

Practical Wireless

and PRACTICAL TELEVISION

Staff:
L. O. SPARK
FRANK PRESTON

BY THE EDITOR

EVERY MONTH
Vol. XIX, No. 438. DECEMBER, 1942

COMMENTS OF THE MONTH

Editor F. J. CANN

Imported Valves—Prices Fixed

THE Board of Trade has made an Order, after consultation with the Central Price Regulations Committee, controlling the prices to be charged by official selling agents, wholesalers and retailers, of all radio valves imported under the Lease-Lend provisions. These prices are set out in related price lists which have been certified by the Board of Trade, the Central Price Regulation Committee and each of the Local Price Regulation Committees.

The Order provides that all agents or wholesalers dealing in these valves must supply either before or at the time of delivery to their customers a written notice which can, if desired, be incorporated in the invoice, stating the correct maximum prices for the valves in question. All retailers selling these valves must display in a prominent position in their shops a notice giving the maximum price appropriate to any of these goods offered for sale by them. This Order came into force on the September 28th, and copies are obtainable for 2d. from His Majesty's Stationery Office, York House, Kingsway, W.C.2.

The prices fixed are as follow:

OZ4, 15s. 3d.; 1A5G and 1A5GT, 11s.; 1A7G and 1A6GT, 12s. 10d.; 1C5G, 1C5GT, 1LA4, 1LN5, 1N5G, 1N5GT, 1Q5GT, 3Q5GT, 1T5GT, 5V4G, 5Y3GT/G, 5Y3G, 5Y4G, 5Z4, 5Z4GT/G, 6X5, 6Z5/12Z5, 7Y4, 23Y5, 25Z5, 25Z6, 25Z6G, 25Z6GT, 35RE, 35Z4GT, 35Z5GT, 45Z5GT and 80, 11s.; 1H5G and 1H5GT, 9s. 2d.; 1C6 and 1LA6, 12s. 10d.; 7B5, 7B7 and 7C5, 12J7GT, 12K7GT, 12S7GT, 12SK7GT, 18, 25A6G, 25A6GT, 25L6, 25L6G, 25L6GT, 35L6GT, 36, 42, 43, 47, 78, 50L6GT, 6F6, 6F6GT, 6J7GT, 6K6G, 6K6GT, 6K7, 6K7GT, 6L7G, 6SK7, 6V6GT, 12s. 10d.; 6A3, 6Q7G, 6Q7GT, 6T7G, 6SQ7, 7C6, 12Q7GT, 12SQ7GT, 75, 85, 11s. 7d.; 6A6, 6B5, 6C8G, 6F8G, 6L6G, 6L6, 6SC7, 18s. 3d.; 6A7, 6A8G, 6A8GT, 6K8GT, 6SA7GT, 7A8, 12A8GT, 12SA7GT, 14s.; 6F5G, 6F5GT, 6L5G, 12F5GT, 12J5GT, 12SE5GT and 76, 9s. 2d.; 5Z3GT/G, 6N6G, 18s. 3d.; 12A7, 25B8GT, 25A7GT, 32L7GT, 117Z6G, 15s. 3d.; 12Z3, 11s.; 45, 11s. 7d.; 1Z40, 66s. 11d.; 6SF7, 15s. 3d.; 6J5GT, 9s. 2d.; 6J8G, 14s.; 12B8GT, 70L7GT and 83, 15s. 3d. This new Order regularises the position, and will prevent the racketeering in American valves in which a few unscrupulous dealers have engaged.

The Position of Service Engineers

THE Radio Manufacturers' Association has circulated all dealers (who filled up their questionnaire on the subject), trade service organisations, manufacturers and wholesalers, informing them of the decision of the Ministry of Labour on the position of radio service engineers, in relation to

deferment. The R.M.A. by means of its questionnaire has collected data relating to the needs of the public in connection with the servicing of receivers. About 4,000 dealers filled up the questionnaire. As a result negotiations have been in progress between the Ministry and the R.M.A. on the question of reservation of a sufficient number of men to maintain an efficient public service. The importance of radio during the war has been stressed, for more than ever it represents the official voice and the official mouthpiece. Until the negotiations had been completed the Ministry had left the industry alone, and had not called up service engineers. The R.M.A. letter says that apart from the question of principle the scheduling of service depots under the Essential Works Orders would present difficulty. It has not been possible to agree on any general scheduling of the wireless service industry. If any dealer has a separate repair depot of any size, particularly if it is doing military work, he can apply for scheduling either through the Supply Department concerned, or if he is on purely civilian work, through the Ministry of Information. Applications for the deferment of service men who are essential, and cannot be replaced by older men, or by women, should be made in the usual way. The applications should state the average number of repairs, both major and minor, carried out per month during the past 12 months, the number of persons the department is divided into (skilled and semi-skilled) and if the area served is limited, any general conditions, relating to the adequacy of repair facilities in the district.

The Ministry of Labour is not willing to work on any rigid datum line as to the number of repairs per person,

i view of varying local conditions and uncertain demands on man-power. The Committee concerned with these negotiations suggested that retailers should see that not less than 55 repairs per skilled man with 25 per cent. addition for each semi-skilled worker are carried out each month.

If deferment is refused the assistance of the Regional Representatives of any Government Department interested in the work of the firm, generally the Board of Trade, should be obtained if it is considered that an exceptional case could be made for the deferment of the men concerned. Such assistance should not be sought merely because the Man-power Board has rejected the application, for the Board will have already consulted the appropriate department before deciding to reject the application. Women born between December 7th, 1910, and December 31st, 1922, will not be withdrawn at present without prior substitution.

We are of the opinion that the radio industry has made a generous contribution of man-power to the Services, and should be left alone

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

The Editor will be pleased to consider articles of a practical nature suitable for publication in PRACTICAL WIRELESS. Such articles should be written on one side of the paper only, and should contain the name and address of the sender. Whilst the Editor does not hold himself responsible for manuscripts, every effort will be made to return them if a stamped and addressed envelope is enclosed. All correspondence intended for the Editor should be addressed to The Editor, PRACTICAL WIRELESS, George Newman, 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 later patent.

Copyright in all drawings, photographs and articles published in PRACTICAL WIRELESS is specifically reserved throughout the countries signatory to the Berne Convention and the U.S.A. Reproductions or imitations of any of these are therefore expressly forbidden. PRACTICAL WIRELESS incorporates "Amateur Wireless."

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this paper should not be taken as an indication that they are necessarily available for export.

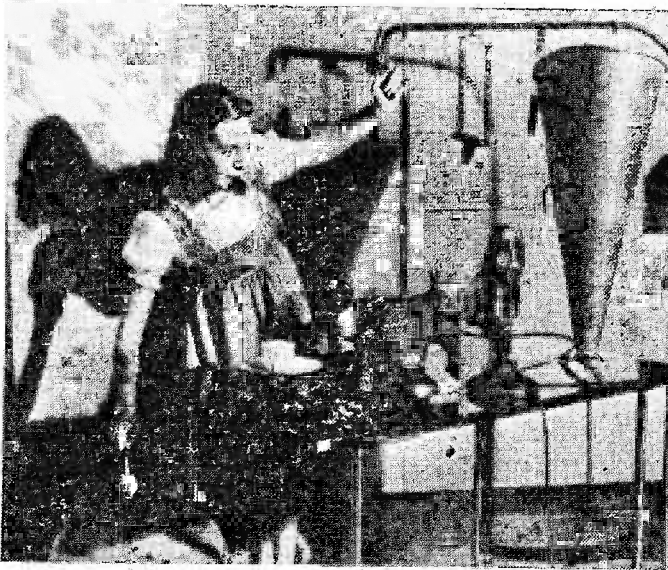
ROUND THE WORLD OF WIRELESS

Sirens on Radio Sets

A NEW YORK firm has invented a private siren, to be attached to a household radio set, which will give the alarm six or seven minutes before the official warning. The set, which is left switched on, starts to howl when the radio stations go off the air.

"Calling All Cars"

IT is reported that the American system of calling all cars by radio telephone, instead of one-way Morse, is to be adopted by Scotland Yard shortly. Technical experts at Scotland Yard have perfected a two-way wireless system which will enable the information room staff to converse with the crews of all Metropolitan police cars within a radius of 75 miles. There is no possibility of anyone else listening in.



The first radio sound-effects woman in America, Miss Beth Mair, in action. She produces the sound effects for the General Electric Company's frequency modulation playhouse.

Radio Here for U.S. Troops

THE broadcasting of special programmes from the United States direct to the American forces in Britain has been the subject of discussions between the B.B.C., the United States Office of War Information, and American Army and Navy chiefs in London recently. It is likely that "home-town news" for U.S. troops will be an important feature.

Radio Salary Cuts!

ACCORDING to a recent report, Dr. James Thomson, new general manager of the Canadian Broadcasting Corporation, is to be paid £10,980, including expenses, in place of £12,000, and Major Gladstone-Murray, the Director-General, will receive £12,000 in place of £14,000.

New Bulgarian Stations

IT is reported that seven new transmitting stations are being built in Bulgaria, presumably under German instructions, one of which will be the most powerful in the Balkans.

Heard Herself Broadcast

AN Englishwoman recently had the novel experience of recording in England a radio message to her husband, a warrant officer in the R.A.F. in Canada, and then hearing it broadcast while sitting beside her husband in a house in Saskatchewan. Between the recording and broadcasting she had crossed the Atlantic by ship. Shortly before she sailed she was invited to take part in a B.B.C. greetings feature.

Unlicensed Radio Sets

DURING a recent prosecution at Liverpool, on behalf of the Postmaster-General, when a number of persons were fined £3 each for not having radio licences, it was stated that in cases where the Postmaster-General considers it necessary he will exercise his right to seek confiscation of the apparatus.

U.S. Radio Curfew

IT is reported that the majority of American radio stations are to close down at midnight in order to save fuel.

Receiver Sales in Canada

THE Dominion Bureau of Statistics states that the sales of radio receivers in Canada during the first three months of this year amounted to 87,953. During the previous quarter the figure was 118,647, and 61,038 in the corresponding period of 1941. The greatest increase was recorded in the province of Ontario.

"Uncle Arthur"

IT is interesting to note that Mr. Arthur Burrows, the first B.B.C. wireless announcer, has been appointed Director of the Broadcasting Division of the Ministry of Information. Few men have had a wider or more varied experience of broadcasting than Mr. Burrows, whose radio enthusiasts will remember as "Uncle Arthur" in the 2LO days. With Mr. Stanton Jefferies, he was in charge of the first B.B.C. programme broadcast on November 15th, 1922. For several years before the war he was manager of the International Bureau of Broadcasting at Geneva.

New B.B.C. Appointment for Fred Hartley

FRED HARTLEY has been appointed Light Music Supervisor of the B.B.C. He was born in Dundee in 1905, began to learn the fiddle when he was four, and the piano at six, because his father did not want him to continue with the fiddle. He won various awards and medals, played at hundreds of concerts, came to the Royal Academy of Music at 16, won the Sterndale-Bennett Scholarship and was official accompanist of the academy.

He says he "wasted a lot of time," and spent many hours playing in dance bands—the London Collegians, Jack Hylton's Kit-Kat Band, and was on and off the music-hall stage for two years.

A stormy interview with his academy principal ended his studies, and he became conductor at the biggest music-hall in Stockholm, after which, in 1926, he returned to this country to become accompanist to the B.B.C. in the Dundee studio.

Five years later he came back to London to form what

was originally known as "Fred Hartley and his Novelty Quintet." He was the first person to use singers as an integral part of a light music ensemble. It was in this way that he introduced to radio Cavan O'Connor, Brian Lawrence, Webster Booth and others.

In his own programmes he does almost everything himself, even to writing the scripts; for a long time he also ran a music publishing firm, and he still keeps an eye on a hand-laundry business in the country. His versatility is equal to his energy.

Light music, he believes, is as essential as variety, and even moderately good light music is better than bad variety. He hopes to improve the standard of light music. Moreover, the kind of light music that suits the early morning does not suit the late evening, and he is keen on the better adaptation of a programme to its period.

