is the interest which the talk conveys and the accuracy of the facts set forth.

From my own enquiries it seems that "Onlooker" was very popular with many listeners, and his talk was certainly free from bombast and silly exaggeration.

Personally, I prefer a rather more vigorous type of speaker, but I found our new friend stimulating, and his quiet manner far more refreshing than "Haw-Haw's" silly blather. Incidentally, why do not the B.B.C. give us a few alternatives to Sir Ernest Swinton? He's not very interesting, and I should like to have his talk only once in three weeks. On one of the other weeks we could have a naval man (Vice-Admiral Sir James Somerville was excellent), and on the other, one whose interest centres chiefly in the R.A.F.

Incidental Music

DESCRIPTIVE talks can be very interesting; but why must they, in so many instances, be rendered unbearable by the introduction of music which, to my melodious ear, apparently bears no harmonious relation to the subject being enacted or described? If there is one thing which makes me "blue-pencilled" wild with the B.B.C. producers it is to have the picture which is being built up in my mind by the skill of the narrators and their script blasted to fragments by the blare or wail of some hideous noise produced, apparently, by an otherwise perfectly good orchestra.

While I will not pretend that I know all the technical details of production, I do most certainly know what pleases and appeals to a vast number of listeners, and I find that I am not alone in my views on this item. If music is essential for descriptive items, and I suppose it does form a useful media with which to link together the script and help to create the correct atmosphere—well, please Mr. Producer, do make such music harmonious to the whole idea, and more so to our ears, which have to suffer from an overload of discordant noises during our working day.

One feature item alone will be sufficient to emphasise the nerve-shattering stuff to which I refer. The "Shadow of the Swastika," an item which, so far as the acting parts are concerned, can create an interesting diversion to the usual run of things, but the incidental noise, sorry—music, forces me to keep my hand on the volume control so that I can cut down on it as soon as it starts to shatter the peace of my study.

A Musical Threat?

WITH the introduction of various mechanical musical (?) instruments during the past few years I have often wondered whether there would be any limit to the type of apparatus which might be inflicted on us in the future. I am not at present thrilled at some of the so-called musical instruments which have been produced in this way, although some of them admittedly have musical possibilities. I now see that the radio industry in America is looking to new developments to increase its volume of sales, and Mr. B. F. Miessner, a pioneer in electronic musical instruments, points out the opportunities in this home application of wireless valves and amplifiers in opening up new fields for manufacturer, distributor and dealer.

Electronic musical instruments, explains Mr. Miessner, (1) extend the tonal range of traditional instruments, (2) provide new types without the limitations of the traditional instruments, (3) give the composer more varied and beautiful tonal colourings, with more expressive means for reproducing them and a wider dynamic range, (4) afford the artist more complete and intimate control, and (5) make the larger instruments smaller, cheaper and more efficient producers of musical tones.

With the greater interest in music on the part of the public, as the result of eighteen years of broadcasting and the greater amounts of general leisure, Mr. Miessner feels that the field of electronic or radio-valve musical instruments is one which radio men should get into without loss of time—in this way adding millions in sales to present radio-set volume.

Comment, Chat and Criticism

The Music of Sibelius

A Brief Account of the Life and Work of Finland's Great Composer, by Our Music Critic, MAURICE REEVE

A FEW weeks ago I took the opportunity, afforded by the invasion of Poland, to write about one of her great sons, Chopin. Unfortunately, another chance presents itself, tragically similar in many details, of writing of another great man—greater, in fact, than even Chopin. Whilst the heel of Russian tyranny was stamped upon Polish freedom for a hundred and fifty years—a period covering the whole of Chopin's life—it is again the grisly bear that is threatening the existence of another and smaller nation, Finland. This remote little country, of fewer than half the souls that occupy the county of London, was, together with Poland, also under the conquering heel of the Czars. In fact, the heir to the "Czar of all the Russias" possessed the title of Grand Duke of Finland, among many others. Now, after a brief respite of twenty-two years, its independence is again challenged by the same terrible agency so that it would seem as if, whether of the right or of the left—Russia is always to be the bane and the nightmare of both nations.

The magnificent, or as Mr. Churchill recently called it the sublime, courage and fortitude now being shown by Finland in the face of well-nigh overwhelming odds, brings to the mind of those interested in the very finest music the grand name of Sibelius. For, make no mistake about it, Sibelius is one of the very greatest of the world's musicians, and is in the direct line of succession in the dynasty of the symphonists. The facts of his life can be briefly told.

He was born in 1865, so that for longer than Chopin's whole life—fifty-three years—he was the subject of Russia. His father was a doctor and his mother a clergyman's daughter. He differs from other Finnish composers in that he is bred from the purest Finnish peasant stock. He was given a classical education and studied law at Helsingfors (Helsinki) University. But before these studies were completed he found that music was his true *métier*, and he went to the Conservatoire under Wegelius, then the leader of the Finnish Nationalist movement in music. He then continued his study in Vienna and Berlin, and returned to his native land in 1893. One of the chief reasons for Sibelius's dominating musical personality is probably to be found in the fact that he never came wholly under the sway of alien or extraneous musical influences. Thus his native genius began to ripen, like Brahms's, very early, and to reach its magnificent fruition in some of his first works.

First Major Work

His first major work was Kullervo, the first of many that were inspired by the national legend of the Kalevala. The University awarded him a life grant in 1897, on which he retired to devote himself to composition. He has paid many visits to London, that in 1921 being at the invitation of Sir Henry Wood. He has also visited the United States, and taught at the Boston Conservatoire. His 50th, 60th, and 70th birthdays were treated in Finland as events of national importance.

Sibelius, as much as any composer whoever lived, is known to millions of people whose circumstances or inclinations prevent their recognition of his great contribution to music, by two small works. Just as "1812" or Lohengrin's "Bridal March" are known wherever an ensemble plays in a cinema, or restaurant, to people who know little of their authors' other works, so are Finlandia and Valse Triste applauded by countless myriads who know naught of the mighty symphonies, the Karelia Suite, or Tapiola. Finlandia, though stirring, is certainly no better than 1812 or William Tell, whilst Valse Triste is one of those curious blendings of sentiment and foreboding which I discussed at length in my article on Musical Taste, and which are so beloved by the English public. Compared to the "Alla Marcia" from the Karelia Suite, Finlandia is like cold rice pudding. It will be recalled that the Finnish people's heroic deeds in the present war are mainly being performed in the Karelian peninsula, and round about the Mannerheim Line there. Get a record of this magnificent pulse-quickening work (H.M.V. C2985), and you will no longer be in any doubt as to why the Finns are putting up the show they are.

Symphonic Music

Sibelius's work might be conveniently divided into two main groups. Whilst it is as a symphonist that he will be most revered by future ages—he has enriched music's biggest and noblest form with eight magnificent examples each teeming with originality and masterful, gorgeous music—it is for his patriotic music that he is venerated in his own country to-day, Finlandia, The Origin of Fire, the Kalevala Suite, The Swan of Tuonela, The Return of Lemmenkainen, Pohjola's Daughter, En Saga, Night Ride at Sunrise, etc., have enshrined Finland's Saga and Folk Legend as few have ever been by a musician. The Finnish people listen to this music in awe and rapture as the Germans do to Wagner's Niebelungen Lores, and they worship the man who wrote them. They preserve for them, and picture to them, those very qualities which the Russians are now finding so stubborn and disconcerting.

Sibelius's symphonies have shared with Beethoven's and Brahms's the honour of being performed in their entirety at the Promenade Concerts in recent seasons. Consequently they are rapidly becoming familiar to the widest circle of music-lovers. At the first few hearings, their uncompromising forthright nature is rather apt to "hit one in the eye," and to cause one to think that he has been given a nut to crack which may be a little too hard for his teeth to manage. Something of the same effect is doubtless obtained on a polar explorer when he first confronts the might and majesty of an iceberg, a glacier or the midnight sun. But similar effects were produced on their audiences by Beethoven and Wagner, and many another giant, and almost all the first wild anathemas that were poured on their "new" music by the detractors who usually are found lurking about the wings whenever "new" music is down for production, have long been swept aside. There is a glow and a passion in Sibelius's work as there is about Tschaikowsky or Mussorgsky, which is far removed from the zero temperature of their native lands. The majestic and irresistible sweep of his pages whirl us up in their tumult and set our pulses throbbing, as only great music can. It is intensely exciting, the bold themes send out a challenge, whilst the thematic work, and the marvellous orchestration, create in us an urge to go along with him as long as, and wherever, he cares to take us.

Varying Moods

His chief qualities may be defined as an intense love of his native soil—which, however, never degenerates into a vulgar patriotism. A brooding melancholy and a quality of sternness and obstinacy seem to suggest that the extreme rigours of his native soil and the limitations which its sub-arctic civilisation and climate must place upon its inhabitants are hemming him in—a kind of struggle for existence which at times looks like winning. But then he will blaze out into great fits of passion and bravado, hurling defiance at polar bears and icebergs, and proclaiming his complete victory over such forces. A dreary sadness passing to almost utter despair can alternate with a reckless enjoyment or a fierce anger. The symphonies are noted for an absolute freedom from convention, and a refusal to be tied down by any convention for mere convention's sake. It was the same with Beethoven and all great men. He refuses, like his great predecessor, to merely conform to tradition but insists on giving complete expression to the many vital things he is always wanting to say. An absence of the decorative and transitional type of passage, which have so endeared the works of Beethoven and Brahms to posterity, is sometimes apt to make Sibelius's work appear rather brusquer, and more uncompromising than it is seen to be on closer acquaintance. The violin concerto, closely modelled on Tschaikowsky's, is a splendid work and enormously difficult. Strangely enough, he is a very indifferent writer for the piano, and has so far contributed nothing to the stock of the most popular instrument. Here, he forms, with Elgar, a striking exception to the run of the great symphonists.

Although Sibelius has not written anything of much consequence during the last few years, it is perhaps premature to ask whether his muse has yet left him. But, even though his life's work may now be completed, he has added sufficient treasure pieces to music's storehouse to insure him an immortality among the greatest of his art.

The Modern Frequency-changer

A Brief Review of the Types of Circuit Most Widely Employed, with Some Notes on the Prevention and Cure of the More Common Faults and Troubles Likely to be Experienced

by The Experimenters

Of the many frequency-changer circuits which have been adopted during the past few years, those employing a pentagrid (or heptode), an octode, or a triode-hexode valve are probably most generally employed to-day. It should be mentioned in passing that an octode is fundamentally the same as a pentagrid or heptode, with the exception that there is an extra grid—a screening grid between the other screens and the anode.

Another type of frequency-changer which is still used to a certain extent, mainly as a short-wave converter, has an H.F. pentode or similar valve wired in a circuit similar to that of a single-valve regenerative receiver.

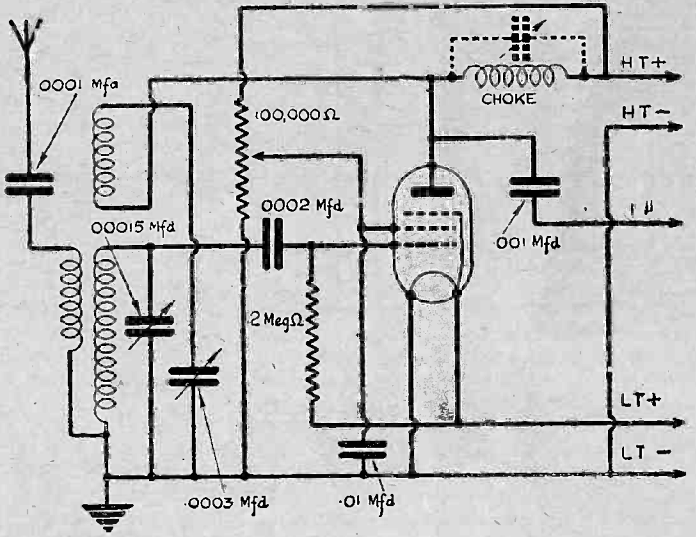


Fig. 1.—The simplest form of frequency-changer is an H.F. pentode used in a short-wave-converter circuit. There are many disadvantages inherent in this arrangement, but it has the advantages of simplicity and convenience.