B.I.R.E. Meeting

AT a members' meeting of the British Institution of Radio Engineers, held on October 23rd, a paper on "Theory of Units" was given by L. H. Bedford, M.A., a synopsis of which is given below:

In the formulation of electro-magnetic theory there are three stages at which arbitrary constants are conveniently introduced for the purpose of defining units. It is customary to assign immediately the value unity to certain of these constants, after which they are lost sight of, and have often, at a later stage, to be painfully resuscitated. A sketch of electro-magnetic theory was given in which the suppression of these fundamental constants (k_1 , k_2 , k_3) did not occur. Maxwell's theory was shown to lead to a certain relationship between the k 's involving the velocity of light. Subject to this restriction, the assignment of k -values is an arbitrary matter, the process of formulating a unit system being one of two degrees of freedom.

A table was constructed showing the assignment of k -values corresponding to the various known unit systems. This table can, among other things, be used to derive the numerical relationship between the unit quantities of the various systems. One necessary example of this was given, but it was pointed out that the (advocated) use of a generalised system of units (k 's unspecified) eliminates once and for all the tiresome and inelegant process of unit changing. Moreover, this generalised system of units is free of the dimensional inconsistencies which characterise the known systems, at least in their more usual modes of expression.

An example was given of the direct use of the generalised system of units: a particular problem which would normally present the most tiresome process of unit changing was solved straight out in generalised units from which the numerical answers were written down at once in practical units. Serious inconsistencies of method and nomenclature in connection with the practical system of units were brought to light, and proposals for rationalisation considered.

Broadcasts to Schools

RADIO'S growing importance in the educational world is shown by the increasing number of schools registering for the special B.B.C. broadcasts. It is hoped that before the end of the school year, which recently opened, the number of listening schools will have reached the

12,000 mark. Already 10,429 schools have registered, which is 469 higher than at the beginning of the last school year. The 1941-42 year ended with a total of 11,299, a figure nearly 2,500 in excess of the highest figure recorded at a corresponding date in any previous year.

It is significant that the figures have risen in spite of the upheaval caused by the war. In pre-war years, for instance, the total was 6,817 at the end of 1936-37, and for 1938-39 registrations numbered 9,952. Incidentally, it should be noted that the above figures do not include Scotland, where a new system of registration has been introduced, and the complete returns are not yet available.

Factors contributing to the success of last year's broadcasts included the issue of an attractive annual programme, the co-operation of local education authorities, and, finally, the extent to which broadcasting has become an accepted part of school life.

New U.S. High-power Station

THE General Electric Company of New York recently opened a 100-kilowatt radio station (WGEO) to be used for broadcasting news to "the oppressed people of the world." In the opening broadcast the announcer said to the people of Germany: "We are coming with a cloud of planes that will darken your land, and blast and destroy your cities."

Radio Telephone to E. Africa

A RADIO-TELEPHONE service between Portugal and Mozambique, Portuguese East Africa, is to be opened shortly.

Incorporated Radio Society of Great Britain.

WE have been notified by the General Secretary that the following persons have been nominated to serve on the 1943 Council of the above society:

Officers: President, Mr. A. D. Cox (G6NF); Executive Vice-president, Mr. E. L. Gardiner (G6GR); Hon. Treasurer, Mr. A. J. H. Watson (G2YD); Hon. Secretary, Mr. H. A. M. Clark (G6OT); Hon. Editor, Mr. J. W. Mathews (G6EL).

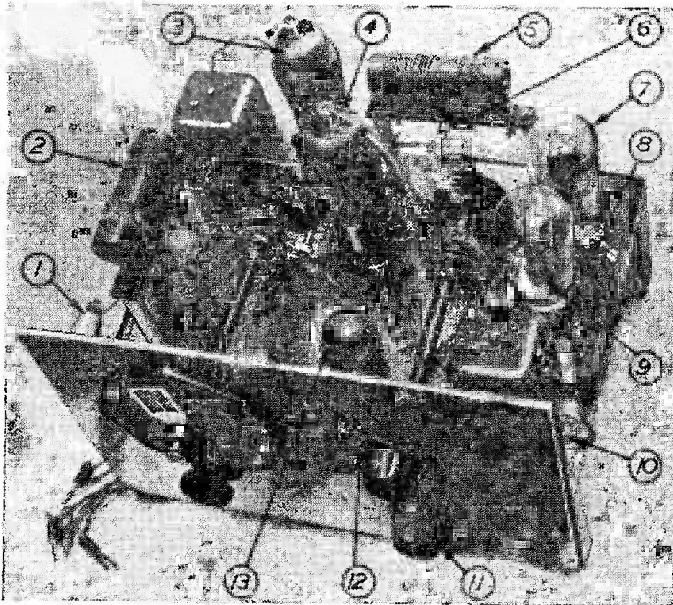
Members (retiring members eligible for re-election): W./Cmdr. G. M. R. Scott Farnie (GW5FT), Mr. G. A. Jessup (G4HG), Mr. W. A. Scarr (G2WS), Mr. E. H. Simmonds (G8QH). New nominations as per Article 13: Mr. F. Charman (G6CJ), Mr. D. N. Corfield (G5CD), S./Ldr. John Hunter (G2ZQ).



Empire pilots taking a course of Morse signalling at an R.A.F. Army Co-operation Command.

A Short-wave Superhet

An Interesting Layout for the Experimentor. By R. L. GRAPER



is that they were originally made for a frequency of 110 kilocycles, but were converted for 465 kilocycles working by careful removal of an equal portion of each winding.

I.F. Transformer Conversion

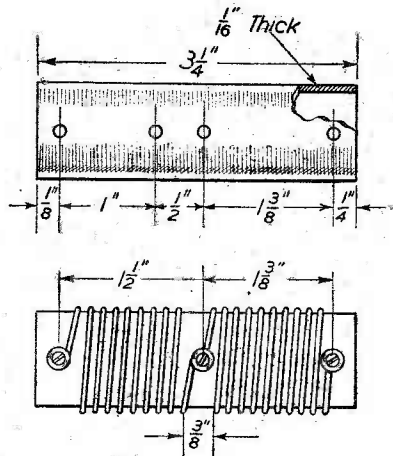
The conversion of the 110 kc/s I.F. transformer to 465 kc/s was carried out as follows: The spool carrying the two coils was removed, after first observing and marking all leads. The spool was then mounted on a spindle in a vice, and a slight braking action obtained by rubber washers. Both coils had turns removed (Fig. 5), until equal to the gauge card, which was marked with the thickness of coils, and cut-out measured for this. Approximately three-quarters of their thickness was removed. I would suggest removing two-thirds, and testing by means of a known-frequency liner, which is facilitated by the method of mounting the trans-

(Left) Above chassis view of the 5-valve superhet, showing the layout of components:

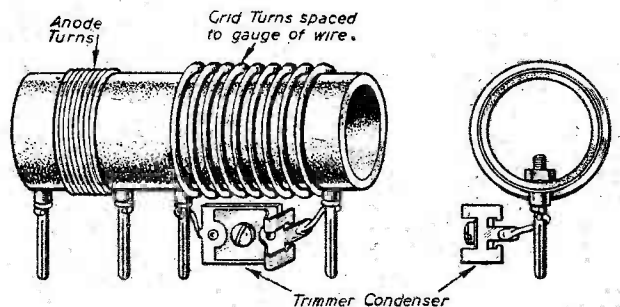
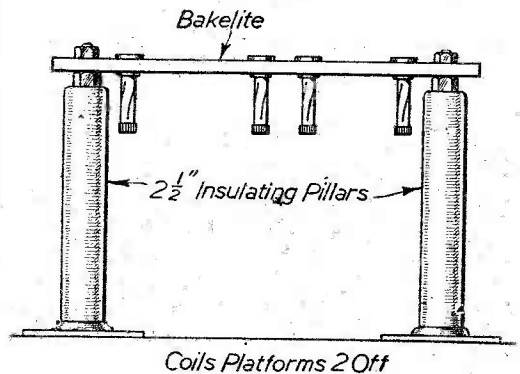
- | | |
|--|--------------------------------|
| 1. Aerial stand-off | 7. L.F. valve. |
| 2. Aerial coil. | 8. Earth wire. |
| 3. TH 2. | 9. Pen. 220A. |
| 4. VP 2. | 10. I.F. sect. |
| 5. Oscillator coil. | 11. Volume control and switch. |
| 6. Trimmer condenser soldered to grid pins on each coil. | 12. Epicyclic Drive. |
| | 13. PM 2 H.L. |

THE following description is of a superhet layout built by the writer primarily for experimental work on the short-wave band. The circuit, Fig. 1, shows a five-valve receiver incorporating a hexode frequency-changing valve followed by an I.F. amplifier, second detector, resistance amplifier, and pentode output. Interesting features are as follows: The coils are wound on rin. formers, and plug into sockets, which are mounted on stand-off pillars, and are easily changed for various wavebands, Figs. 2 and 3. The oscillator coils have small trimmer condensers soldered to the pins of the grid section, Fig. 4. The I.F. transformers are mounted on stand-off feet, to simplify wiring.

An interesting point regarding these I.F. transformers



Figs. 2, 3 and 4.—Constructional details of coils and holder.



former on stand-off feet. As trimmers were found to need adjusting to almost three-quarters maximum, less turns might be removed with advantage. No attempt was made to shorten the distance between coils, to produce closer coupling, but this might be found advantageous, if found possible, in other designs of r.f.o. transformer.

Aerial and Oscillator Condensers

The aerial and oscillator tuning condensers are not ganged, although by rearrangement of layout they could be converted to single control, as the two condensers were found to keep well in step over the waveband covered. By the way, the oscillator condenser is about half the capacity of the aerial tuning condenser, being double spaced as regards the vanes. Both aerial and oscillator condensers are approximately of .0001 mfd. maximum capacity, and .00005 mfd. respectively. Note the main earth wire, raised just clear of the metal chassis, for direct earth connection.

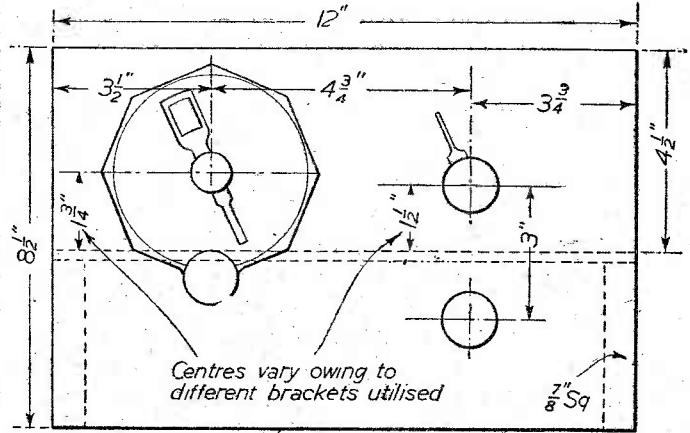


Fig. 6.—Panel layout.

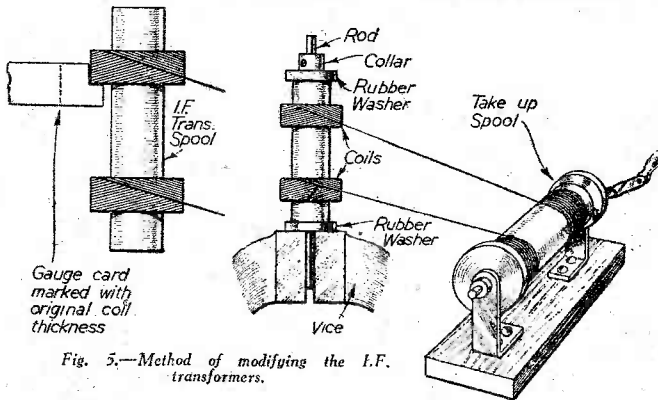


Fig. 5.—Method of modifying the I.F. transformers.

Coil No. 1 covers an approximate wave range of 14 to 25 metres. Its oscillator anode winding consists of 12 turns of 20 s.w.g. and the grid 10 turns of 18 s.w.g. The aerial coil primary requires 8 turns of 20 s.w.g. and the grid coil 10 turns of 18 s.w.g.

Coil No. 2 has an approximate coverage of 30 to 57 metres. The oscillator anode section requires 20 turns of 32 s.w.g., and the grid coil 27 turns of 22 s.w.g. The primary of the aerial coil has 16 turns of 32 s.w.g., while the grid section consists of 27 turns of 22 s.w.g.

General Construction

The photograph of the completed receiver shows the general assembly, but for more detailed information relating to the component layout and wiring, reference should be made to the wiring

tions. This is also incorporated on the underside of the chassis. The valve holders for the hexode frequency-changing valve, and the one for the I.F. amplifying valve, are raised clear of the chassis for short direct connections to the coils and condensers.

Coil Data

There is one point which should be noted with regard to the construction of the coils and holder, as it will save a certain amount of time and labour. Although two centre pins are shown, it is sufficient to provide and use only one, as their connections are actually common, i.e., both taken to earth. The ultimate position of the pin is determined according to the number of turns.

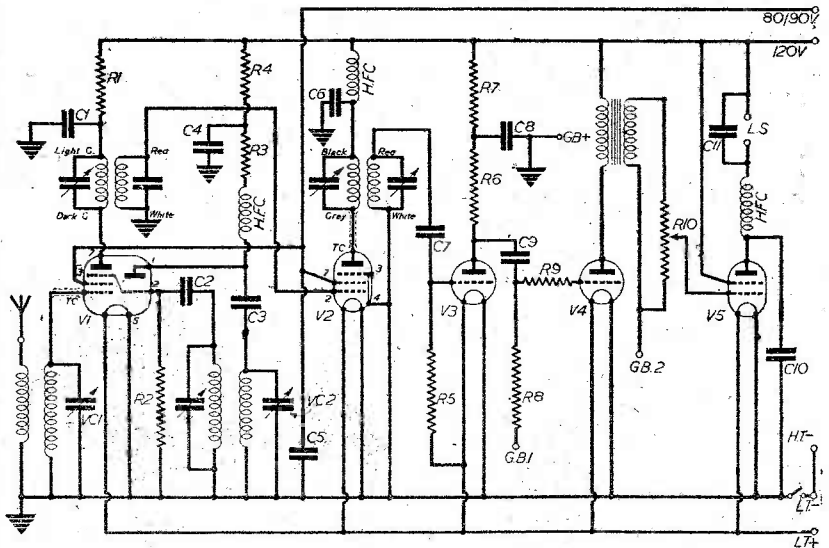


Fig. 1.—Theoretical circuit diagram.

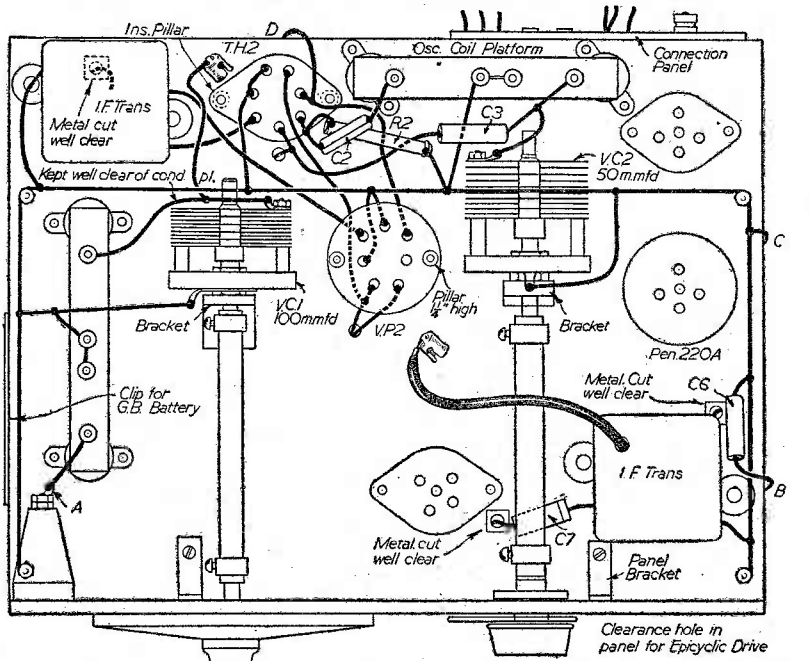
plan. Dimensions for the panel, as used by the writer, are given in Fig. 6.

The construction lends itself to experimental work, which, as mentioned earlier, was one of the main objects the writer had in mind. Unfortunately, it was not possible to put the receiver through exhaustive tests—owing to service in the Forces—but sufficient results were obtained to prove that the general design and layout were capable of putting up a very satisfactory performance which, no doubt, could even be improved upon as soon as time permits further tests and adjustments.

It will be noticed that no attempt has been made to incorporate some of the refinements which are usually embodied in a super-super or a "communication" receiver. Such items can be added at a later date, according to the components and valves available. During the initial experimental work it is advisable to keep the circuit as straightforward as possible, to eliminate likely sources of trouble. It is far better to improve and extend, making sure,

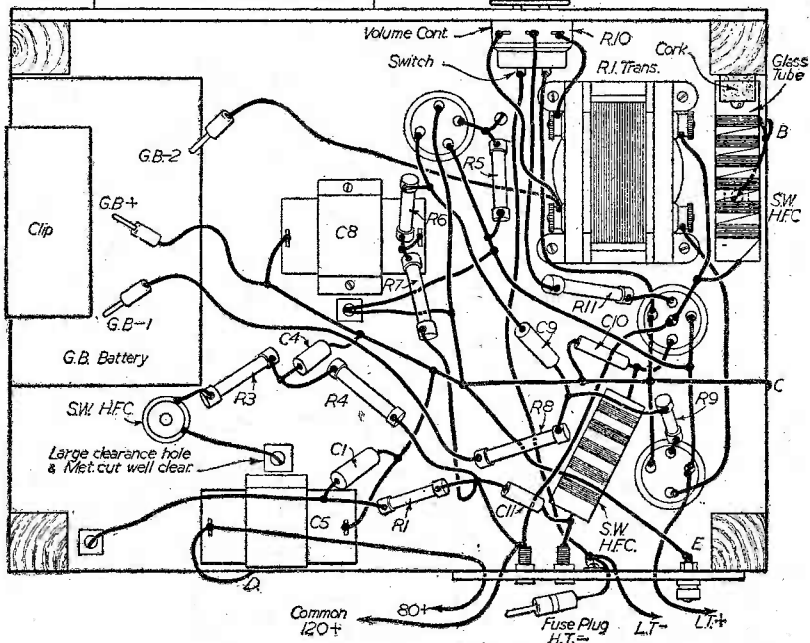
step by step, that individual parts of the circuit are approaching 100 per cent., than to build up an elaborate design, and, if one is unlucky, have to cut out sections here and there to try and find the cause of some particular trouble.

WIRING DIAGRAM OF THE 5-VALVE SUPERHET



COMPONENT VALUES

- C1 .1 mfd.
- C2 .0001 mfd.
- C3 .0001 mfd.
- C4 .1 mfd.
- C5 .25 mfd.
- C6 .1 mfd.
- C7 .0001 mfd.
- C8 .25 mfd.
- C9 .01 mfd.
- C10 .01 mfd.
- C11 .002 mfd.
- R1 5,000 ohms.
- R2 50,000 ohms.
- R3 30,000 ohms.
- R4 50,000 ohms.
- R5 1 megohm.
- R6 30,000 ohms.
- R7 20,000 ohms.
- R8 1 megohm.
- R9 100,000 ohms.
- R10 0.5 megohm.



Fundamental Oscilloscopic Tests

Voltage and Current Measurements, Phase and Frequency Comparison

By S. A. KNIGHT

IT is not possible in an article of this nature to go over the use of the oscilloscope in every field of its application, but a certain amount can be said on the subject of basic tests, and uses which are invariably required in almost every application of the instrument.

Generally, tests which are carried out by the oscilloscope can be divided into voltage and current measurements, phase and frequency comparison or determination, gain and distortion in valve circuits and component testing.

These basic tests will be described in detail, and others based on these fundamentals considered briefly though fully enough for a complete understanding of them to be obtained.

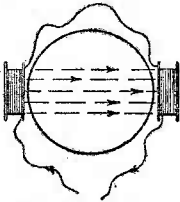


Fig. 1.— Deflector coils for current readings.

Voltage Tests

Since the application of a voltage to either pair of deflecting plates will cause the spot to move across the screen, it is a simple matter to see that by measuring the amount of movement caused, the potential of the applied voltage can be determined. In this way the cathode-ray tube becomes a voltmeter which will read for either A.C. or D.C.

The difference, however, between an A.C. and a D.C. measurement is that in the case of the former the spot is drawn out into a line the length of which is equal to the peak voltage applied, while in the latter the spot just changes position, and finishes up in a different position on the face of the screen.

It is, of course, necessary that before a tube can be used in this way its sensitivity must be known, and the screen accordingly calibrated. Most tubes are given certain figures for sensitivity by the makers, and this is usually quoted in so many volts per centimetre deflection. A celluloid graticule divided into cm. squares, and also preferably millimetre squares, attached over the face of the screen is therefore necessary.

For obvious reasons, an oscilloscope is rarely used for D.C. measurements, but for A.C. work it is extremely useful. It is practically independent of the frequency of the supply under measurement, the input impedance is generally quite high and loading errors are avoided, and the scale is linear, i.e., a trace will double its length if the applied voltage is doubled.

Since the oscilloscope measures peak voltage, this must be converted into R.M.S. by multiplying by .707 or dividing by 1.414. No time base is required for voltage measurements, a single vertical trace being sufficient for measuring purposes.

Current Measurement

Current readings can be taken similarly to that of voltage by using deflector coils mounted on the outside of the tube. For vertical deflection two coils placed

one on either side of the tube neck are required, such that a horizontal field is produced when a current is flowing through them. (Fig. 1.) The electron stream travelling along the tube axis will be deflected up or down while it is under the influence of this magnetic field, the magnitude of the deflection depending upon the current in the coils.

The screen can therefore be calibrated for current measurements, larger currents than those producing full screen diameter being read by the method of conventional shunting.

It is sometimes more convenient in practice to measure current electrostatically, that is, by means of the deflector plates and not coils, since inductive effects of the latter are sometimes such that the constants of the circuit under examination are upset and errors introduced.

The voltage dropped across a non-inductive resistor in series with the load circuit will give a measure of the current flowing, provided such drop is small compared with the total supply to the test circuit. This method generally requires the use of amplifiers to produce a satisfactory deflection, and this has its disadvantages.

In all cases where amplification is necessary, it must be borne in mind that frequency range is probably limited to certain maximum and minimum figures, and that most amplifiers impose a load on the system under measurement.

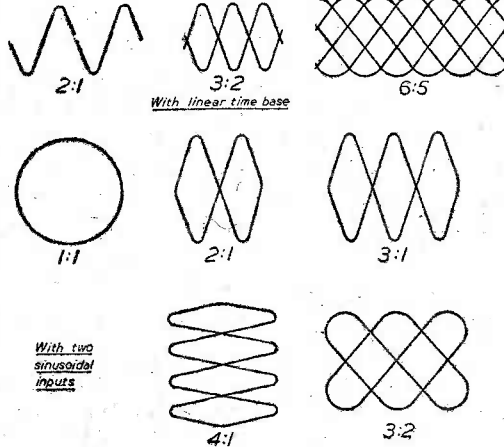


Fig. 2.— Typical figures for frequency ratios. These are known as Lissajous figures.

Lissajous Figures and Frequency Comparison

When the ratio of the time base frequency and an applied work frequency can be expressed as an integer, i.e., a whole number or a

ratio of two whole numbers, the resultant trace is a stable figure. This might be a single or an intricate pattern which might at first sight appear difficult to understand, but which is quite simple of interpretation.

If the ratio of the two frequencies is not an integer, but has considerable differences, the pattern races and is confused. Typical figures obtained for various ratios are shown in Fig. 2, these being known as Lissajous figures, and the determination of the ratios is arrived at in the following way.