H.F. Pentode

A circuit of this type is shown in Fig. 1, where it will be seen that it could be used equally well as a single-valve receiver, or as a short-wave adapter. Although very simple and convenient in many respects, this arrangement is by no means a good one when compared with other modern circuits. This is principally because it has only one tuning circuit; this circuit is not tuned to the frequency of the signal to be received, but to a frequency higher or lower by the intermediate frequency to be employed. As a result of this, any transmission can be received on at least two different settings of the tuning condenser. One of these represents a wavelength which is higher, and the other a wavelength which is lower, than that of the signal.

Additionally, the circuit is not selective when judged by present-day standards, and is not suitable for other than short-wave work. Even then it is liable to cause interference with other receivers, and even to introduce interference in the receiver with which it is used. It is customary, when using this system of frequency-changing, to include an H.F. choke in the anode circuit to provide the load, and to act in conjunction with the .001-mfd. condenser shown as an output coupling. A better arrangement is to employ a tuned coil in place of the choke, so that the I.F. can be shifted if necessary to avoid interference, and so that there is a band-pass effect between the F.C. and the broadcast receiver with which it is used. The component values shown in Fig. 1 are average ones which are generally satisfactory. As for the tuner, this can be the usual six-pin S.W. coil, but the reaction condenser might well be of rather more than average capacity to ensure that the valve can oscillate readily.

Pentagrid and Octode

The pentagrid or octode circuit shown in Fig. 2 is very widely employed, and is fairly satisfactory for use on all wavelengths down to about 20 metres. It can often be used on still lower wavelengths, but there might then be some difficulty in ensuring that the oscillator section will provide sufficient output over the waveband. Any difficulty in this respect can usually be overcome easily enough by connecting a small-power valve in parallel with the oscillator section. Actually, the best procedure is to connect both oscillator grid and the triode grid to the end of the oscillator coil, through fixed resistors of about 50 ohms, and to connect the oscillator anode (another grid in practice) to the screening grids of the pentagrid. The anode winding of the oscillator coil is then included in the anode circuit of the extra triode.

Oscillator Tuning

It will be seen from Fig. 2 that the tuned winding of the oscillator coil is in the grid circuit, but there is seldom any objection to including it in the anode circuit, as shown in the case of the triode-hexode illustrated in Fig. 3. Generally, however, the tuned-grid arrangement is most effective for the pentagrid. Values given in Fig. 2 are average ones only, and the resistors and condensers should be chosen to agree with the recommendations made by the makers of the particular valve employed. Another point which will often arise in practice concerns the application of A.V.C. to the frequency-changer. Connections for this can be made as indicated by broken lines in Fig. 2. When the receiver is to be used for short-wave reception only, it is generally better to replace the by-pass condensers marked as having a capacity of .1 mfd. by others of .01 mfd.; this is not of great importance if good-quality non-inductive condensers are fitted.

The Triode-hexode

The triode-hexode frequency-changer, shown in Fig. 3, is coming into increasing use, especially for S.W. and all-wave receivers. It is generally more effective on the S.W. bands, due to the oscillator

(Continued on next page.)

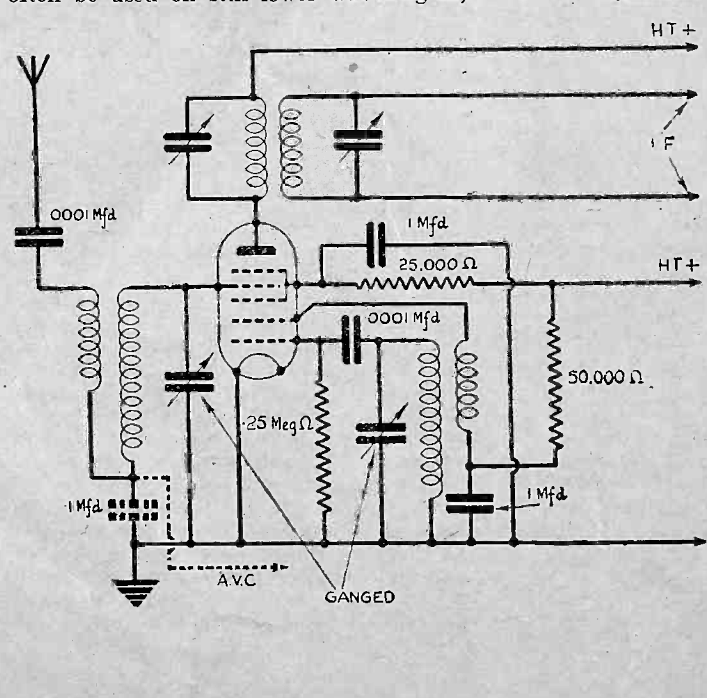


Fig. 2.—The pentagrid or heptode frequency-changer is probably used most extensively at the present time. It is efficient on all wavebands down to about 20 metres, but in some cases an additional triode should be used as separate oscillator.

THE MODERN FREQUENCY-CHANGER

(*Continued from previous page.*)

output being steadier than with the pentagrid. In addition, there is less trouble, due to the oscillator tuning "pulling" the input tuning. The circuit used for this valve is similar in all major respects to that required for a pentagrid, but it is nearly always desirable, if not essential, to tune the anode circuit of the oscillator section, and to parallel-feed the anode winding, as shown in Fig. 3. Thus, the high-tension current for the oscillator anode is supplied through a fixed resistor (50,000 ohms is a good average value) and to feed the H.F. to the coil through a .0001-mfd. fixed condenser. By following this method of connection there is little damping of the tuned circuit, and the oscillator output is "evened out" over any particular waveband.

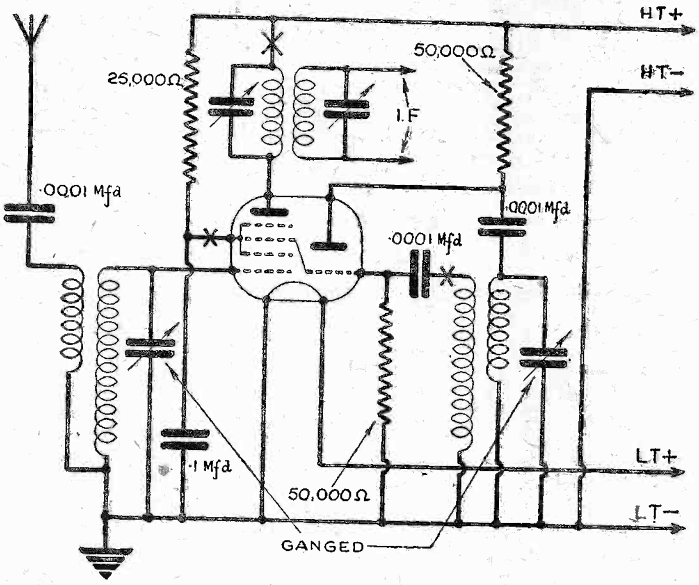


Fig. 3.—In the case of the triode-hexode frequency-changer one grid is common to both portions of the valve. This type of frequency-changer circuit is coming into increasing use for all-wave and short-wave receivers.

In those rare instances when the output from the oscillator section is insufficient on very short waves it is necessary to wire a small triode as separate oscillator, following the connections mentioned above in respect of a pentagrid. This is seldom required, and the extra valve should be resorted to only after carefully checking up on the circuit as a whole.

Nowadays, it is almost standard practice to employ 465 kc/s as the intermediate frequency. This is not just an arbitrary figure, but one which has been arrived at by many designers as being the most satisfactory for all-round use. It is not necessary to go into the reasons here, but it can be taken for granted that it is best to use this frequency unless there are important reasons for deciding otherwise.

Input Tuning Circuits

One advantage of 465 kc/s is that it is not necessary to employ a band-pass input filter to avoid second-channel and other forms of interference. When using 150 or 110 kc/s a band-pass filter is desirable, although it is possible to compromise in this respect by making use of an aerial loading coil, which is connected across the input circuit in series with a fixed condenser. Coils of this type are available for about 2s. 6d. and often improve selectivity and thus minimise interference although not being tuned by means of a variable condenser.

Audible Oscillation

A well-planned superhet is inherently stable and seldom gives any trouble due to self-oscillation and parasitic oscillation. At the same time minor troubles may often be experienced. They may be concerned with the I.F. circuits, and these should certainly receive attention first. In some instances, however, the frequency-changer is responsible. One form of trouble is that of audible oscillation, which sounds like a cross between a squeak and a groan, and is often described as "squegging," at the bottom end of the tuning range, or on the lower wavelengths only. It can generally be stopped by replacing the oscillator grid-leak by one of lower value, but this will not always be effective if the valve is old and in need of replacement. A value down to 25,000 ohms can be used; the average value is about 100,000 ohms for a triode-hexode and 150,000 ohms for a pentagrid.

Cures for Parasitic Oscillation

Sometimes parasitic oscillation is experienced, this often having the effect of rendering the receiver "dead" at certain frequencies. There are two or three methods which generally prove effective in preventing this, one being to insert a 50-ohm resistor between the grid condenser and the top end of the oscillator-grid winding. Another method is to include a fixed resistor of about 3 ohms, or a S.W. choke, in the screening-grid lead as near to the valveholder as possible. Yet another method is to fit a small S.W. or U.S.W. choke between the primary winding of the I.F. transformer and the H.T.+ line. These three points are indicated by crosses in Fig. 3, but the connections mentioned are also applicable to the pentagrid circuit shown in Fig. 2.

The circuits shown in Figs. 2 and 3 are intended to be diagrammatic, for in practice two- or multi-range tuners would probably be used instead of the S.W. coils indicated. Additionally, with some coils padding and tracking condensers would be required in the oscillator tuning circuit. These are omitted because their use is dependent upon the particular coils and tuning condensers used and because the values of the condensers, if required, are governed by the components chosen.

NEW G.E.C. BATTERY PORTABLE

THE General Electric Co., Ltd., recently introduced a new four-valve portable radio receiver, built to stand the strain of alternate use in A.R.P. shelters, in the train or car, and in the user's home. The casing, which is specially shaped for easy portability, has a grained leather-like finish and looks smart enough for anywhere indoors. Reliability for all kinds of outdoor work is ensured by the rubber mounting on which the components are assembled, and the generally sturdy chassis construction.

Battery problems are minimised by use of G.E.C. BB395 combined H.T./L.T. dry battery, which is connected by a fool-proof non-reversible four-pin plug. High efficiency is obtained by superhet circuit, incorporating frequency-changer, I.F. amplifier, double diode triode, and power output—all new 1.4 volt dry battery economy valves.

Other details of the specification are: Three control only—volume, slow-motion tuning, combined on/off and wavechange switch; dial, calibrated in wavelengths and station names; speaker, 6½in. P.M. moving coil, acoustically matched to cabinet; frame aerial; valve complement, Osram X14, Z14, HD14, N14; sockets for connection of external aerial and earth when extreme range is required. A useful easy-service feature that dealers will appreciate is the fact that the casing comes completely away from the base when two fixing screws are removed from the side of the cabinet. The dimensions are 11½in. x 12½in. x 7¾in., and the price £8 18s. 6d., complete. Supplies will be available from March 2nd.

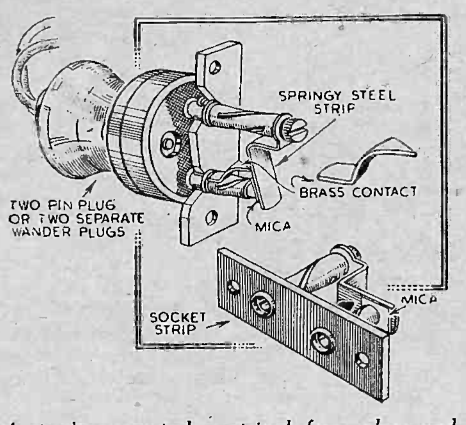
The new G.E.C. portable.

Practical Hints

A Simple Meter Jack

THE accompanying sketches give details of a simple meter jack which I have found to be very efficient in practice and much cheaper than a jack and plug.

The socket strip can be purchased for a few pence, and the type having screw connections should be used as this enables the spring steel strip to be screwed to one



A simple meter jack contrived from plugs and sockets.

leg. The other leg is cut short enough to allow the plug (which may be of the two-pin type or two separate wander plugs) to protrude and push the spring away from the brass contact which is soldered to the short leg. A small piece of mica must be stuck to the underside of the spring strip to insulate it from the socket when the jack is open circuited.—V. W. BUDD (Portsmouth).

An Adapter for Charging Dry Accumulators

ALTHOUGH the adapter illustrated was made and constructed by the writer primarily for holding the cycle type dry accumulator during charging, it was also designed to take the "torch" type models, and as it is quite possible the latter may become popular for grid-bias and other wireless purposes, the adapter will no doubt be of interest to home constructors.

Owing to the special purpose for which the above-mentioned models are designed, terminals could not of course be incorporated, so for safe and easy charging some such adapter as above is useful.

All the models made by Messrs. Varley specially for wireless purposes are fitted with suitable terminals. The sketches of the adapter are self-explanatory, but in brief, its use is as follows: The cycle type accumulator is slipped in from the right-hand side of the adapter (Fig. 1) when the negative contact strip of the accumulator engages with the springy contact strip of the adapter, which contact strip is connected to a terminal at the top. This is the negative terminal. A central set screw is adjusted to engage with the lead top of the accumulator (positive) which set screw is connected by a metal strap to a second

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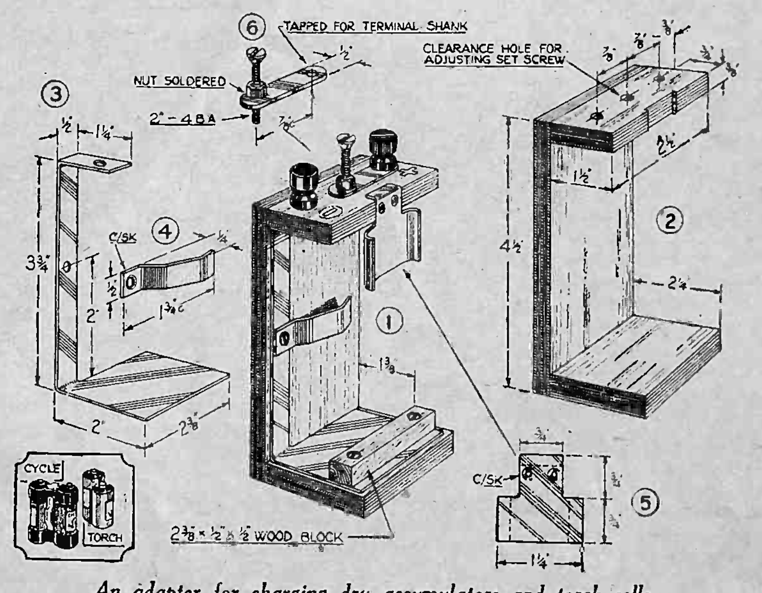
terminal at the opposite end. This is for the positive connection to the charging apparatus. In the case of the torch type models, these are placed on the metal platform, which is of course in connection with the springy strip and negative terminal, and the set screw is adjusted to connect with the top (positive) cap as before.

The main parts are shown in Figs. 2, 3, 4, 5, 6. The frame (Fig. 2) was constructed from ⅜in. plywood and is quite simple. The 2⅜in. x ½in. x ½in. wood block is screwed down on top of the metal connecting plate (Fig. 3), and acts as a guide for the accumulator at the bottom, whilst the small shaped plate (Fig. 5) serves a similar purpose at the top, as shown. The springy strip (Fig. 4) can either be soldered or screwed as shown, according to the metal used. The adjusting set screw (Fig. 6) should be about 2ins. long, and if an insulating type terminal is fitted at the opposite end, care should be taken to see that its shank is in good electrical contact with the connecting strap.—R. L. G. (Essex).

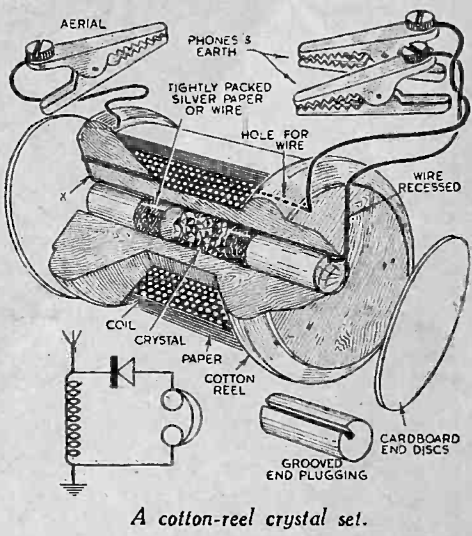


An adapter for charging dry accumulators and torch cells.

A Miniature Crystal Set

WE have had occasion to build this miniature set between us, and think that it might be of interest to those who require a midget and portable crystal detector, which will work from a water-pipe earth and a bed spring aerial. The accompanying diagram gives a section of the finished article. The requirements are few and inexpensive. They include a cotton-reel, three crocodile clips, about 4 yards of different coloured flex for aerial, earth and 'phones, an old 75-turn plug-in coil, and a crystal.

First insert the crystal, the contacts being established by wire springs or silver paper wedged in at each end. The wire from the crystal is let into the wood (see end X) and a flat cardboard disc is glued over both ends to keep out all dirt, etc., and to give a finished appearance to



A cotton-reel crystal set.

the set. The coil is next wound on the cotton reel, one end (X) being taken to the crystal and to the aerial; the other end is taken to earth and the 'phones. The other 'phone contact is made from the crystal, with a short piece of flex. The coil is covered with paper and then varnished. The set is, of course, automatic, and needs no adjustment to find the sensitive spot. We think that 70-80 turns of wire are enough, the wire being taken from the old plug-in coil. —J. N. PHILLIPS, R. P. ALEXANDER (Taunton).

A Universal

Constructional Details
Experimenter - - By

WHEN dealing with the testing of valves most radio engineers and keen experimenters long for the super valve-tester which will do this work with the least trouble and sure results, but it is the experience of most that the modern valve-tester, expensive as it is in most cases, nearly always leaves something out which is needed, and is not flexible enough in its tests to satisfy the ardent experimenter. As two examples of this, what tester will give a positive indication of noise in a valve, and when switches become faulty in a tester, can the readings be any longer taken as correct ?

But this is not intended to be a comment on the present ranges of valve-testers, which are in most cases very good instruments, but rather an introduction to the snags which the designer of the tester about to be described has tried to avoid. This tester is based on the requirements of the radio engineer and experimenter alike, and the question of cost has been carefully considered.

The instrument, for the purposes of construction, is divided into three separate sections, and these can be used quite separately and independent of one another. The reason for this is very simple. The constructor can commence with the main section first, and then add the other parts as he requires them; and furthermore, some of the parts may be already at hand.

While no claim is made that this is the perfect valve-tester (which would involve again the question of cost) it is said that it is very simple to construct, is not expensive, is quite accurate, has great flexibility, and can be adapted for numerous other uses besides the testing of valves. There are no complicated switches to cause possible trouble, and the tests can be verified in more than one way on the one instrument.

The three sections which constitute the complete tester are the Main Valve Panel, the Bridge Unit, and the Power Supply Unit.

These will be described under their separate headings, and the use of each for the complete testing of valves, etc., will be outlined.

Main Valve Panel

This is the main part of the whole instrument, and it consists of a number of valveholders suitably wired to take the various types of valves on the market. There is provision for the testing of current in the filament, anode, grid, screen-grid, and extra grid or oscillator anode. The voltage across any parts can also be determined. The connections to the various electrodes of the valve under test is by plug and socket connections, and not by switches (for reasons already mentioned). This makes it possible to test any new valves which may appear in the future without in any way interfering with the circuit. All the power supplies are applied externally, and in this way the constructor can commence with simple battery valves only requiring battery voltages, and later he can add the Power Supply Unit which will give any combination of voltages.

The tester will operate with British, Continental or American type valves, and an extra holder is left in case a new panel is ever needed in the future, and this can be connected with a multiple cable. Separate meters are necessary, and these can be used as required or where the voltages are known to be correct, then they may not be needed at all (when using the Bridge Unit). The grid-bias supply is always battery operated, as this is found to be better than incorporating it in the filament and H.T. unit. A few 9-volt batteries in series are needed.

It may appear from the above description that the tester is slightly involved, but actually, when the user has become proficient with it the various tests can be made very quickly; and let the reader remember that it is primarily for experimental purposes that it is designed. This means that it has advantages which other testers do not possess.

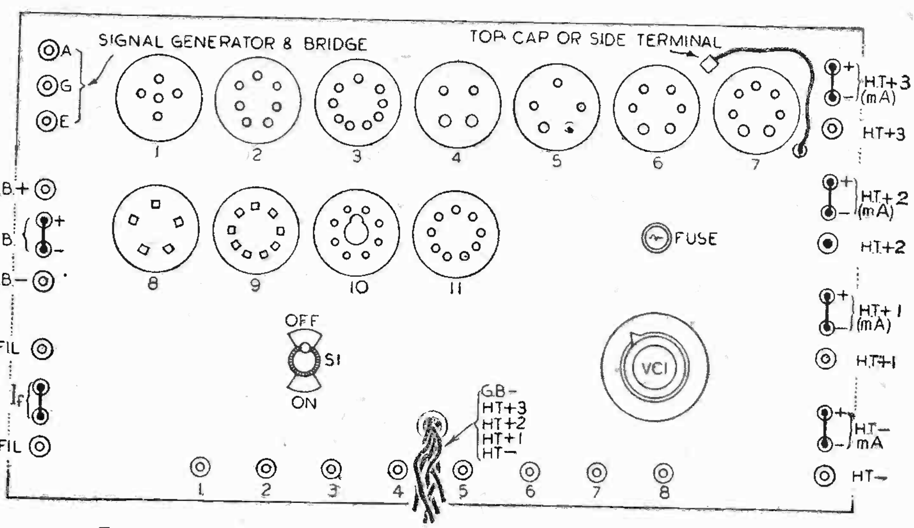


Fig. 1. Front view of the tester, showing layout of valveholders and sockets.

The Panel

The panel can be of good plywood, well varnished, or ebonite. It can be made to the constructor's own taste, but to give plenty of room for working it is suggested that it measures 2ft. long by 1ft. wide. The lay-out of the various parts is shown in Fig. 1. It will be seen that there are 11 valveholders, and these are mounted on the panel by drilling holes in the panel to take the socket pins of the holders. This is to avoid cutting out large holes which only weaken the panel, and in the case of ebonite, may eventually break it. A needle pushed down the socket when the holder is in place will mark the panel for the hole.

The holders are for valves: British 1, 2, 3, 8, 9, 10, American 4, 5, 6, 7, 10, and Continental are much the same as British or American bases. One to 7 are for valves with pins of ordinary type; 8 and 9 are for side contact types such as universal valves; and 10 is for octal bases.

The other parts are placed as shown, and consist of the plug sockets at the sides and bottom for the various voltage supplies, and it will be noticed that jumper leads are across various sockets when no meters are being used. A.G.E. are the sockets for the bridge unit, and sockets 1 to 8 are the electrode sockets. A hole is bored at the top right-hand side of the panel for a lead to the valve tops or side terminals, and another hole at the bottom as shown for the electrode leads to come through.

A fuse-holder is placed above the grid-bias potentiometer VC1, and a shorting switch is shown at S1 for the purpose of testing battery valves as distinct from mains types. This is placed at the "on" position for battery valves and connects H.T.— to the filament.

The various sockets for the meters should preferably be of a smaller type than the other sockets to avoid confusion, and they will need to be marked by placing white cardboard or celluloid discs underneath, suitably engraved.

Mullard P.M.22A., Marconi P.T.2, Mazda Pen 220, Cossor 220P.T.
Output Pentode
Filament voltage—2v. If .15 amp.
Anode voltage—100-150. Ia 4.5-9.5 mA
Screen voltage—100-150.
Grid bias—3-4.5 volts.
Optimum load—20,000 Ω
Base—4 or 5 pin.
4 pin. Holder 1, H.T.—to O; H.T. + 1 to 1; H.T. + 2 to 8; G.B. to 3.
5 pin. Holder 1, H.T.—to O; H.T.+ 1 to 1; H.T.+2 to 2; G.B. to 3.
(S1 closed.)