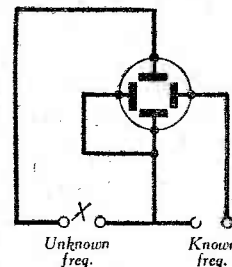
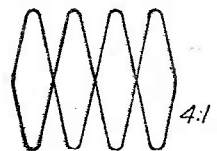


Fig. 3.— (Left) A simple method of frequency comparison.

Fig. 4.— (Below) The pattern for a frequency ratio of 4 : 1.



The ratio of the number of complete peaks in the horizontal direction to the number of entrants in the vertical direction, or the ratio of the number of complete peaks in the horizontal direction to the number of horizontal lines joining similar points of intersection of the pattern waves, plus one.

A simple method of frequency comparison up to ratios of about 12 : 1 is obtainable in this way, using a known frequency applied to one pair of plates, and the unknown applied to the other pair (Fig. 3). As variation is made in the unknown frequency, Lissajous figures will appear as stable patterns at certain settings, and the ratio can then be easily determined between the two frequencies. Suppose a pattern similar to that shown in Fig. 4 was obtained, then if the known frequency was taken from 50 ~ mains, the unknown is obviously 200 cycles, since their ratio is 4 : 1.

Careful counting of the loops is necessary where the ratio becomes high, and generally above ratios of 12 : 1 the pattern becomes too complicated for the Lissajous rule to be applied. Other methods must be used, which will be described later.

Phase Shift Determination

The cathode-ray oscilloscope is useful in checking the phase relationship between two alternating voltages. The phase relationship at various points in an amplifier, or the phase distortion in a complete amplifier, can be determined, the difference in phase being shown by the position of the trace on the screen.

A simple circuit is shown in Fig. 5, where the phase distortion in a complete amplifier is being examined. By suitable adjustment of R_1 and R_2 , relative amplitudes of X and Y deflection may be equalised, and the figures on the screen easily inspected.

As will be seen from Figs. 6 and 7, as the phase difference moves from 0 to 180 deg. a line trace is formed moving from an angle of 45 deg. to the left, through an angle of 90 deg. back to a line of 45 deg. to the right, and changing from a line to an ellipse and a circle as the phase passes through the intermediate stages. Then at any position the phase angle is equal to the angle subtended by the axis AB at the vertex C, i.e.:

$$\tan \theta/2 = AB/CD \text{ (Fig. 8 a)}$$

and assumes that the X and Y amplitudes of deflection

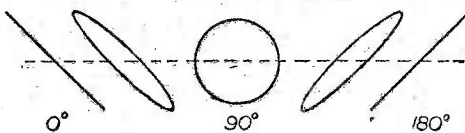


Fig. 7.—The line traces formed as the phase difference moves from 0 to 180 deg.

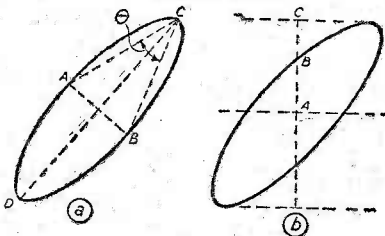


Fig. 8.—(a) $\tan \theta/2 = AB/CD$. (b) $\sin \theta = AB/AC$.

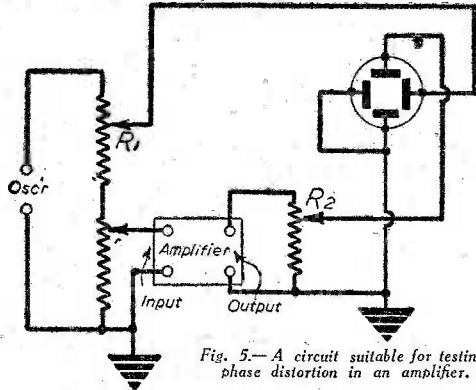


Fig. 5.—A circuit suitable for testing phase distortion in an amplifier.

are equalised. Alternatively (Fig. 8 b) the phase angle θ is given by:

$$\sin \theta = AB/AC$$

Phase Angle of a Reactive Load

This can generally be determined by using a circuit as in Fig. 9. If by suitable adjustment of resistance R the relative amplitudes of the X and Y deflections are equalised, then

$$\begin{aligned} \text{Impedance of load} &= Z = R \\ \therefore R &= R^2 + X_c^2/L \\ \text{Axes ratio} &= \tan \theta/2 \end{aligned}$$

where θ = phase angle of the load.

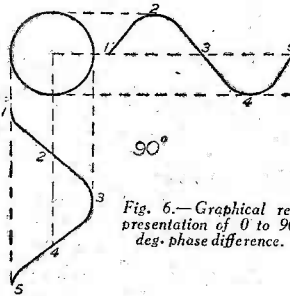


Fig. 6.—Graphical representation of 0 to 90 deg. phase difference.

Determination of Capacity by Phase Pattern

The circuit shown in Fig. 10 will, if the reactance of the condenser C is equal to resistance R, give a circular traverse, as there is a 90 deg.

phase shift across a capacitive load.

If an unknown capacity is connected at C and R is adjusted so that a circular traverse results, then:

$$R = \frac{1}{WC}$$

and C can be determined knowing the resistance of R.

Phase Delay

Phase shift, measured by the ellipse method, can be converted into phase delay, the expression giving the time in seconds required by a cycle of a certain given frequency to travel through the wiring of a receiver or amplifier under test.

$$\text{Phase delay} = \frac{\text{phase angle}}{\text{Frequency} \times 360}$$

Phase distortion occurs when the delay in time varies with the frequency injected. If there is no variation for all the frequencies handled then there is no phase distortion, and the phase shift is proportional to frequency. This method of investigating phase distortion is used chiefly in television work, where trouble of this nature can prove objectionable.

Precautions Necessary

In studying phase shift patterns on the oscilloscope, it must be remembered that the X and Y deflector plates generally have different sensitivities. The inclination of the line (0-180 deg.) will not therefore be at 45 deg. to the horizontal even if the inputs are equalised, neither will a 90 deg. shift in one produce an exact circle.

Again, apart from the above, if the input voltages are

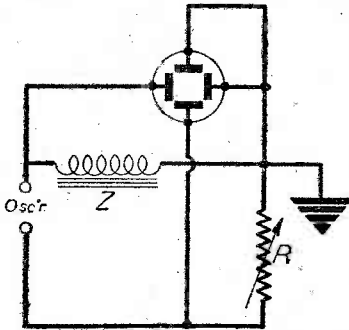


Fig. 9.—Circuit to determine phase angle of a reactive load.

it must be seen that this itself does not introduce a phase shift. Single stages of amplification nearly always cause a shift of 180 deg.—apart from cathode followers which are not actually amplifiers—and this must be watched and allowed for.

not equal in amplitude, the inclination will be different, and the tangent of the angle of inclination to the horizontal will give the ratio of the vertical to the horizontal voltage.

Two voltages, though out of phase, may be compared in this way.

If it becomes necessary to use an amplifier in the oscilloscope,

waveform to be observed gives the number of separate waveform images observed on the screen; thus to give the image of a single wave the frequency of the time base and the signal must be identical.

For obvious reasons it is not possible to give details of every type of waveform which can be observed on an oscilloscope, the number being practically limitless, and the type depending on conditions. A few examples are given in Fig. 13, however, and show how actual circuit conditions can be represented on the screen.

- Trace A. Undistorted sine wave, applied, say, to the grid of a valve.
- Trace B. Output of the valve, showing distortion due to grid exceeding cut-off.
- Trace C. Squegging action, due to grid current charging the grid condenser of a valve and cutting the valve off. The exponential discharge through the grid leak is shown. (Grid waveform.)
- Trace D. Anode waveform of the above valve, showing the negative pulses which occur during the period when the valve is conducting heavily.
- Trace E. Continuous oscillation in a circuit.
- Trace F. Intermittent oscillation.

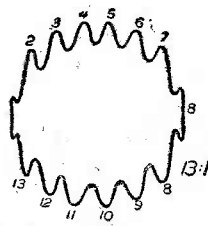
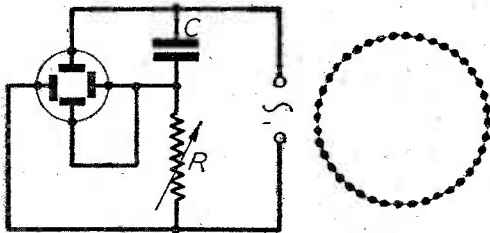


Fig. 10.—(Left) When frequency a exceeds $12 : 1$, this circuit can be used.

Fig. 11. (Centre) Trace produced by circuit.

Fig. 12. (Right) an alternative trace.

Other Methods of Frequency Comparison

When the ratio between the work and sweep frequency exceeds 12 : 1, a limit is reached such that comparison by simple Lissajous figures is impossible. Other arrangements are therefore made.

One method is to apply the lower of the two frequencies in and out of phase circuit similar to Fig. 10 to the X and Y axes, thus producing a circular trace, and then modulate the tube grid by means of the other frequency, such that the beam is extinguished at peak amplitudes and the trace appears as a dotted ring.

The ratio of the frequencies is then given by the number of dots. If the frequencies differ considerably the pattern races and is confused, but slip frequencies of a few cycles will show as a slow rotation. (Fig. 11.)

It might happen that adjacent dots do not represent successive cycles, i.e., the frequency ratio is not an integer, and dots on the second rotation of the circular frequency may be occurring between those of the first one. If a magnet is moved quickly across the tube, such that the beam is moved horizontally, the dots will move as a line if the frequency ratio is an integer, and will break up into separate rows if it is not so.

Another method is to apply one of the frequencies as a circular trace as above, and apply the other to the Y axis. A figure similar to Fig. 12 will result where the ratio can be determined by counting the number of peaks occurring on the circle.

The Meaning of Waveforms

The most useful feature of the oscilloscope is its ability to produce actual waveforms of voltage and currents occurring at various parts of a circuit. A linear time base must be applied to the horizontal controlling plates, while the waveform to be observed is applied to the vertical controlling plates, either direct or through an amplifier.

The ratio between the time base frequency and the

- Trace G. Half-wave rectifier output without smoothing.
- Trace H. The above with conventional smoothing arrangements.

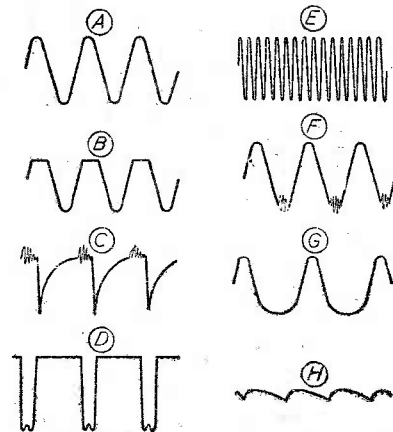


Fig. 13.—A few examples of the many types of waveform produced on the oscilloscope.

NEWNES SHORT-WAVE MANUAL

6/—, or 6/6 by post from

George Newnes, Ltd., Tower House, Southampton St., London, W.C.2.

PRACTICAL WIRELESS, December, 1942.