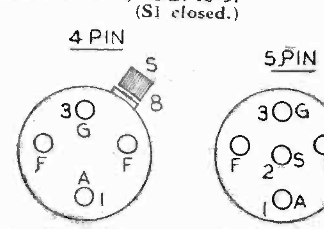


Fig. 3.—How to mark out the cards when calibrating.

Circuit and Wiring

When the parts have been assembled on the panel the wiring can be commenced. The wiring diagram is given in Fig. 2, and from this it will be seen that the holders have been placed in order of the number of pins, 5-pin first, 7-pin second, etc. First the filament pins of all valves are wired in parallel, and to the filament supply sockets.

'alve-tester—I

ı Useful Unit for the

DAY-LEWIS, A.M.I.R.E.

Then from electrode socket 1 a continuous lead is brought to the first pin socket on the valves, reading anti-clockwise where possible, and commencing at the filament pins. The same procedure is adopted with socket 2, and subsequent sockets, until all have been wired as shown.

The wiring is best carried out with long lengths of tinned copper wire cut approximately to the length measured from the electrode socket to the last point to be wired. As one part is completed a short length of sleeving can be slipped over the wire. Good, soldered joints are recommended as the sockets will get a lot of movement when valves are being tested.

The rest of the wiring needs little explanation, and can be followed from the diagram. The resistance R1 is 3,000 ohms fixed and VC1 is 100,000 ohms variable. S1 is an ordinary panel mounting single pole switch. The fuse is in the H.T. negative line and should be rated to carry 100 mA. The leads from the voltage supply terminals end in flexible wire, such as flex, and terminate with plugs for the sockets on the bottom of the panel.

Final Details

The cabinet is best made of wood, and the back should be made to open for the occasional inspection of the panel back. The whole panel and cabinet should be made as rigid as possible, and particular attention should be paid to the wiring and connections, as in places around the valve pins various wires will pass very close to one another, and their insulation will be touching. These wires under operating conditions may be carrying different signals, and may be at widely different potentials, and any bad insulation may result in a failure of the test being conducted.

The electrode leads are marked H.T. neg., G.B. neg., and H.T. 1, 2, 3, and the latter are for anode, screen, and extra screen or electrode. This should be remembered when calibrating the instrument. The same applies to the power supply sockets.

The extra valveholder 11 is for a plug and multiple-way cable to additional valve panels which may be later wanted. It can also be used to test between the various voltage points of the valve under test, as at least some of its pins will be in contact with those of the socket being used.

Calibrating

For this obtain a number of valve makers' catalogues and also a quantity of "card index" cards, or ordinary postcards. Then looking at the base connections of any one valve in the catalogue (looking at the bottom of the valve) obtain the positions of the various electrodes. Draw the base on the card, and mark in the electrodes. Now from the circuit of the tester find the corresponding valveholder, and also where the electrodes on it are connected to, then these sockets will give various electrodes; mark these down by their numbers on the card. This is shown in Fig. 3, which represents a simple pentode valve. By further reading of the valve manuals the equivalent types of other manufacturers can be determined, and these can also be marked on the card.

As the various valves are identified and marked on separate cards, it will be found that a complete card index of all types of valves is made, and when using the instrument it is only necessary to consult the card required to determine the voltage requirements of the valve, what socket it is placed in, and where the electrode plugs are placed for correct operation.

Operation

For the present we will suppose that the experimenter is only starting to use the instrument with a few valves of battery type, then only batteries are needed for the power supplies. We will also assume that the bridge is not yet being used, and meters are available; a simple multiple voltmeter and milliammeter are all that are necessary.

Supposing that we wish to test the valve given in the example. Then we connect up a milliameter in the sockets marked I H.T. pos. 1, and connect up the H.T. neg., H.T. pos. 1 (anode), H.T. pos. 2 (screen) and L.T. battery to the corresponding sockets, removing, of course, the jumper lead where the milliammeter is connected.

We then close the switch as instructed for battery valves, plug in the valve (a 5-pin one), and place the electrode plugs in the numbered sockets shown on the card, *i.e.*, H.T. neg. left unconnected, pos. 1 to socket 1, pos. 2 to socket 2, and G.B. to 3.

The milliammeter should now give a reading, and we then apply the G.B. battery voltage. By measuring across the next, or some other valve socket, we can obtain the exact voltages on the various valve electrodes, and correct, if wrong, until makers' figures are arrived at. The G.B being adjusted by the potentiometer VC1.

When this condition is arrived at the milliammeter should give the correct anode current or be within very close limits to the maker's figures, if the valve is perfect.

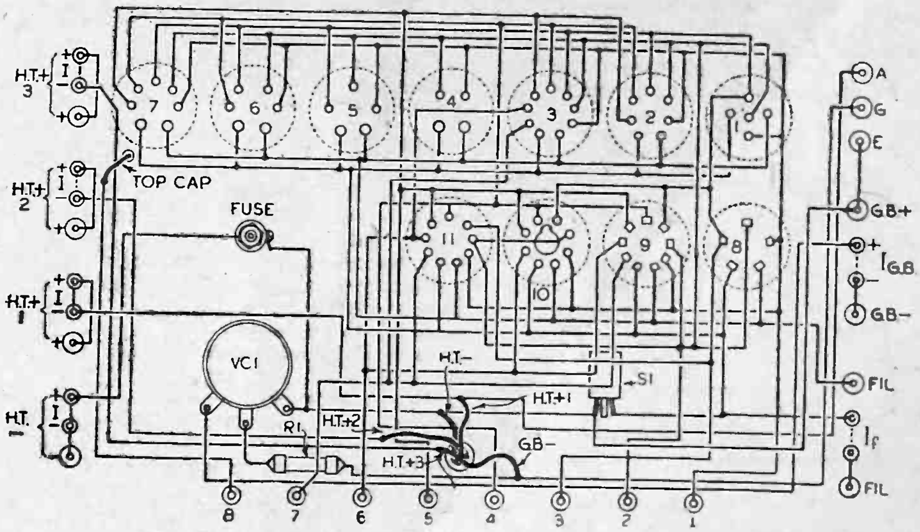


Fig. 2. Wiring diagram of the universal valve-tester.

The current in the other parts may be similarly measured, and when doing this always tap the valve to see if there are any loose electrodes causing a change in the current values.

The mutual conductance of the valve is obtained by changing the grid bias by one volt, and noting the change of anode current, which is expressed as so many milliamps per volt. The impedance can likewise be determined by altering the anode voltage and noting the change of anode current, and the impedance is given by

$$\frac{\text{change of anode voltage} \times 1{,}000}{\text{change in anode current in mA}}$$

equals ohms.

And from these the amplification factor can be determined, for amplification factor equals impedance multiplied by mutual conductance or:

$$M = \frac{\text{Mutual conductance} \times \text{Impedance}}{1{,}000}$$

This, briefly, is the method adopted when testing with meters, and in the next article we shall deal with the testing of valves without the need of emission tests with a milliammeter (fundamental check in keen experiments).

COMPONENTS REQUIRED FOR UNIVERSAL VALVE-TESTER.

- 5-, 7-, 9-, 9-pin British valveholders, flush mounting.
- 5-, 9-pin Universal valveholders, flush mounting.
- 8-pin Octal type valveholder, flush mounting.
- 4-, 5-, 6-, 7-pin American valveholders, flush mounting. (All by Clix.)
- Nineteen large banana type plugs and sockets.
- Twelve small split pin wander plugs and sockets.
- One panel-mounting fuseholder, and 100 mA fuse for same.
- One toggle on-off switch (Bulgin).
- One 3,000 ohm fixed resistance.
- One 100,000 ohm volume control.
- Tinned copper wire for connecting and short lengths of good flex.
- Sleeving and solder.
- Nuts and bolts.
- Celluloid name discs if required.
- Ebonite or plywood panel 2ft. by 1ft. and fairly thick.
- Cabinet with open back if required.
- Batteries for L.T., H.T. and G.B. supplies.
- Milliammeter and voltmeter if not already possessed, and if not at hand. If batteries whose voltages are known are being used, then these are hardly necessary.

A.-C. Two-valve Receivers

Points of Design in Economy Sets Based on the A.C. Twin - - - By W. J. DELANEY

In April, 1933, I described a simple two-valve A.C. mains receiver, for which Blueprint No. P.W.18 is still available. A receiver of this type is ideal for modern conditions, embracing the simplest possible form of circuit for mains operation, resulting in low costs of both construction and maintenance. The original coil is not now available, and one or two of the other components have now been withdrawn from circulation, but any constructor can build a similar receiver from parts on hand. Apart from this, however, there are several interesting points in design which are worth discussing in these days of economy. Firstly, the circuit included two valves acting as detector and output, with a third valve in the mains section. To ensure maximum gain the two valves were both of the pentode type, and as permanent-magnet loudspeakers were not in those days so sensitive as energised models the receiver was designed to utilise the latter model and thus the mains section was designed to deliver 350 volts. To-day a good P.M. speaker is just as sensitive as a mains model, where the energising current available is only small, as it will be in a simple two-valver, and therefore the mains section could be designed to take a 250-volt rectifier.

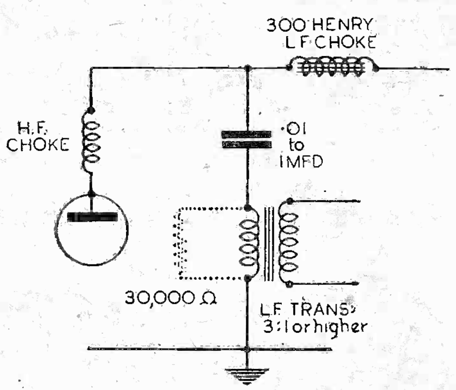


Fig. 2.—Anode circuit and L.F. coupling for high-impedance detector valves.

Mains Unit

Therefore, the requirements on the mains side are a transformer delivering 4 volts at 2 amps for the two valves, and an H.T. winding at 250 volts 60 mA. or 350 volts 60 mA., if an energised model is to hand. Fig. 1 shows the essential parts, with the alternative smoothing arrangements according to the speaker in use. In the original model this mains unit was separately built and housed on a shelf in the cabinet, leaving the receiver chassis complete so that modifications could be made if desired. Any mains transformer could be used in a receiver of this type, additional unwanted mains secondaries (for heaters) being ignored and left unconnected. Care should be taken to guard against short-circuits by wrapping the ends of such a winding, where flex connections are provided, and insulating them against all possible contact.

On the receiver side there are several interesting alternatives available, and those who are interested in experimenting will find such a circuit very instructive in this connection.

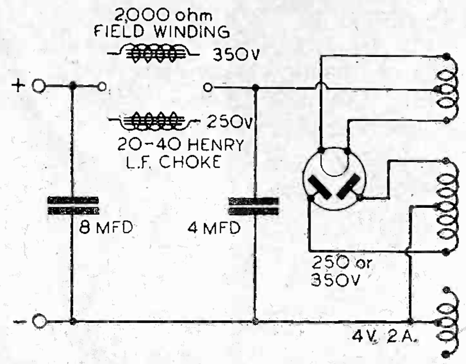


Fig. 1.—Arrangement of the mains section to suit a P.M. or an energised speaker.

Coupling

When a pentode or S.G. valve is used as detector, the normal rectification follows much on the lines of a straightforward triode, but it is important to remember that the impedance of such a valve is very much higher than that of a triode, and thus to obtain the increased amplification of which the valve is capable special steps have to be taken with the anode coupling component. If an ordinary L.F. transformer is connected in the anode circuit the gain is bound to be low—probably no greater than if a simple triode is used. A resistance could be used so that either resistance-coupling or a resistance-fed transformer circuit could be employed, but the drawback with this is that the anode voltage which can be applied to the valve will be lowered, and if the 250-volt mains unit is employed the valve will probably receive a very low H.T. The useful value of resistance in the case of a good mains pentode is of the order of 100,000 ohms, and thus this is ruled out for practical purposes.

A high inductance choke will, however, afford a more equal load to the valve and will not give any appreciable voltage drop, as the D.C. resistance of a good choke of this type is only about 2,000 ohms. In the original circuit, therefore, this was used and a standard L.F. transformer was then parallel-fed to provide a good step-up to feed the output valve. A tone corrector, in the form of a 30,000-ohm resistance across the primary of the transformer also compensated for the effect of the L.F. choke and gave very good low-frequency response. It is, therefore, recommended that this method of coupling be retained in a simple receiver of the type mentioned, and all that then remains is to take steps to see that the detector operates in the most efficient manner.

The Detector Stage

Any standard coil and tuning circuit may be adopted, but a single waveband (medium waves) will probably be selected at the present time, and thus only the reaction circuit is available for experimental purposes. There are two alternatives. Firstly, the normal reaction winding with standard reaction condenser may be used, in which case the capacity of the usual anode by-pass condenser is the only really critical component, or secondly, the electron-coupled circuit may be used. This was not adopted in the original design as a commercial coil was used. If, however, a simple coil is made up for medium waves it will be possible to tap this so that the cathode may be joined to the tapping and then reaction controlled by varying the screen voltage, and this forms a very effective reaction control which is a great improvement on the original circuit from the point of view of obtaining one or two distant stations. The receiver is, of course, primarily intended for use as a home-station receiver, but with a good reaction circuit, and a good speaker, the combination will bring in quite a number of continental stations, and it is recommended that the reaction arrangements be built up on the lines shown in Fig. 3.

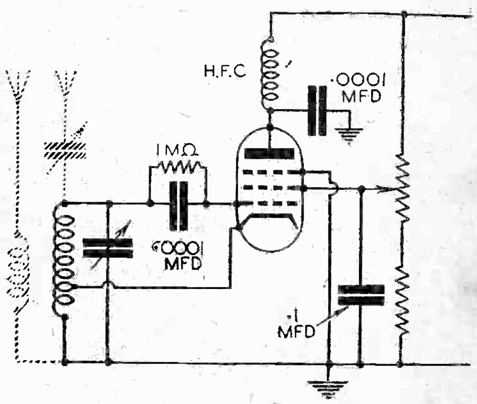


Fig. 3.—Detector circuit utilising a very effective reaction system.

The position of the tap on the coil will no doubt have to be found by experiment in order to obtain the best effect, but approximately one-tenth of the total number of turns on the coil should be permitted between earth and the tap. The variable resistance should have a value of about 50,000 ohms, and the resistance in series with it may be from 15,000 to 25,000 ohms, again the most effective value being found on trial with the particular valve in use. If a simple coil is employed the selectivity necessary to permit station separation may be obtained by the series aerial condenser, although if a commercial coil is used the aerial coupling coil could be used. The receiver was originally employed in the London area with an indoor aerial and gave full volume, although naturally in some districts it will not be possible fully to load the output stage with a simple detector—in spite of the high gain of an H.F. pentode. The valves recommended are Cossor MS/PEN/A or equivalent for the detector stage, and MP/PEN or equivalent for the output stage.

Notes from the Test Bench

Lightning Arresters

THE main feature of a lightning arrester is a small spark gap, across which a static charge could pass, but which would not permit radio signal currents to pass. If the latter point is not complied with there will be a loss of signal strength (weak reception of distant stations), whilst if the former point is not attended to there may not be a discharge and damage might arise to the receiver. A favourite idea is to use two pieces of hacksaw blade facing each other and this is quite in order, although brass or similar material might prove preferable as it will not rust and the H.F. resistance is lower. A disc of mica, with a small hole punched in the centre, and two brass square-ended rods bearing against the disc on opposite sides is a very good arrester, but whatever type is used it should be remembered that one side of the arrester is joined to aerial and the aerial terminal of the receiver, and the other side is permanently connected to earth—preferably a completely different earth from that used with the receiver.

Chassis Coupling

WE have before mentioned the fact that instability can be caused by the coupling of different parts of a circuit through the metal of a chassis. Although connected to earth, probably at only one point, there is sometimes a difference of potential existing across various parts of a chassis and this may result in the ability of the chassis to carry various additional currents, thereby introducing instability. It is thus a good plan to earth the chassis at two or three points if such instability is experienced, and furthermore to complete the screening of certain components which rely upon the chassis as part of such a screen.

Ganged Circuits

WHEN a set of ganged coils is tuned by a ganged condenser it is sometimes found that the ganging will not hold throughout the scale. It is well to remember that if the ganging becomes more out of step as the condenser is advanced, the fault is most likely to be due to the coils, whilst if the ganging is erratic, that is, it goes out of gang at one or two points in the scale but comes back into gang at others, then the condenser is most likely in need of alignment. The split-end vanes provided on a gang condenser will need adjustment in the latter case.

THE POWER AMPLIFIER IN PRACTICE

(*Continued from page 476*)

"matching" of load and valve impedances.

Undistorted Power and Power Sensitivity

This may, however, be looked at in two different ways—first, the load for *maximum undistorted power*, and secondly, the load for *maximum power sensitivity*.

Power sensitivity may be defined as the power for unit grid-signal, at such small inputs that the distortion factory may be neglected. It is a maximum at a given load impedance, and is expressed in terms of watts per (volt) ^{2}. Power sensitivity may be increased or decreased at will by pre-amplification, and is therefore of little importance in determining the best condition for output matching.

Undistorted power may be defined as the power for an agreed percentage of harmonic content or distortion. Its optimum load is that which enables the maximum power, including such distortion to be obtained with a suitably chosen grid input.

Fig. 13 shows how the undistorted power, and power sensitivity, vary with load for a given pentode valve.

A question often arises: How much distortion should be tolerated in expressing the "undistorted" power output of a valve as so many watts? Fortunately, the cathode-ray oscilloscope helps us here, for it has been found that those kinds of distortion, which are just audible in the average loudspeaker, are also just visible on the cathode-ray tube.

Fig. 14 shows the nature of a curve taken on a given valve in which the measured voltage output is plotted against varying load impedance, the input grid voltage being adjusted at each value of loading until visible distortion is just apparent on a cathode-ray oscilloscope.

Complications are introduced because, in practice, a loudspeaker load is *reactive*, and its impedance varies widely over the audio-frequency range and, further, that imperfections in the output transformer also modify the effect of the loudspeaker impedance as "looked at" by the valve.

Most loudspeakers exhibit two marked resonance peaks, and it has been found that the primary of an output transformer should be so designed as to present a load for maximum "undistorted" power at the bass impedance peak.

Under constant current conditions, which could be the case with an ideal pentode or tetrode of infinite impedance, and operated with correct loading, a desired frequency response could be obtained by deciding on the optimum load and constant signal voltage. It might be thought, therefore, that modification in frequency response could be obtained by modifying the transformer, i.e., the "optimum loading." However, such a modification of tone-quality by mis-matching is accompanied by a considerable reduction in available undistorted power output, and hence the desirability of a fixed loading—that is, a fixed output transformer of correct ratio and design—determined on the basis of maximum undistorted output only. Numerous methods, both electrical and mechanical, are available for modifying the overall frequency response if so desired, but the subject of "tone control" is another story.

NEW SERIES

RADIO ENGINEER'S POCKET-BOOK

COIL-WINDING TABLES

No. 13

(LONG-WAVE COILS)

Diameter of Former	Inductance 1,600 Microhenrys. No. of Slots.	Wire.	Turns per Slot.	Inductance 2,100 Microhenrys. No. of Slots.	Wire.	Turns per Slot.	Inductance 3,000 Microhenrys. No. of Slots.	Wire.	Turns per Slot.
1 in.	4	36 enam.	80	4	36 enam.	92	5	38 D.S.C.	95
	5	36 D.S.C.	69	5	36 enam.	80	6	36 enam.	85
1½ in.	3	36 D.S.C.	71	3	36 enam.	81	3	36 enam.	97
	4	36 D.S.C.	57	4	36 D.S.C.	65	4	36 enam.	78
	5	34 D.S.C.	53	5	34 enam.	60	5	36 D.S.C.	72
2 in.	3	34 enam. or 36 D.S.C.	56	3	36 D.S.C.	65	3	36 enam.	77
	4	34 D.S.C.	45	4	34 D.S.C.	51	4	36 D.S.C.	61
	5	34 D.S.C.	38	5	34 D.S.C.	44	5	34 enam. or 36 D.S.C.	53

No. 14

(MEDIUM-WAVE COILS)

Diameter of Former	Inductance 175 Microhenrys. Wire.	Turns	Length in inches.	Inductance 200 Microhenrys. Wire.	Turns	Length in inches.	Inductance 230 Microhenrys. Wire.	Turns	Length in inches.
1¼ in.	32 enam.	84	1.01	32 enam.	93	1.11	30 D.S.C.	115	1.71
	30 D.S.C.	93	1.38	30 D.S.C.	102	1.52	32 enam.	102	1.22
1½ in.	30 D.S.C.	74	1.10	30 D.S.C.	82	1.22	30 D.S.C.	90	1.34
	28 D.C.C.	94	2.24						
1¾ in.	30 D.S.C.	63	0.94	30 D.S.C.	68	1.01	30 D.S.C.	76	1.13
	28 D.S.C.	67	1.16	28 D.S.C.	73	1.26	28 D.S.C.	80	1.38
2 in.	30 D.S.C.	54	0.805	30 D.S.C.	59	0.88	30 D.S.C.	65	0.97
	28 D.S.C.	58	1.01	28 D.S.C.	64	1.13	28 D.S.C.	70	1.24
2¼ in.	26 D.C.C.	70	1.96	26 D.C.C.	78	2.18	26 D.C.C.	86	2.40
	28 D.S.C.	52	0.925	28 D.S.C.	57	1.01	28 D.S.C.	62	1.10
	24 D.C.C.	65	2.08	24 D.C.C.	72	2.30	24 D.C.C.	80	2.56
2½ in.	28 D.S.C.	47	0.835	28 D.S.C.	51	0.91	28 D.S.C.	56	1.0
	24 D.C.C.	58	1.85	24 D.C.C.	64	2.04	24 D.C.C.	70	2.24
3 in.	26 D.S.C.	41	0.86	26 D.S.C.	45	0.95	26 D.S.C.	49	1.03
	22 D.C.C.	50	1.90	22 D.C.C.	55	2.09	22 D.C.C.	61	2.32

No. 15

TWIST DRILL GAUGE SIZES

No. Drill.	Decimal Sizes.	No. Drill.	Decimal Sizes.
1	.2280	31	.1200
2	.2210	32	.1160
3	.2130	33	.1130
4	.2090	34	.1110
5	.2055	35	.1100
6	.2040	36	.1065
7	.2010	37	.1040
8	.1990	38	.1015
9	.1960	39	.0995
10	.1935	40	.0980
11	.1910	41	.0960
12	.1890	42	.0935
13	.1850	43	.0890
14	.1820	44	.0860
15	.1800	45	.0820
16	.1770	46	.0810
17	.1730	47	.0785
18	.1695	48	.0760
19	.1660	49	.0730
20	.1610	50	.0700
21	.1590	51	.0670
22	.1570	52	.0635
23	.1540	53	.0595
24	.1520	54	.0550
25	.1495	55	.0520
26	.1470	56	.0465
27	.1440	57	.0430
28	.1405	58	.0420
29	.1360	59	.0410
30	.1285	60	.0400

LETTER SIZES OF DRILLS

A	.234	H	.266	O	.316	U	.368
B	.238	I	.272	P	.323	V	.377
C	.242	J	.277	Q	.332	W	.386
D	.246	K	.281	R	.339	X	.397
E	.250	L	.290	S	.348	Y	.404
F	.257	M	.295	T	.358	Z	.413
G	.261	N	.302				

No. 16

RESISTANCE WIRE DATA

S.W.G.	Eureka. Resistance per yard.	Yards per lb.	Current Capacity.	German Silver. Resistance per yard.	Yards per lb.	Current Capacity.
18	0.37	48	3.5	0.117	51	3.5
20	0.66	85	2.5	0.315	90	2.5
22	1.10	140	1.5	0.520	147	1.5
24	1.77	227	1.0	0.844	238	1.0
26	2.65	340	0.5	1.26	349	0.5
28	3.91	502	0.25	1.85	527	0.25
30	5.58	714	0.2	2.65	750	0.2
32	7.35	943	0.15	3.50	984	0.15
34	10.13	1,300	0.1	4.82	1,360	0.1
36	14.84	1,905	.05	7.06	2,000	.05
38	28.81	3,060	—	11.83	3,295	—
40	37.18	4,761	—	17.70	4,920	—