GROUND DIRECTION-FINDING

Practical Wireless

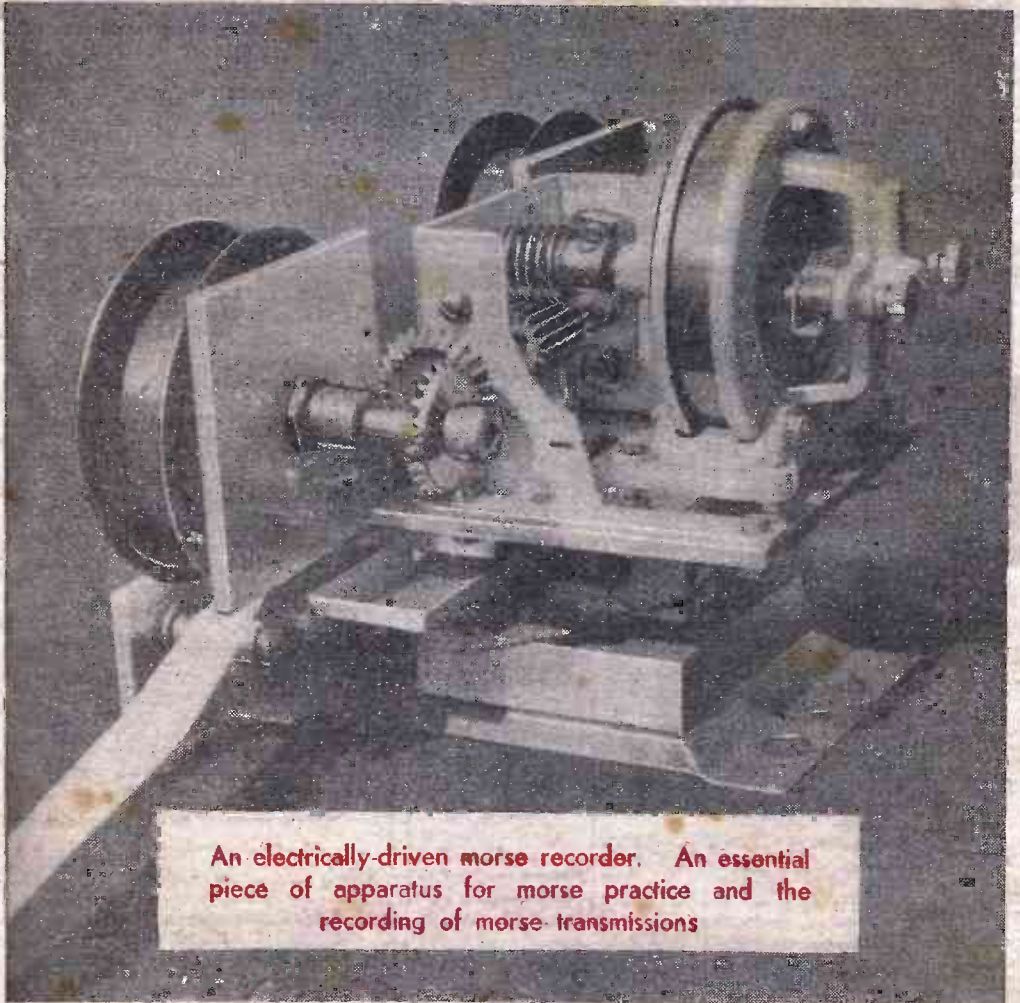
9^D
CENT
MONTH

Editor
F. J. CANN

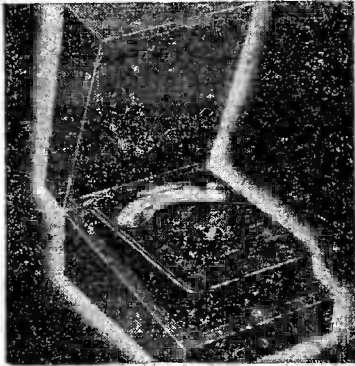
Vol. 19. No. 438.

NEW SERIES.

DECEMBER, 1942



An electrically-driven Morse recorder. An essential piece of apparatus for Morse practice and the recording of Morse transmissions



The D.C. AvoMinor

Electrical Measuring Instrument

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

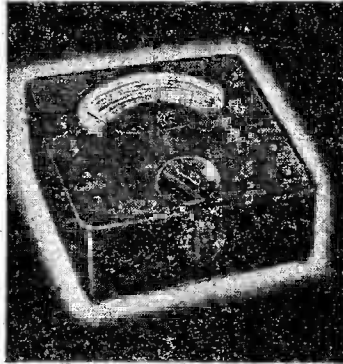
Universal AvoMinor

Electrical Measuring Instrument

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



Regd. Trade Mark



PRECISION TESTING INSTRUMENTS

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

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

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

Sole Proprietors and Manufacturers:—

AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO. LTD.
Winder House, Douglas Street, London, S.W.1

Phone: VICTORIA 3404-7

PREMIER RADIO

NEW PREMIER S.W. COILS

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

4-pin Type		6-pin Type	
Type	Price	Type	Price
04	9-15 m. ... 2/6	06	9-15 m. ... 2/6
04A	12-26 m. ... 2/6	06A	12-26 m. ... 2/6
04B	22-47 m. ... 2/6	06B	22-47 m. ... 2/6
04C	41-94 m. ... 2/6	06C	41-94 m. ... 2/6
04D	76-170 m. ... 2/6	06D	76-170 m. ... 2/6
04E	130-350 m. ... 3/-		
04F	255-550 m. ... 3/-		
04G	490-1,000 m. ... 4/-		
04H	1,000-2,000 m. ... 4/-		

New Premier 3-Band S.W. Coil, 11-25, 25-38, 38-66 m., 4/6.
Rotary Wave Change to suit above, 1/6.

SHORT-WAVE CONDENSERS

Trofit insulation. Certified superior to ceramic. All-brass construction. Easily ganged.

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

Premier 2 gang. S.W. Condenser. 2 x 00015 mfd. with integral slow-motion, complete with pointer, knob and scale, 10/6.
S.W. H.F. Chokes, 10-100 m., 10/d. High-grade Pie-wound, U.S.A. type, 5-200 m., 2/6 each.

PREMIER REPLACEMENT VALVES

4-volt A.C. types, 5-pin. ACHL, ACSG, 5/6 each.

MOVING COIL SPEAKERS

Rola 5in. P.M. Speaker, 25/-.
Cefesion 5in. P.M. Speaker, 25/-.
Plessey 5in. 2,000 ohms Field Speaker, 25/-.
Above Speakers are complete with output transformers.
Rola 5in. P.M. Speaker, 3 ohms Voice Coil, 21/-.
Rola 6in. P.M. Speaker, 3 ohms Voice Coil, 25/-.

"SPECIAL OFFER"

Mains Transformers. Primary, 220-230 v.; secondary, 350-0-350 v., 100 ma., 3 v. 2 a., net C.T., 6.3 v. 3 a., C.T., 21/-.

"LEARNING MORSE?" Then purchase one of the new practice Oscillators.

Supplied complete with valve, on steel chassis 27/6

Practice Key, 3/3; TX Key, 5/9.

Super Model, on Wooden Base, 10/6.
Brown's Headphones, 19/6 pair.

3 Henry Chokes, 10/-.
Good Quality Buzzer, 3/-.

PREMIER MAINS TRANSFORMERS, CHOKES AND VALVES. Still available. Send for lists.

MATCHMAKER UNIVERSAL OUTPUT TRANSFORMERS.

Will match any output valves to any speaker impedance.
11 ratios from 13-1 to 80-1, 5.7 watts, 20/-, 10-15 watts, 26/-.

PREMIER 1 VALVE DE LUXE

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

I.F. TRANSFORMERS

Iron-cored 450-470 kc/s. plain and with flying lead, 5/6 each.

ELECTROLYTIC CONDENSERS

Tubular wire end type, 8 mf. 125v., 1/6 each; 25 mf. 25v., 1/6 each; 50 mf. 12v., 1/6 each; 50 mf. 50v., 3/- each; Bakelite cased type, 15 mf. 50v., 1/- each.

PREMIER 4-WATT A.C. AMPLIFIERS

Each Amplifier is completely wired and tested. Selected components. Valves and Energised Moving-Coil Speaker, 25 5s.

PREMIER MICROPHONE

Transverse Current Mike. High-grade large output unit. Response 45-7,500 cycles. Low hiss lever, 23/-.

Moving-coil Mike. Permanent Magnet model, requiring no energising. Response 90-5,200 cycles. Output 25 volt average. Excellent reproduction of speech and music, 63/-.
Super Model, 25 5s.
Microphone Transformers, 10/- each.
Chromium Collapsible Type Microphone Stand, 52/6.

Mains Resistances, 660 ohms, 3 A., tapped 360 + 180 + 60 + 60 ohms, 5/6. 1,000 ohms, 2 A., tapped at 500, 600, 700, 600, 500 ohms, 4/6.

2 Way Line Cored Resistance, 50 ohms per foot. Price 1/4 per foot.

Valve Screens, for International and U.S.A. types, 1/2 each.
Push-Back Connecting Wire, 2d. per yd.
Resin-cored Solder, 7/d. per Coil.

ALL ENQUIRIES MUST BE ACCOMPANIED BY A 2/d. STAMP.

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

CALLERS TO: Jubilee Works, or 169, Fleet Street, E.C.4 (Central 2833).
or 50, High Street, Clapham, S.W.4 (Maccaulay 2381).

Ground Direction-finding

How the Bearings and Positions of Ships, Aircraft and Other Transmitting Stations can be Determined from a Fixed Receiving Station

MANY readers will remember the article on direction-finding from aircraft, which appeared in the issue of PRACTICAL WIRELESS dated December, 1941. It was explained how a rotating loop aerial picks up strongest signals from a transmitter in line with the plane of the loop, and how the pick-up is zero from a station on a line at right angles to that plane.

A similar system of D.F. could be used on a ground station, but there are many objections to it. One of the greatest of these is that a very large loop aerial would be required to receive sufficiently strong signals from the low-power transmitter used in the average aircraft, for example. Another is that a rotating loop aerial mounted near to the ground is subject to appreciable errors. In any case, the mechanical operation of a large loop would present a number of difficulties.

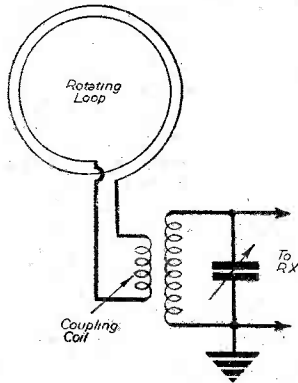


Fig. 1.—The connections for a rotating loop aerial, as used for direction-finding in an aircraft.

The first systems to be adopted—and it has been in use for many years—is that known as Bellini-Tosi. The general arrangement is shown in Fig. 2, and this should be compared with the method employed on aircraft, illustrated in Fig. 1. There are two large square or rectangular loops, fixed in position and mounted at right angles to each other. Normally, these are mounted so that the plane of one is in a north-south line, whilst the plane of the other is from east to west.

The Goniometer

A fixed inductance coil is connected in the lower arm of each of the fixed loops, the two coils being mounted at right angles to each other and wound on a cubical former, as illustrated diagrammatically in Fig. 3. Within these two fixed coils is a third coil, this one being so mounted that it can be rotated within the fixed coils. It is electro-statically screened from the fixed coils, but arranged so that it can be coupled inductively to either or both of them. Clearly, when it is parallel to one of the coils it is closely coupled to it, so that any H.F. circulating in the circuit of the fixed coil will be induced into it. Its coupling with the other fixed coil

Bellini-Tosi System

In practice, a very simple system is employed, and one which is capable of producing bearings accurate to a very high degree. One of the

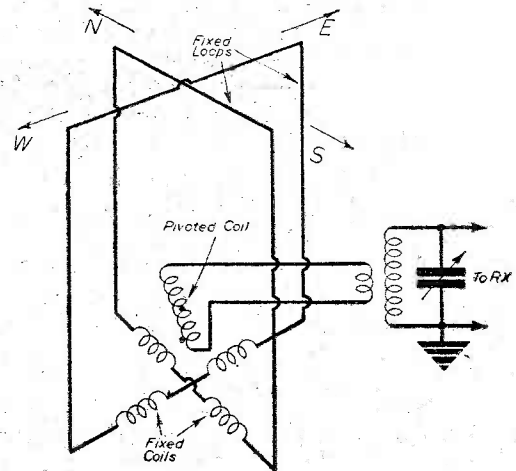


Fig. 2.—The essentials of the Bellini-Tosi system of direction-finding. The fixed loops act as D.F. aeriels, and these may be several yards square.