CURRENT-CARRYING CAPACITY OF WIRE

S.W.G.	Current Capacity (Amps.).	S.W.G.	Current Capacity (Amps.).	S.W.G.	Current Capacity (Amps.).	S.W.G.	Current Capacity (Amps.).
10	19.305	19	1.8855	28	.258	37	.0545
11	15.855	20	1.527	29	.218	38	.0425
12	12.7425	21	1.206	30	.1812	39	.0318
13	9.872	22	0.9237	31	.1586	40	.0272
14	7.5405	23	0.6786	32	.1374	41	.0228
15	6.108	24	0.5702	33	.1178	42	.0189
16	4.8255	25	0.4703	34	.0998	43	.0153
17	3.6945	26	0.3818	35	.0831	44	.012
18	2.715	27	0.3168	36	.0681	45	.0093

No. 17

Copper Wire Data

Standard Wire Gauge.	Diameter in Inches.	Resistance in Ohms per Yard.	Resistance in Ohms per Pound.	Pounds per Ohm.	Weight in Pounds per 1,000 Yds.	Yards per Pound.	Turns per Inch. Enamel Covered.	Single Silk Covered.	Double Silk Covered.	Single Cotton Covered.	Double Cotton Covered.
10	.128	.001868	.0120	83.3	148.8	6.67	↓	7.64	7.55	7.35	7.04
11	.116	.002275	.0200	50.0	122.2	8.16		8.41	8.30	8.06	7.69
12	.104	.002831	.0280	35.7	98.22	10.23		9.35	9.22	8.93	8.48
13	.092	.003617	.0550	18.1	76.86	13.00		10.5	10.4	10.0	9.43
14	.080	.004784	.0820	12.2	58.12	17.16		12.1	11.8	11.4	10.6
15	.072	.005904	.1400	7.14	47.08	21.23		13.3	13.1	12.5	11.6
16	.064	.007478	.2021	4.95	37.20	26.86	15.0	14.9	14.6	14.1	13.2
17	.056	.009762	.3423	2.38	28.48	35.00	17.1	16.9	16.5	15.9	14.7
18	.048	.01328	.6351	1.56	20.92	47.66	19.8	20.0	19.4	18.5	17.2
19	.040	.01913	1.315	.757	14.53	68.66	23.7	23.8	23.0	21.7	20.0
20	.036	.02362	2.012	.497	11.77	85.00	26.1	26.3	25.3	23.8	21.7
21	.032	.02990	3.221	.309	9.299	107.6	29.4	29.4	28.2	26.3	23.8
22	.028	.03905	5.498	.181	7.120	140.6	33.3	33.3	31.8	29.4	26.3
23	.024	.05313	10.14	.098	5.231	191.6	38.8	38.5	36.4	33.3	29.4
24	.022	.06234	14.38	.069	4.305	228.3	42.1	42.1	40.0	35.7	31.3
25	.020	.07653	21.08	.0471	3.632	275.3	46.0	46.0	43.5	38.5	33.3
26	.018	.09448	32.21	.0309	2.942	340.0	50.6	50.6	47.6	41.7	35.7
27	.0164	.11138	46.55	.0215	2.442	410.0	55.9	55.1	51.6	44.6	37.9

No. 18

DRILLS AND DRILLING

WHITWORTH THREADS

Diameter	1/8in.	5/32in.	3/16in.	1/4in.	5/16in.
Tapping size	3/32in.	No. 31	9/64in.	3/16in.	Letter D
Clearing size	7/64in.	11/64in.	13/64in.	17/64in.	21/64in.

B.S.F. THREADS

Diameter	1/4in.	9/32in.	5/16in.	3/8in.
Tapping size	No. 5	Letter B	Letter G	Letter O
Clearing size	17/64in.	19/64in.	21/64in.	25/64in.

B.A. THREADS

Diameter	0	1	2	3	4	5	6	7	8
Tapping size	No. 10	No. 17	No. 24	No. 29	No. 32	No. 37	No. 43	No. 46	No. 50
Clearing size	Letter B	No. 3	3/16in.	No. 19	No. 27	No. 30	No. 33	No. 39	No. 43

WOOD SCREWS

Size No.	00	0	1	2	3	4	5	7	7	8
Clearing size	No. 52	No. 51	No. 50	No. 44	No. 40	7/64in.	1/8in.	9/64in.	5/32in.	11/64in.

New Trade for the R.A.F.

Recruiting for Radio Mechanics Starts

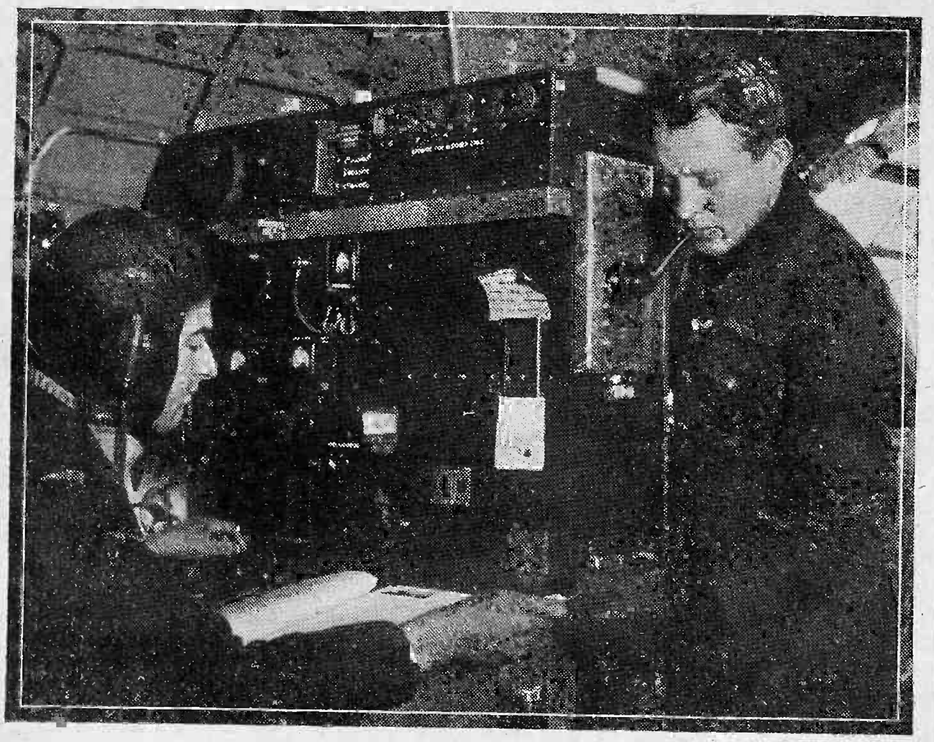
THE Air Arm is the most mobile and quick-striking of all the weapons of modern warfare. The air war is one of rapid actions and counter actions, which call for quick decisions from Air Staff. These decisions can neither be made nor carried out without a rapid and efficient communication system.

That system is provided for the R.A.F. by a vast radio organisation.

As the tempo of aircraft production gathers greater speed and the front line strength of the Air Force attains ever greater proportions, it becomes necessary to expand the radio communication system which welds that multitude of individual aircraft and crews into one mighty unit for the prosecution of the war.

Radio mechanics will first undergo a short course of disciplinary training, after which they will be sent for special training without delay.

The type of man required for the new trade must have a sound knowledge of radio and above all the keenness and intelligence to "reason why." He may be found among professional radio engineers or in the ranks of the enthusiastic radio amateurs. A knowledge of morse is not required. He should be between 18 and 50 years of age, and will be required, with few exceptions, for ground duties only. Flying will be voluntary, and although required mainly for Home Defence, service in various parts of the world under the R.A.F. may be obtained.



The captain on one of our Coastal Command flying-boats, takes a code message. Radio mechanics are needed at once in connection with the installation, maintenance and upkeep of the R.A.F. radio equipment.

The time for an expansion of the radio organisation of the R.A.F. has arrived.

Last week the Air Ministry announced the inauguration of a new specialist trade category in the R.A.F.—that of "radio mechanic." Recruiting is now open for men with the right qualifications for this new trade.

Promotion in a Day

Recruits of the highest quality are required in considerable numbers. Applicants will have to undergo a fairly stiff examination. If accepted they will enjoy the unusual privilege of being reclassified, the day after enlistment, as Leading Aircraftmen with pay at the rate of 5s. 6d. a day plus allowances.

How to Apply

1. Application for the post of radio mechanic should be made to the candidate's nearest Combined Recruiting Centre, or to the Air Ministry Information Bureau, Kingsway, London, W.C.2.

2. If the candidate is considered suitable by the Recruiting Officer, he will be sent to a Receiving Centre for a technical test by the Trade Test Board (a free travelling warrant will be issued for this purpose).

3. In no circumstances should candidates give up their civil employment until they have passed their trade test and been given definite instructions to report for duty.

RADIO CLUBS & SOCIETIES

Club Reports should not exceed 200 words in length and should be received First Post each Monday morning for publication in the following week's issue.

PROPOSED RADIO CLUB FOR WATFORD AND DISTRICT

AT an informal meeting held in Watford recently it was decided to consider the possibility of forming a local radio club. It was suggested that an open meeting should be held on Wednesday, the 21st inst., at 7.30 p.m., at No. 8, St. John's Road, Watford, to elect members for Committee. Will all those interested please communicate with Mr. J. Norwood, 173, Hampermill Lane, Watford, Herts.

ASHTON-UNDER-LYNE AND DISTRICT AMATEUR RADIO SOCIETY

Headquarters: 17A, Oldham Road, Ashton-under-Lyne.

Hon. Secretary: K. Gooding, 7, Broadbent Avenue, Smallshaw, Ashton-under-Lyne, Lancs.

AT a recent meeting, G3BY demonstrated a new audio amplifier which he has constructed. The combination was rather unique, consisting of a 6C5 push-pull transformer-coupled to the two halves of a 6F8 (twin triode). Direct connections were used for the coupling, without any condensers. The output valves work with positive bias on the grids all the time, and consequently are always working on the straight part of their curves. By this method of coupling, a certain amount of negative feed-back is also obtained. With 250v. H.T., 9-watts output was obtained with a very low percentage harmonic distortion.

The Chairman, W. P. Green, and J. Phillips have constructed a professional-looking signal generator for the club, and there is a long waiting list of members who wish to line up their I.F.'s.

The morse classes are also very busy, and it is prophesied that the club will soon be able to boast of a 100 per cent. C.W. membership.

THE SURREY RADIO CONTACT CLUB.

Hon. Sec.: S. A. Morley, 22, Old Farleigh Road, Selsdon, Surrey.

THE February meeting of the above club was in the form of a "Query Bee." Each one present was given a slip of paper upon which was written a subject, and each person had to give a short talk on the subject which was written upon the paper.

(*Continued in next column.*)

Many of the speakers raised debatable points which were open for discussion, and quite an appreciable amount of knowledge was gained in this way.

The March meeting will be the annual general meeting.

BOOKS RECEIVED

SHORT-WAVE RADIO. By J. H. Reyner, B.Sc. (Hons.), etc. 174 pp. 93 illus. Published by Sir Isaac Pitman and Sons, Ltd. Price 10s. 6d.

THIS is the second edition of a book first published in 1937, dealing with the entire subject of short waves—both from the transmitting and receiving points of view. The book first discusses what short waves are, then passes on to the propagation of wireless waves. Subsequent chapters deal with Aerials and Feeders; Aerial Arrays; Receiving Aerials; Short-wave Transmitters; Modulation; Short-wave Receivers; Ultra-short Waves and Micro Waves. A moderate amount of mathematics is included, and illustrations make the various explanations perfectly clear. The book is invaluable to those who are interested in the short waves.

THE SUPERHETERODYNE RECEIVER. By A. T. Witts, A.M.I.E.E. 183 pp. 114 illus. Published by Sir Isaac Pitman and Sons, Ltd. Price 3s. 6d.

THIS is the fourth edition of a valuable treatise on the modern superhet receiver which has been previously reviewed by us. It covers every phase of the superhet from the principles involved to explanations of several modern commercial receivers and includes a section on the maintenance of this particular type of receiver. The final chapter now deals with the superhet as applied to the reception of television.

PROBLEMS IN RADIO ENGINEERING. By E. T. A. Rapson, M.Sc.(Eng.), etc. 123 pp. Published by Sir Isaac Pitman and Sons, Ltd. Price 5s.

THIS is the seventh edition of a popular volume of problems which have been collected and classified to facilitate the class work in Radio Engineering. The problems are drawn from past examination papers of the City and Guilds of London Institute in Radio Communication, the Institution of Electrical Engineers in Electrical Communications and the University of London in Telegraphy and Telephony.

A NEW ELECTRON MULTIPLIER DESIGN

THE number of designs used for practical examples of electron multipliers using secondary emission is increasing at quite a rapid rate, and in each case claims are put forward emphasising the advantages associated with the new models when compared with their earlier prototypes. In this class is one of the new successive impact forms of electron multipliers whose design is very ingenious. The main or first emitting cathode, together with the secondary emissive or target electrodes, is made in the form of rings which are mounted at regular intervals one below the other so that they are concentrically displaced to a wire running down the centre of the tube. To this is applied a high positive potential, while the final collecting anode is a concave-shaped metal surface at the end of the tube. Surrounding the outside of the glass tube is an electro magnet which serves to produce a magnetic field along the axis of the tube. When electrons are released from the initial cathode the dual action of the coil's magnetic field and the centre rod's static field force the electrons to impact each of the hollow cylindrical target electrodes in turn. As a result of secondary emission at these electrodes it is claimed that there is an amplification factor of between six and ten at each stage, and obviously the overall magnification is in direct proportion to the number of target electrodes incorporated in the device.

PRACTICAL TELEVISION

February 24th, 1940. Vol. 4. No. 191.

Early Scanning Experiments

THE death, a short time ago at the age of 75, of Mr. L. B. Atkinson served to recall the little-known fact that this very versatile electrical engineer produced as far back as 1882 models for demonstrating the analysis and synthesis of images by the use of revolving mirrors. The simple principles which his fertile brain conceived were shown at a television exhibition a few years ago. As photo-electric cells were almost unknown at that period, these scanning devices were designed to work in conjunction with selenium which, as readers know, was later abandoned for television purposes because of the inherent sluggishness of its reactions to changes to light. According to the claims of the inventor, revolving mirrors were employed for analysing the image, that is, projecting every part in turn on the light sensitive cell, and another set of mirrors for integrating the image from the light pulses. Bearing in mind that the inventor was under 20 years of age when conducting his experiments, it is interesting to record the suggestions made nearly sixty years ago and see how they differ so radically from present-day equipment, which is based primarily on wholly electronic methods of synthesising. Some of the receiver suggestions depended on the use of telephone receivers to which the mirrors were attached, and the varying currents caused the mirrors to produce a combined line and frame-scanning action. No records appear to be available showing what degree of success was obtained with these models, but they serve to show the enormous progress which has been made in recent years in perfecting a service which the rigours of war has temporarily removed from everyday life.

Television Aerial Considerations

WHEN consideration is given to the frequency-band width of a modern high-definition television signal, it is realised that fairly stringent requirements have to be met in the case of aerials, both transmitting and receiving, together with their associated transmission lines. Unless this is done there is a loss of power transference coupled with the annoying ghosts or multiple image effects which are all too evident in the received picture built up on the home-set screen. If it is possible to so design the input circuit of the television receiver that it presents a pure resistance to the feeder line, and is equal to the characteristic impedance of the line over the whole band of picture frequencies involved, then the difficulties associated with the design of a satisfactory receiving aerial are minimised very considerably. Many experiments are being conducted in America to find the most satisfactory solution of the aerial problem in so far as it relates to practical equipment. In one case what is termed a folded dipole has been developed. This is really a pair of closely-spaced half-wave aerials which are connected together at their ends. One of these dipoles is broken at its mid-point where it is fed by a balanced transmission feeder cable. Yet another scheme is to use a double-cone aerial, that is, two copper cones with their apexes joined at the centre. Since all television transmissions in America are horizontally polarised there is no difficulty in supporting such a device, but in this country a scheme of that character would not find favour. It satisfies the most rigid of requirements in respect to the band width of frequencies which the aerial has to deal with, but for most general purposes the simple half-wave dipole seems to meet normal conditions. Mechanically there is everything in its favour, and judged on performance with the majority of good-quality home receivers and using efficient feeder cable connections, it would appear that this will be the most popular device for some time to come.

Noise-level Problems

ONE of the most important problems which beset the engineer responsible for the design of a television receiver is that associated with what has commonly come to be known as noise level. Without any previous knowledge of the nature of the location at which the set is to be employed, the reduction of noise level to an economic figure cannot be properly assessed. If refinements of an elaborate character are introduced to reduce the noise level of the set to a very low figure, all this work is nullified if the viewer is situated in a locality where interference noises are of a very high order. These are the conditions which American television receiver manufacturers are called upon to face. That continent is the home of multitudinous domestic electrical appliances, flashing signs, lifts, countless motor-cars, and so on. All of these are potential sources of electrical interference, the effects of which manifest themselves all too prominently on the cathode-ray tube receiver screen. These electrical disturbances in their various forms are found very frequently to exceed the internal noise level of the receiver, and satisfactory pictures cannot be obtained unless the received signal has a value of several millivolts. In places free from interference it has been found an advantage to employ a radio frequency stage in the set, as this has the effect of reducing the noise level of the set, and in consequence the observed picture is relatively free from overall mush. Of course, there are other considerations to be borne in mind when considering the desirability of incorporating a radio frequency stage. For example, there is the question of reducing the interference effects from strong signals which might be present on an adjacent carrier channel. In any case, various practical factors have to be taken into consideration in addition to the fundamental theoretical ones, and it is for this reason that the set-designers' task is far from being the sinecure that many people imagine.

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).

"The Rapide 3"

SIR,—I have been a reader of your excellent journal for the past eighteen months, and have derived much pleasure and knowledge from its pages. Other readers may be interested to know that the "Rapide 3" which I built from instructions given in PRACTICAL WIRELESS is still giving admirable service. I have not constructed any receivers since that one, but I hope I shall have the pleasure of making your new 1940 set when it is released in March. If any beginner reads this letter who is looking for a straight-forward set to build, I thoroughly recommend the "Rapide Straight 3," as it gives good results, and is quite cheap to construct. I understand that the blueprint is still available. If any reader would like to correspond with me I should be highly delighted, and will endeavour to answer all letters received. In fact, if J. A. Blandon, of Horsham, reads this letter I hope he will write to me. Also, if any reader has any second-hand "Telsen" L.F. choke of 100 henries or 20 henries, would he please communicate with me? The 20 h. choke is the most important. I would also like to purchase a blueprint or circuit of the "Telsen Empire Screen Grid 4." I wish your paper every success in the future, and hope it will continue to keep me interested in radio for many years to come.—J. PARKER, The Nautical Training School, Heswall, Cheshire.

Correspondents Wanted

SIR,—I would like to correspond with any young reader of PRACTICAL WIRELESS who is a beginner in wireless. I am a fairly new reader of your excellent paper, and hope to read it for many years to come.—F. DUMBILL, "Windyridge," Congleton Road, Talke, Stoke-on-Trent.

SIR,—I am wondering if there is any reader in this district who is thinking of learning the Morse Code, and who is interested in short-wave listening. If so, I would like to communicate with him. I have been a keen short-wave listener for two years now, but I was evacuated recently and have not a short-wave receiver here, at present. My set is the Economy One-Valver, with an L.F. stage added.

All my knowledge of wireless has been gained from PRACTICAL WIRELESS, and I am very pleased that I can still get it under present conditions. With best wishes for the continuation of your good work.—PETER HORN, c/o Mr. Howard, Warwick House, Long Road, Carlton Colville, Nr. Lowestoft.

The "Admiral Four"

SIR,—I would be greatly obliged if any reader who has built the "Admiral Four," would kindly get in touch with me—G. BROWNLOW, "Avoca," Ballinderry Road, Lisburn, Co. Antrim, Ulster.

A Reader's Den at Tottenham

SIR,—I have always been very interested in photos of readers' dens which have appeared in PRACTICAL WIRELESS from time to time, and I enclose a photo of my den which may interest other readers. My

A corner of Mr. D. G. Shephard's den.

receiver is an o-v-1, which is fed into the D. D. pen section of a mains set. I have a vertical aerial on the roof and a 20-metre doublet in the loft; also a small experimental doublet in my room.

It may interest readers to know that when taking the photo I used "Selo" ultra-rapid film, and gave it 20 seconds exposure at f.8.8. I used three lamps for lighting, one 150w. and two 60w. lamps. I should like to exchange my S.W.L. card with anybody at home or abroad. I Q.S.L. 100 per cent. In closing I should like to wish your fine journal every success in these difficult times.—DENNIS G. SHEPHARD, 82, Brentwood Road, Tottenham, N.17.

Full-wave Detection

SIR,—I was interested in reading the article on Old Circuits in your issue dated January 6th, and particularly the *full-wave detector* circuit using two crystal detectors, one at the "top" and one at the "bottom" of a centre-tapped coil. It is noted that the writers of the article were never successful in obtaining any better reception than could be obtained from a single crystal.

I have not proved it, but am of the opinion that full-wave detection of radio frequencies is impossible—or, in other words, that there is no such thing as full-wave detection of radio frequencies by any method. If anyone challenges this statement will he please forward full experimental proof to the contrary?—D'ARCY FORD (Exeter).

Frost and Radio

SIR,—I was very interested in a recent paragraph in your journal under the heading "Frost and Radio," and think that my own experience may help to solve the mystery.

I had an A.C. receiver working quite normally on my test bench when it was switched off for the night. Next morning, however, when it was switched on the set was dead except for a hum that shrieked smoothing trouble. On examination I found small beads of ice had formed on top of the electrolytic condensers, which were of the wet type. The condensers were also cold to touch and I came to the conclusion that they were frozen.

I placed my 60-watt bench lamp close up to them, and left it for about half an hour. When I switched on again the set was quite normal.

I have never heard of this trouble before, so perhaps some reader can inform me of the freezing point of this type of condenser.—VICTOR T. RUSSELL (Chingford).

Exchanging S.W.L. Cards

SIR,—I have been a reader of your fine paper for nearly a year now and take this opportunity to thank you for such a useful paper. I am particularly interested in the "Impressions on the Wax" page, which I think is a useful guide. I would like to exchange my card with any other S.W.L.s, A.A.s or "hams" either at home or overseas, and will Q.S.L. 100 per cent.—F. H. POYSER, The Hospital, Debden Road, Saffron Walden, Essex.

SIR,—I offer my congratulations for your excellent journal. I would like to exchange cards with any S.W.L., A.A., or full ham anywhere.—J. E. CHARLESWORTH, 35, Town Terrace, Leeds Road, Huddersfield.

Prize Problems

PROBLEM No. 388.

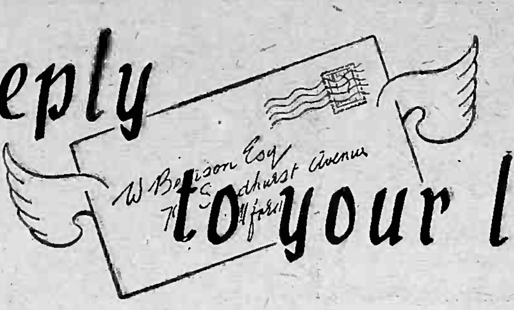
JEROME had a three-valve battery receiver employing S.G., Detector and Pentode stages. He connected a new pick-up to the detector stage, with correct connections and bias, but although it worked, it did not give sufficient volume. He therefore decided to add a further stage, and thought that the H.F. stage could be converted for the purpose. He broke the grid circuit of this stage and connected the change-over switch so that the pick-up would be correctly connected, and a 1.5 volt grid-bias tapping was tried. He failed to obtain any signals, however, and in spite of cutting out bias entirely, no results could be obtained. Why was this? 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. 388 in the top left-hand corner and must be posted to reach this office not later than the first post on Monday, February 26th, 1940.