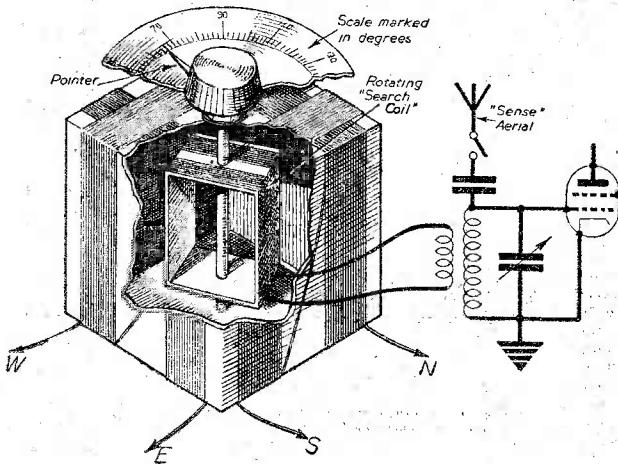


Fig. 3.—How a goniometer is made, and how it is connected to the input circuit of a receiver.

is nil. The complete component, comprising the two fixed coils and the rotating coil, is known as a goniometer or radio-goniometer.

The pivoted coil is described as the search coil, and is connected to the input circuit of a receiver, through a separate winding on the receiver tuning coil. Suppose, now, that the receiver is tuned to a transmission which emanates from a point due north of the aerial system. The transmitted signal will be received at maximum strength when the search coil is rotated so that it is parallel to the coil in series with the north-south loop. The signal will gradually be reduced in strength as the search coil is turned through 90 degs., and when the search coil is parallel to the coil in the east-west loop the signal will be inaudible. In practice, the signal may not be eliminated altogether, but it will, at any rate, be of reduced strength.

Should the rotation of the search coil be continued, the signal will again increase in strength, once more reaching a maximum when the search coil is again parallel to the north-south fixed coil. Similar results would be obtained if the

transmitter were situated due south of the receiver, and it is thus necessary to take further steps to "sense" the bearing; that is, to determine from which side of the loop it originates. That point will be dealt with later. Should the transmitter be due west or due east of the receiver, the same effects would be observed on rotating the search coil, except that maximum signal strength would be obtained when the search coil was parallel to the coil in the east-west loop, and minimum signal strength would be found with the search coil turned through 90 degs. from this position.

Action of the Goniometer

As with a rotating loop, it is necessary to "search" for the position of minimum signal strength, because this is more defined and more easily detected by the ear than is the position of maximum signal. It is possible to show that if the receiver is tuned to a transmission emanating from the north-east, for example, minimum signal strength will be obtained when the search coil is pointing north-west and south-east in relation to the fixed coils of the goniometer. It should be pointed out, however, that the goniometer may be set in any position and at any angle to the aerials loops, provided only that the loops themselves are correctly aligned and the goniometer properly connected.

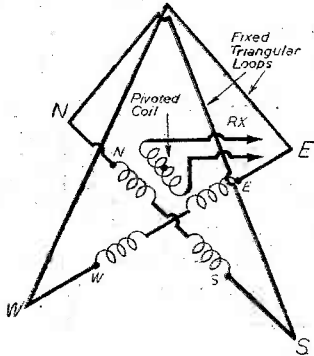


Fig. 4.—A more practically convenient type of loop aerial assembly than that shown in Fig. 2. The whole system can be supported by means of a high central mast and four short masts, one at each corner.

large fixed rectangular loops present various mechanical difficulties in regard to erection. In practice, therefore, the arrangement is often simplified, by making the loops triangular in shape, as shown in Fig. 4. They can then be erected by using a central-high mast, with four shorter masts, one at each corner of the aerial array. There are no serious objections to this layout, and it has been widely employed.

Adcock Aerials

In the ordinary way, both layouts described are liable to certain errors, especially on high frequencies. These are due to the horizontal arms picking up horizontally-polarised waves, which may result from reflection and retraction of the radiated signal. This difficulty is perhaps most readily overcome by the use of a so-called Adcock (due to its originator) aerial system, types of which are illustrated diagrammatically in Fig. 5. The essentials of this array are that there are four vertical aerials situated at the corners of a square. The leads from these are generally either "overlapped" or screened, to avoid pick-up by the horizontal leads. One practical form of Adcock layout is shown in Fig. 6. Here it will be seen that there are four self-supporting or mast-type vertical aerials placed at the four corners of a square whose diagonals are in north-south and east-west directions. These aerials are mounted on insulating supports, and the leads from them are by co-axial or similar low-loss screened cable. The cable is taken underground to the receiver cabin, which is situated in the centre of the aerial system, and the screening is adequately earthed by being connected to substantial buried plates.

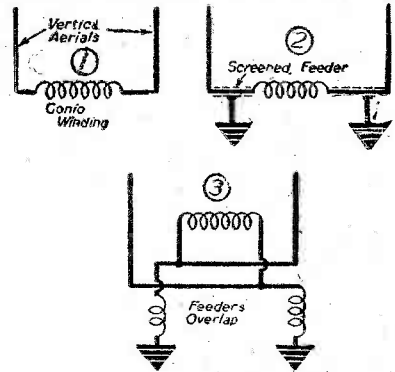


Fig. 5.—These types of Adcock fixed D.F. aerial, where one winding of the goniometer is shown as an inductor. Type 1 is little used; type 2 is similar to 1 but the feeders are screened. In the third type the feeders overlap so that any pick-up in the horizontal leads is cancelled out. In all cases there is a second array at right-angles to that shown.

The "Sense" Aerial

The four low-loss leads are connected to the fixed coils of the goniometer, as previously explained. In addition, there is a fifth aerial, this being the "sense" aerial. For convenience, and to keep the array completely symmetrical, it is suspended from four rope supports attached to the upper ends of the vertical D.F. aerials. In planning this—and all other types of D.F. aerial system, the utmost care is taken to ensure complete symmetry; any out-of-balance will render the bearings taken inaccurate since the pick-up and/or losses in the four arms will vary.

A Modified Aerial Array

It is obvious that

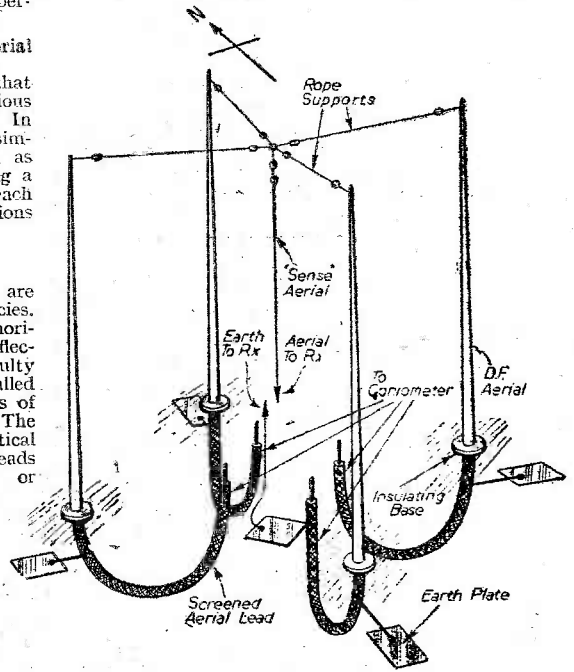


Fig. 6.—A practical form of Adcock aerial system, using screened feeders for connecting the bases of the vertical D.F. aerials to the goniometer.

Aerial Polar Diagrams

It has already been pointed out that rotation of the search coil will give two positions of minimum signal, and that it is necessary to find the direction to the transmitter. This is known as "sensing," and is dependent upon the same laws as those governing the use of a rotating loop aerial. If we were to draw the polar diagram representing the signal pick-up by one pair of D.F. aeriels, we should obtain a figure of eight, as shown by broken lines in Fig. 7. This explains why there are two positions of the search coil for minimum and maximum signal; the minima are obtained when the coil is set north and south, and the maxima when it is in an east-west position, as represented in Fig. 7.

But by connecting another aerial (the so-called vertical or "sense" aerial) this diagram can be modified. The polar diagram of this aerial is a circle—since the aerial has equal pick-up from all directions—as represented by the chain line in Fig. 7. The effect of combining the pick-up from both sets of aeriels is to produce a heart-shaped or cardioid diagram such as that indicated by a full line. It will be seen, therefore, that when both aerial arrays are in use there is only one direction from which a minimum signal can be received.

We can make use of this property by providing two pointers for the search coil, as also illustrated in Fig. 7. They are 90 degrees apart, and one of them is for D.F. and the other for "sense." Assuming the transmitter to be in the direction shown in Fig. 7—due west of the aerial array—the procedure for taking a bearing would be as follows. The search-coil knob would be rotated until a minimum-signal position was found; this would be at either 0 degrees or 180 degrees, as indicated by the D.F. pointer. Suppose the pointer were at zero degrees.

"Sense" Determination

We should then bring the "sense" aerial into use by closing the on-off switch shown in Fig. 3. Next, we should swing the search coil through 180 degrees and back again. If signal strength were at a minimum when the coil was in its original position, the direction of the transmitter would be as shown by the "sense" pointer. On the other hand, if maximum signal strength were obtained at that setting the pointer would show the reciprocal of the bearing.

The procedure briefly explained is not necessarily that which would be followed in all cases, since the precise method of operation would depend on the actual design of the goniometer and the arrangement of the pointers. But the principle does not vary. Should any reader

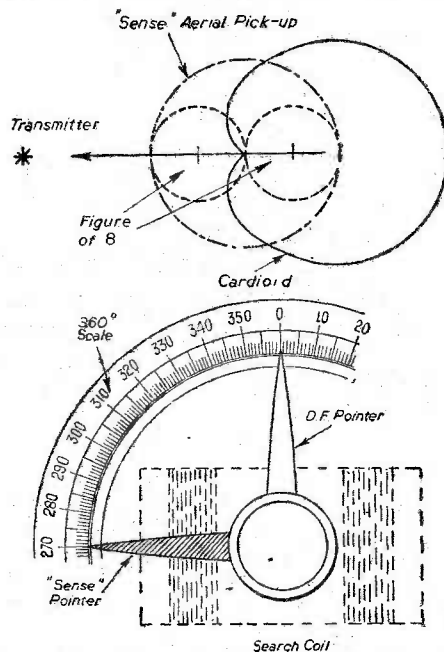


Fig. 7.—These diagrams show how "sensing" is carried out after finding a minimum signal with the D.F. aeriels.

experience any difficulty in following the general technique, it is suggested that he might look up the article on aircraft direction-finding which has previously been referred to.

So far we have considered only the method of finding the bearing of a transmitter. Should it be necessary to establish its position it would be necessary to employ two or more D.F. installations and to take a bearing from each at the same time. If those bearings were then plotted on a map, the point at which the two or more bearing lines intersected would give the exact position of the transmitter.

W.A.A.F. Wireless Operators

AN aircraft is flying somewhere over Germany. It has flown through the flak, delivered its load of bombs and got back once more through the barrage. Now the pilot wants further instructions or assistance, and it is the job of his wireless operator to get them. The transmitting-set has been damaged by a fragment of German shell, and the operator is not quite sure that his signals will be strong enough to be picked up at all. However, he perseveres, tapping out his message at intervals, and hoping it will get through.

Back at the station sits an airwoman, wearing ear-phones, listening intently for any signal that may come on her wavelength. She moves the "knob" infinitesimally one way and another, to make sure that she is tuned in correctly. She has had nothing through for an hour and a half, but she cannot relax for a second, because at any moment a message might come. Now, as she strains her ears, she can hear the faintest of sounds. Surely they are dots and dashes. Yet they are so faint that she cannot make sense of them. She listens still more intently, until she detects some sort of rhythm in the signal. At last she is able to piece

together a connected message. She writes it down and passes it on.

A decision is taken and another airwoman begins to transmit signals with a firm rhythmic touch. The message flashes to its correct destination, passing perhaps through various links to a remote part of the country.

On the accuracy of these W.A.A.F. wireless operators in sending or picking up messages the success of a whole operation may depend. They work in watches, three airwomen covering the 24 hours. They may be busy or merely sitting and listening. At work they must be calm, quick and accurate; while listening and waiting they must be constantly on the alert, ready to detect the first sound of a signal coming over.

They must be intelligent, able to concentrate for long periods, and extremely patient. They must have a thorough knowledge of Morse, and know all the code-signs and procedure-signals connected with their particular Command. They may be sending or receiving messages between Command and Group, or between aircraft on operations and the base at home. Their integrity and discipline must be beyond question.