Solution to Problem No. 387.

The coil in Dickson's coil unit was internally connected to the screening can and, therefore, when he earthed the latter he was actually short-circuiting the input circuit of the receiver, as the lower end of the wave-trap coil was connected to the receiver aerial terminal.

The following three readers successfully solved Problem No. 386 and books have accordingly been forwarded to them: F. G. Alison, 149, Bravington Road, Maida Hill, W.9. D. King, Stalham Hall, Norfolk. Sgm. Cockill, E. G., 11, Park Terrace, Glasgow.

In reply to your letter



Motor Tuning

"I have a mains set which is fitted with a motor-tuning device, and this has been giving a bit of trouble lately. Sometimes when trying to get a new station the dial keeps going and does not stop, or else it runs for a little while and then stops. After this, pressing the button does not have any effect until the set has been switched off for a time and then it will work properly. I wonder if you can explain the cause of this trouble and how I may cure it."—L. K. (Colindale).

WE think that the instrument is quite in order, but that in pressing the button for a station you accidentally depress the next to it. On some motor-tuned sets the operation of two buttons at once may make the motor run continuously, or until some automatic switch device fitted to the motor comes into action and prevents the motor burning out. The effect of the motor running for a period like this will result in overheating, and thus you must switch off for a time to permit it to cool before it will become effective again. Make certain, therefore, that only one button at a time is pressed.

What Is An Abac?

"I was reading one of your back numbers and you said that it was possible to get the number of turns for a coil from an abac. I should be glad if you could tell me what this is and where I can obtain one for coils. Perhaps you could also give the price."—C. E. S. (Harrogate).

AN abac is a form of calculating table generally consisting of three vertical lines placed in definite positions in relation to each other. In the case of coil abac one line would carry the inductance values, one the wavelength and one the capacity required, and then by placing a straight-edge across the three lines so that the desired wavelength and the capacity being used are in line it would be possible by following the straight-edge to see what inductance is needed. A similar table could be prepared to show the number of turns per inch for a given inductance and any other factor. We have not published any sets of these.

Superhet Oscillator

"I am very interested in the superhet receiver, and I have been studying the principles of this from the various articles you have written. There is just one point about which I am in some doubt, and I should be glad if you could assist me in ascertaining the reason for the grid condenser and leak in the oscillator grid circuit. Does this perform the same function as in a grid leak detector?"—S. R. (Penge).

THE combination of the condenser and leak acts as a smoothing device to ensure constant oscillation in the oscillator circuit. Should excessive oscillation take place grid current will flow, and this will produce an increased voltage drop down the grid leak, increasing the negative bias and thereby reducing anode current and thus restricting the oscillatory voltage.

A.V.C. Circuit

"I have been trying to fit A.V.C. to my set with parts which I had on hand. I enclose a circuit which I have been trying to use, and have marked out one or two parts which I do not think are essential and should be glad if you could explain why this will not work. I am only interested in obtaining the basic arrangement and wish for a start to cut out all refinements."—K. S. E. (Kettering).

YOU have apparently attempted to cut out the decoupling components, but in doing so have overlooked the fact that one of the resistances in the circuit is the load resistance, across which the A.V.C. voltage is developed. Without this there is no voltage for application to the early stages for volume control purposes. The resistance in question is that joined direct from the diode to earth and the A.V.C. line may then be taken as at present from the diode. You may find, however, that it will be necessary to include one decoupler for the I.F. stage.

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 must be enclosed with every query.

Condenser Discharge

"I have made a four-valve A.C. set and enclose the wiring herewith. The set is perfectly good except for one small detail, and that concerns the switching. When I switched on for the first time everything was good. I switched off after a short period of listening in order to place the chassis in the cabinet. When I touched the electrolytic condenser on the mains side I got a shock. I did not trouble about this at the moment, but I have since found that if I switch off for only two or three seconds and then switch on there is a tremendous hum and distortion, but if the set is switched off and left for two or three minutes it performs perfectly when switched on again. Perhaps you can explain this."—E. T. C. (St. Albans).

WE think the effects mentioned are merely due to the method of connecting your electrolytic condensers on the mains side. These are correctly joined on each side of the smoothing choke, but we note that you have connected the negative side of these two condensers direct to the centre tap of the secondary winding instead of to earth (chassis). The on/off switch you have included breaks the centre tap lead and thus the condensers cannot discharge in the usual way as they are isolated when the set is switched off. Incidentally, it is not usual to place a switch in the H.T.— lead and this is only included in sets of the communications type for "send" and "receive" switching, and it is not necessary to use this switch in addition to the ordinary on/off switch in the mains primary leads. We therefore suggest you ignore this section of your multi-switch and connect H.T. negative (centre-tap) direct to earth and this should cure your trouble.

A.C. Hall-Mark 4

"I have obtained a blueprint for this receiver, but on applying to the firm you recommend I am told that the mains transformer has been discontinued. I should be glad if you could give me full details of the transformer so that I can obtain one elsewhere or wind one myself. Also, where could I obtain a substitute for the mains dropping resistance in the Universal Model of this receiver?"—C. P. (N.10).

THE transformer in question was designed with two secondary windings, one delivering 4 volts at 4 amps. for the four valves, and the other 150 volts at 300 mA for use with an H.T.10 rectifier in a voltage-doubler circuit. This rectifier is also discontinued but is replaced by the H.T.17, of similar characteristics. The voltage dropping resistance for the other model may be obtained from Messrs. Bulgin.

REPLIES IN BRIEF

The following replies to queries are given in abbreviated form either because of non-compliance with our rules, or because the point raised is not of general interest.

M. J. R. (St. Albans). Several firms make the type of set mentioned. We suggest you write to Stratton & Co., Ltd., of Eddystone Works, Bromsgrive Street, Birmingham, 5, and the G.E.C., of Magnet House, Kingsway, W.C.2. The latter firm make a special set for tropical use, whilst the former can supply details of a home-made receiver.

R. L. H. (Rawcliffe Bridge). We have not published a design of the type you require. There is one commercial model, we believe, although it is not certain at the moment that this is on sale in this country yet.

A. B. (Luton). The trouble may not be due to the ratio but to L.F. instability. Try reversing the connections to the secondary of one of the transformers, and if this is unsuccessful decouple one of the stages.

I. J. T. (Harrow). We do not recommend the set now as the valves are not obtainable. With regard to the other set the coil is not now obtainable, but plug-in coils could be used. The transcoupler may be obtained from Bulgin, type L.F.10, price 11s. 6d.

F. A. (Barrow-in-Furness). Messrs. Dubilier can supply a component of the type mentioned, under the name Fadover. The price is about 7s. 6d. We do not know of an L.F. transformer with the ratio mentioned, but a mains transformer with a 2.5 volt secondary would give a ratio of 100 to 1. Would this suit in your case?

J. W. W. (Lewisham). Write to the Hon. Sec., E. A. Gibson, New Eltham Ratepayers' Association (Radio Section), 87, Montbelle Road, New Eltham, S.E.9.

T. W. Y. (York). We regret that we have no details now available concerning the particular speaker mentioned.

A. S. B. (Luton). The trouble may be threshold howl or some other form of instability, and is no doubt due to the general design on the short-wave section. We are unable to advise more definitely without a circuit or other details.

P. N. (Barbourne). Write to the Recruiting Officer, R.A.F., Air Ministry, Kingsway, W.C.2.

The coupon on page iii of cover must be attached to every query.

Practical Wireless BLUEPRINT SERVICE

PRACTICAL WIRELESS	*Date of Issue.*	*No. of Blueprint.*
CRYSTAL SETS.		
Blueprints, 6d. each.		
1937 Crystal Receiver	—	PW71
The "Junior" Crystal Set ..	27.8.38	PW94
STRAIGHT SETS. Battery Operated.		
One-valve : Blueprints, 1s. each.		
All-Wave Unipen (Pentode) ..	—	PW31A
Beginners' One-valver	19.2.38	PW85
The "Pyramid" One-valver (HF Pen)	27.8.38	PW93
Two-valve : Blueprint, 1s.		
The Signet Two (D & LF) ..	24.9.38	PW76
Three-valve : Blueprints, 1s. each.		
Selectone Battery Three (D, 2 LF (Trans))	—	PW10
Sixty Shilling Three (D, 2 LF (RC & Trans))	—	PW34A
Leader Three (SG, D, Pow) ..	22.5.37	PW35
Summit Three (HF Pen, D, Pen)	—	PW37
All Pentode Three (HF Pen, D, (Pen), Pen)	29.5.37	PW39
Hall-Mark Three (SG, D, Pow) ..	12.6.37	PW41
Hall-Mark Cadet (D, LF, Pen (RC))	16.3.35	PW48
F. J. Camm's Silver Souvenir (HF Pen, D (Pen), Pen) (All-Wave Three)	13.4.35	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)	21.3.36	PW62
The Centaur Three (SG, D, P) ..	14.8.37	PW64
F. J. Camm's Record All-Wave Three (HF Pen, D, Pen) ..	31.10.36	PW69
The "Colt" All-Wave Three (D, 2 LF (RC & Trans))	18.2.39	PW72
The "Rapide" Straight 3 (D, 2 LF (RC & Trans))	4.12.37	PW82
F. J. Camm's Oracle All-Wave Three (HF, Det., Pen) ..	28.8.37	PW78
1938 "Triband" All-Wave Three (HF Pen, D, Pen)	22.1.38	PW84
F. J. Camm's "Sprite" Three (HF Pen, D, Tet)	26.3.38	PW87
The "Hurricane" All-Wave Three (SG, D (Pen), Pen)	30.4.38	PW89
F. J. Camm's "Push-Button" Three (HF Pen, D (Pen), Tet)	3.9.38	PW92
Four-valve : Blueprints, 1s. each.		
Sonotone Four (SG, D, LF, P) ..	1.5.37	PW4
Fury Four (2 SG, D, Pen) ..	8.5.37	PW11
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
F. J. Camm's "Limit" All-Wave Four (HF Pen, D, LF, P) ..	26.9.36	PW67
"Acme" All-Wave 4 (HF Pen, D (Pen), LF, Cl. B)	12.2.38	PW83
The "Admiral" Four (HF Pen, HF Pen, D, Pen (RC))	3.9.38	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) ..	7.1.39	PW35C
D.C. Premier (HF Pen, D, Pen) ..	—	PW35B
Ubique (HF Pen, D (Pen), Pen) ..	28.7.34	PW36A
Armada Mains Three (HF Pen, D, Pen)	—	PW38
F. J. Camm's A.C. All-Wave Silver Souvenir Three (HF Pen, D, Pen)	11.5.35	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)	24.7.37	PW45
Universal Hall-Mark (HF Pen, D Push-Pull)	—	PW47
SUPERHETS		
Battery Sets : Blueprints, 1s. each.		
£5 Superhet (Three-valve) ..	5.6.37	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
Universal £5 Superhet (Three-valve)	—	PW44
F. J. Camm's A.C. Superhet 4 ..	31.7.37	PW59
F. J. Camm's Universal £4 Superhet 4	—	PW60
"Qualitone" Universal Four ..	16.1.37	PW73
Four-valve : Double-sided Blueprint, 1s. 6d.		
Push Button 4, Battery Model .. / Push Button 4, A.C. Mains Model	22.10.38	PW95
SHORT-WAVE SETS. Battery Operated.		
One-valve : Blueprint, 1s.		
Simple S.W. One-valver	23.12.39	PW88
Two-valve : Blueprints, 1s. each.		
Midget Short-wave Two (D, Pen)	—	PW38A
The "Fleet" Short-wave Two (D (HF Pen), Pen)	27.8.38	PW91
Three-valve : Blueprints, 1s. each.		
Experimenter's Short-wave Three (SG, D, Pow)	30.7.38	PW30A
The Prefect 3 (D, 2 LF (RC and Trans))	—	PW63
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