ON YOUR WAVELENGTH

By THERMION

Musical Frequencies

I HAVE received many interesting letters on the subject of musical frequencies which I raised last month. Mr. Ernest Vass, of Aldershot, points out that the earliest known scales were tetrachords, groups of four notes in diatonic succession. St. Ambrose, Archbishop of Milan (374-397), arranged the four diatonic scales known as authentic modes. Later on, Gregory the Great (590-604) added the plagal modes, commencing a fourth below the authentic in the following order:

Authentic	Plagal	
Dorian DEFGABCD	Hypo-dorian ABCDEFGA	
Phrygian EFGABCDE	Hypo-phrygian	BCDEFGAB
Lydian FGABCDEF	Hypo-lydian GDEFGABC	
Mixo-lydian GABCDEFG	Hypo-mixo-lydian	DEFGABCD

It would seem that the hypo-lydian gave rise to the modern major scale, and the hypo-dorian to the modern minor scale. Further, the hypo-mixo-lydian duplicated the dorian.

Most of my correspondents seem to agree that the haphazard arrangement of the frequencies were for aesthetical reasons rather than mathematical. The harmonic series produces sound pleasant to the ear, although some argue in favour of quarter tones and oriental music.

Taking my own selection of intervals, and figures, 2 to 1 octave, 3 to 2 fifth, 4 to 3 fourth, 5 to 4 major third, 6 to 5 minor third, and 5 to 3 major sixth, there seems a reasonable answer to my question concerning half-tones throughout the octave; because as there is only a minor third between 5 and 6 one of the intervals must be a semi-tone. We could only have another semi-tone between E and F if the interval between 5 and 6 were a major third. On the other hand, as there is a major third between 4 and 5, we can insert semi-tones between the two steps of a tone which make up that interval.

It is true that by a complete revision of notation, and a complete revolution in musical instrument manufacture, there could be more notes to the octave, and composers would devise harmonious effects, but there are practical implications to be considered. For example, the size of the pianoforte if it were to cover the same compass as at present, the much wider expansion of the figures for octaves, arpeggi, and devising, to say nothing of reading of the necessary expanded form of staff notation.

It emerges from the mass of correspondence I have received that musicians responsible for music are non-mathematical, non-scientific, and that we have arrived at the present stage in music by haphazard and unscientific means. It is too late now to make a change, for it would mean scrapping all our present instruments and re-writing the world's music. In any case, the present system works, and there seems no reason to alter it.

The New Brains Trust

THE expanded Brains Trust does not seem any more successful than its predecessor, for it has been flooded on two or three occasions by comparatively simple questions. The B.B.C. states that the Brains Trust is its most popular feature. Perhaps it is because we all remember our schoolboy days, and we all know the keen delight it gave us to propound questions which the master could not answer. Thus, the item is for entertainment rather than for education. The Brains Trust is intended as a debating society, but the propounders of questions regard it as a baiting society!

British Music versus Jazz

I HAVE received the following interesting letter from K. T. Hardman, of Birkenhead, which speaks for itself:

"I think there can be no dispute that you deserve the thanks of listeners as the instigator of the campaign against slush. And most of us hope you will continue it—for we know by experience what the B.B.C. can do in the way of back-sliding.

"But I think you are a bit too severe with English composers and lyric writers, because it is practically impossible for them to get any hearing by reason of the various vested interests they have to contend with. And the worst culprit in this direction is the B.B.C. itself.

"It has definitely educated listeners to swallow the floods of sickly sentimental slush sent over from Tin-Pan-Alley—all ready-made and being the least troublesome method of filling in programme time.

"American films also are greatly to blame for the encouragement of such depraved taste—many of them feature a number of alleged 'lyrics' set to whining slush tunes, and thus getting their first 'British boost,' which is later exploited by the song publishers, band leaders, and the B.B.C.

"And as there is big money in this vicious circle for many interested parties, it can easily be understood why any native talent has very small chance of recognition, especially when unlimited funds are behind the 'slush' to advertise and boost it. This dirty and disgusting 'industry' is highly organised team work between composers and lyric writers, and is always on tap.

"In Great Britain a man or woman may be able to compose most pleasing and catchy melodies, and quite incapable of writing suitable lyrics to fit them to, or vice versa, and it is futile to submit either without the other to any song publisher. Even when a suitable combination between a composer and lyric writer exists or, in rarer cases, where both are combined in the one person, there is seldom (or never) the cash available for boosting or advertising the native product. And, in consequence, the British publisher will not look at the work, much less publish it.

"All of which brings me back to my first point—that the B.B.C. is the worst culprit and the least anxious for any change. It is cluttered up with too many people who would feel the draught too badly. They are much too well dug in and all of them experts at scratching each others' backs.

"I am no admirer of Lord Haw-Haw, but think he has justification for his remarks about the 'Jazz-soaked British,' and if the general press would follow PRACTICAL WIRELESS' lead, it might give us some hopes of real and continued improvement. We have been so educated with rubbishy filth by the B.B.C. that if Gilbert and Sullivan were reincarnated they wouldn't have a dog's chance to-day."

PRACTICAL WIRELESS SERVICE MANUAL

By F. J. CAMM.

From all Booksellers 8/6 net, or by post 9/- direct from the Publishers, George Newnes, Ltd. (Book Dept.), Tower House, Southampton St., Strand, London, W.C.2

P.W. Blueprint Service

This Month We are Reprinting the Essential Details of Another Design of "P.W." Receiver in Popular Demand

(Continued from page 519, November issue.)

Fury Four Super (P.W. 34 C.)

THE circuit arrangement is particularly interesting, embodying, as it does, a number of unusual and particularly good features. For example, instead of using the same method of coupling between the first and second variable- μ valves as between the second variable- μ and the detector, a tuned-grid circuit is made use of in the first position and tuned anode is used in the second. This will at first seem rather unusual, but it has the extremely beneficial effect of rendering the receiver absolutely stable under all conditions, despite the enormous degree of H.F. amplification which is provided. This does not affect the correct ganging of the two-gang condenser, as might be expected, since the coils themselves are accurately matched and are perfectly suitable for this circuit arrangement. In order to ensure that the voltage applied to the screening grid of the two H.F. valves shall be perfectly accurate, a potentiometer device has been incorporated in preference to the usual series resistance arrangement, and this in turn provided with decoupling circuits to avoid any possible instability in this part of the receiver. The usual drawback to this arrangement, namely, the continual drain on the high-tension battery caused by the potentiometer across the total supply, has been avoided by the method of utilising a four-point on-off switch.

Low Detector Grid-circuit Damping

The detector grid circuit is of rather unusual design, and avoids one of the principal difficulties experienced when high-efficiency coils are employed. The grid condenser, it will be seen, is connected direct to the anode of the second high-frequency valve, and this in turn connected to a transfer tapping on the grid coil, thus, providing a constant load on long or medium waves and enabling full use to be made of the efficient coil on both wavebands. The grid

circuit is provided also with a change-over switch for gramophone-record reproduction, and the only slight departure from usual practice here is the method of connecting the grid leak to the grid direct, instead of to the grid condenser. Although this means that the leak is in circuit even when the gramophone pick-up is being employed, it enables the leak to be connected in the most direct manner to the grid, and ensures stability on radio by dispensing with an otherwise long lead. The remaining lead, as well as that for one of the pick-up connections, is carried in the usual metal braiding, which is earthed, and it will be found that the set is thus perfectly stable on both settings of the switch.

Uniform Reaction Control

The reaction circuit, although perfectly normal as a whole, incorporates a small resistance in series with the condenser in order to prevent any possibility of parasitic oscillation on either waveband, and the small anode by-pass condenser forms an essential part of this circuit.

L.F. Coupling

Coupling between detector and output valve is carried out by a parallel fed L.F. coupling device, which includes in the moulded case the anode coupling resistance, a coupling condenser, an L.F. transformer, and yet a further resistance of high value, which is connected in series with the grid of the output valve, as a further precaution against instability. As the specified L.F. Coupling Unit might not now be obtainable, an ordinary L.F. transformer can be used in conjunction with a separate resistor of 50,000 ohms, and a fixed condenser of 0.1 mfd. These should be connected as shown in the theoretical diagram. Thus it will be seen that at every part of the circuit great care has been taken to ensure that no possibility of instability can occur. The high-efficiency pentode valve feeds the loud-speaker through an output filter comprising a tapped choke and large-

(Continued on page 16.)

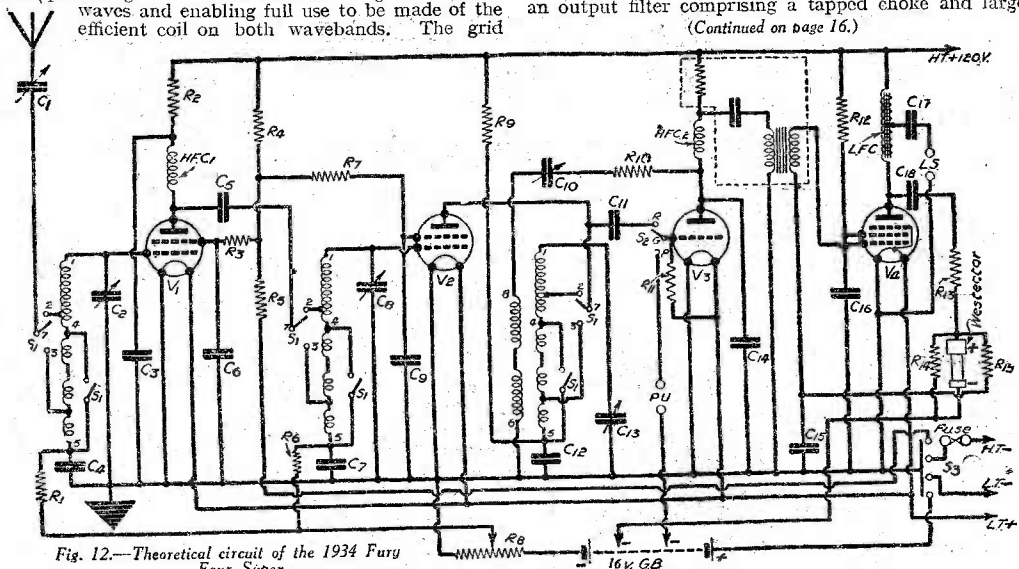


Fig. 12.—Theoretical circuit of the 1934 Fury Four Super.

C1—0.003 mfd. pre-set; C2 and C8—0.005 mfd. ganged; C3 and C12, 1 mfd.; C4, C6, C7 and C9—1 mfd.; C5—0.001 mfd.; C10—0.002 mfd. reaction; C11 and C14—0.002 mfd.; C13—0.005 mfd. variable; C16 and C17—2 mfd.; R1, R5 and R6—50,000 ohms; R2, R3, R7, R9 and R12—1,000 ohms; R4—25,000 ohms; R8—10,000 ohm potentiometer; R10—500 ohms; R11—1 megohm; C15, C18, R13, R14 and R15 are all included in the Graham-Farish Booster Unit.

DAGENITE

are used for London's Buses,
Rolls-Royce and Bentley Cars,
Britain's Lifeboats and Aircraft.

PERTRIX

are supplied to His Majesty's
Government and, like Dagenite,
are used in every other connection
where the utmost dependability
is essential. You, too, should use
Dagenite or Pertrix in your car
or radio.

BATTERIES

for RADIO, CARS, MOTOR CYCLES
COMMERCIAL VEHICLES, ETC.

Sole Concessionaires:
HOLSUN BATTERIES LTD.
137, Victoria Street, London, S.W.1
D37/42

A FIRST COURSE IN WIRELESS

By "Decibel." This is a reprint of a Series of articles giving a careful explanation of the fundamental principles of wireless, particular attention being paid to points which have been found by experience to present difficulty. 5s. net.

RADIO SIMPLIFIED

A.T.C. cadets will be looking forward to this follow-on book by **John Clarricoats**—to be remembered for his "Radio Simply Explained." This time the author goes farther, and deals more fully with modern radio practice. A masterpiece of compression, elucidation and instruction. 4s. 6d. net.

SHORT-WAVE RADIO

By **J. H. Reyner**. A comprehensive, practical survey of modern developments in the use of short, ultra-short and micro-waves. It provides a great deal of valuable data concerning the practical methods of their use in radio and television transmission. 10s. 6d. net.

Complete lists of **PITMAN'S RADIO BOOKS** and graded list—**BOOKS ABOUT JOBS**—will be sent to you post free on request.

PITMAN

39-41, PARKER ST., KINGSWAY, W.C.2
Sir Isaac Pitman & Sons, Ltd.



TABLE MICROPHONES

A new hand/table-microphone, fitted with the famous ROTHERMEL D104 Microphone insert housed in new metal casing, mounted on heavy stand and base as illustrated, with joint for angle adjustment. 50-80,000 cycles, output level 60 d.b.

Price **82/6**

CELESTION AMPHENOL VALVE-HOLDERS



8-pin International Octal. Brand new. **1/3**

PHILIPS HIGH VOLTAGE TRANSFORMER



They are robust in construction: weight approx. 13 lb. Dimensions: 5 1/2 by 5 1/2 by 4 1/2 in. Specification: 350-0-350 v., 70 m.a. Four tappings giving 4 v. 3 amps., 6.3 v. 4 amps., 4 v. 0.65 amp. and 4,000 v. at 3 m.a. Input 100/250. Free wiring diagram. Carriage forward. Price **32/6**

PUSH-BUTTON CONDENSERS



A chance for Experimenters! 0.0005 mfd. 2-gang, 6 push-button Superhet Condensers. Mechanical cam lever type (not trimmer type), easily adjustable, to receive any six stations desired. Excellent workmanship. A product of General Instrument Corp., U.S.A. A real bargain. Price **10/6**

TELEPHONE HAND-PIECE



Combined Transmitter and Receiver, as illustrated. Ideal for the factory, the office and the home. All in good working order. Price **7/6**

PHILIPS SMOOTHING CHOKES



Brand new, well-built chokes 60 ohms D.C. resistance 100/120 m.a. Size: 2 1/2 in. by 2 1/2 in. by 1 1/2 in. 5/6 each. Also 400 ohms D.C. resistance 60 m.a. Size: 1 1/2 in. by 1 1/2 in. by 1 in. 3/6 each.

OAK SWITCHES



2 1/2 in. spindle. Complete with knob:

4-way, 3-bank ...	4/6
4-way, 2-bank ...	3/9

POSTAGE

Postage **MUST** be included with all orders. Write your name and address in **Block Capitals**. No orders can be sent C.O.D. Orders cannot be accepted from **Eire** or **Northern Ireland**.

LONDON CENTRAL RADIO STORES

23, LISLE STREET, GERard 2969. LONDON, W.C.2

capacity fixed condenser, whilst also connected in this part of the circuit is a battery economiser. The purpose of this is to reduce the total anode current required by the pentode when no signal, or a very quiet signal, is being received, and yet permits the current to rise to any required value to produce loud passages without distortion.

The Construction

The first thing to do is to place all the components on the chassis, as shown in the blueprint, and to mark their positions. The screw holes may then be started and the wiring holes drilled. The template which is supplied by the condenser manufacturers should be positioned on the chassis and the necessary clearance holes drilled to accommodate the holding-down screws. When this has been done, the two component brackets should be mounted on the side runners (Fig. 13), and it will be found easier, although not essential, to mount the fixed condensers on these runners whilst they are still unscrewed from the base of the chassis. In this manner the screws are driven home without difficulty.

The Coils

The specified coils will be found to have soldering lugs projecting below the baseplate, and before the assembly is mounted gin. lengths of connecting wire should be soldered to the required lugs as shown by the wiring plan. It will be seen that two of the wires are kept on the upper side of the base and connected to the fixed sections of the two-gang condenser, whilst the remainder pass down through holes in the base for subsequent connection on the underside of the chassis. These holes are shown in the centre of the wiring plan, and the lugs to which they are connected are indicated by the numbers at the side of these holes. The coils are supplied without a switch on the end of the spindle and it is most important that the correct type be used in this position. The switch is a Bulgin Type 87a. The switch must, of course, be mounted so that the small finger at the end of the coil-switch rod operates the dolly of the switch in the correct manner, and this will be when the two end contacts are towards the right, the coil being viewed from the front. Now screw down the coils, passing the connecting wires down through the holes in the base, and proceed to mount the remainder of the components, using as your guide the wiring plan. There are no difficult points to explain in this part of the assembly, as all parts are quite easy to get at, and there are no pitfalls for the unwary. The receiver is ready for wiring, and this should be carried out in a neat manner, avoiding slackness and making quite certain that good contact is provided at the required points.

Earth Returns

It will be noticed that there are one or two points on the wiring plan marked "M.B.," and these are earth return connections which are connected to the metallised surface of the chassis, and in the case of those connections on the upper surface it will be sufficient to twist the wire into a loop to be held down by an ordinary round-head wood screw. Where these letters appear on the under-surface it will be necessary to pass a small bolt through the chassis, with a washer beneath the head making good connection on the upper surface, and the wire held beneath a nut on the under side.

The screened leads must be passed through the metal braiding, and this should be turned back at each end to avoid short-circuits on the inner wire, and small metal brackets used to clamp the braiding to the metal surface. These brackets may easily be made from odd scraps of metal. There is no necessity to screen any

leads other than the two indicated in the wiring plan.

If the specified coils cannot be obtained, we would suggest using three modern screened dual-range coils, accurately matched, and modifying the wiring to suit.

Unscreened coils should not be used in the layout as shown on the blueprint, as instability would, undoubtedly, result. Some of our advertisers might be able to supply a suitable alternative coil unit.

ORIGINAL LIST OF COMPONENTS FOR THE 1934 FURY FOUR SUPER

- One set "Ferrocort" type "G" coils (G.10, G.14, G.13) (with switch—see text) (Colvern).
- One "Nugang" single variable condenser, .0005 mfd. with type A drive (C.13) (Jackson Bros.).
- One "Nugang" 2-gang variable condenser, .0005 mfd. with type A drive (C.2, C.8) (Jackson Bros.).
- One disc type H.F. choke (H.F.C.2) (Lissen).
- One 1 megohm resistance with wire ends (R11) (Lissen).
- One pre-set aerial condenser, .0003 mfd. (C.1) (Lissen).
- One "Pentode" nichoke (Varley).
- One graded volume control, type C.P.158 (R.8) (Varley).
- One super H.F. choke, type H.F.4 (H.F.C.1) (Bulgin).
- One fuse holder, type F.5 (Bulgin).
- One 100 m.a. fuse (Bulgin).
- One G.B. bias clip, type 2 (Bulgin).
- Three 50,000 ohm $1\frac{1}{2}$ watt "Ohmite" resistances (R1, R5, R6) (Graham Farish).
- Five 1,000 ohm ditto (R2, R3, R7, R9, R12) (Graham Farish).
- One 25,000 ohm ditto (R4) (Graham Farish).
- One 500 ohm ditto (R10) (Graham Farish).
- One .0002 mfd. reaction condenser (C10) (Graham Farish).
- One "booster" unit (Graham Farish).
- Two 1 mfd. fixed condensers, type 9200 B.S. (C3, C12) (Dubilier).
- Four .1 mfd. ditto (C4, C6, C7, C9) (Dubilier).
- Two 2 mfd. ditto (C16, C17) (Dubilier).
- One .0001 mfd. ditto type 670 (C5) (Dubilier).
- Two .0002 mfd. ditto, type 670 (C11, C14) (Dubilier).
- Three 4-pin chassis type valveholders (Clix).
- One 5-pin ditto (Clix).
- Four wander plugs marked G.B.1, G.B.2, G.B.3, G.B.+ (Clix).
- One Passfeeda coupling unit (B.R.G.).
- Two large component brackets (B.R.G.).
- Three terminal mounts (Belling-Lee).
- One 4-way battery cord (Belling-Lee).
- Six type B terminals (aerial, earth, L.S.+ , L.S.—, pick-up, pick-up) (Belling-Lee).
- One "Westector" type W.4 (Westinghouse).
- One "Metaplex" chassis (Peto-Scott).
- One "Fury Super" cabinet (Peto-Scott).
- Four valves, types P.M.12M., P.M.12M., P.M.2DX., P.M.22 (Mullard).
- One moving coil loud-speaker, type P.M.6 (W.B.).
- One 120-volt H.T. battery (Siemens).
- One 16-volt G.B. battery (Siemens).
- One 2-volt L.T. battery (block batteries).
- Connecting wire, length metal braiding, screws, etc.

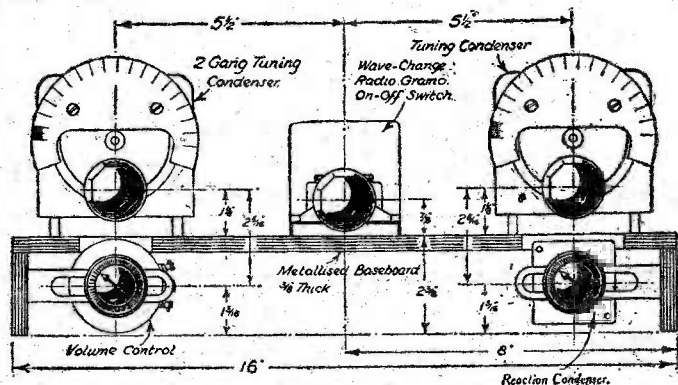


Fig. 13.—Front view of the chassis of the Fury Four Super.

A Simple Ohm-meter

A Useful Instrument Which Utilises a Low-reading Voltmeter

THE detection of faults in a commercial mains-operated set is not beyond the capacity of the average wireless enthusiast, and in these days when servicing is difficult to obtain, is sometimes the only way of keeping a set in use.

For this purpose, however, some means of measuring resistances is essential. While an accurate ohm-meter is a comparatively expensive instrument, one that will give the values of resistances to a degree of approximation quite sufficient for most testing purposes can easily be made.

The materials required are an ordinary voltmeter reading to 6 or 10 volts, and a dry battery. A 9-volt tapped grid bias battery will be suitable. Connect the positive terminal of the battery to the positive of the voltmeter, as shown in the diagram, and take the negative lead from a tapping that will give nearly full-scale deflection on the voltmeter when the leads are short-circuited—i.e., 9 volts for a 10-volt meter, or 6 for a 6-volt meter.

Calibration.

To calibrate the instrument it is necessary to know the internal resistance of the voltmeter. In the case of a good-class instrument this will probably be given; or, alternatively, the current taken in milliamperes for full scale deflection may be stated. The resistance can then be found by multiplying the full-scale voltage by 1,000 and dividing by the number of milliamps. Thus a voltmeter which takes 3 milliamps for a full-scale deflection of 6 volts has a resistance of $6,000 \div 3 = 2,000$ ohms.

If the resistance of the voltmeter is not known, it can easily be found, by applying the leads of the ohm-meter to a known resistance. If this resistance has a value of R ohms, and if the meter reads V volts with the leads short-circuited, and v volts in series with the resistance, then the internal resistance of the meter is $Rv/(V-v)$ ohms. If, for example, the known resistance is of 600 ohms, and the meter reads 9 volts short circuited, and 6 volts across the resistance, then the internal resistance of the meter is $(600 \times 6) \div (9-6) = 1,200$ ohms. The resistance of a cheap voltmeter may be very much less than this. If it is too low the accuracy of the ohm-meter will be impaired by the excessive current taken from the small cells of a grid bias battery.

A table can now be prepared showing the voltage readings corresponding to the required range of resistances. If r is the internal resistance of the meter, V the short-circuited reading, and v the reading with an external resistance R in circuit, then the value of v is obtained from the relation $v = Vr/(R+r)$. Taking r to be 1,200 ohms, and V to be 9 volts, a table such as the following will result.

Ohms	Volts	Ohms	Volts	Ohms	Volts
50000	0.2	3000	2.6	600	6.0
20000	0.5	2000	3.4	400	6.7
10000	1.0	1500	4.0	200	7.7
5000	1.7	1000	4.9	100	8.3
4000	2.1	800	5.4	0	9.0

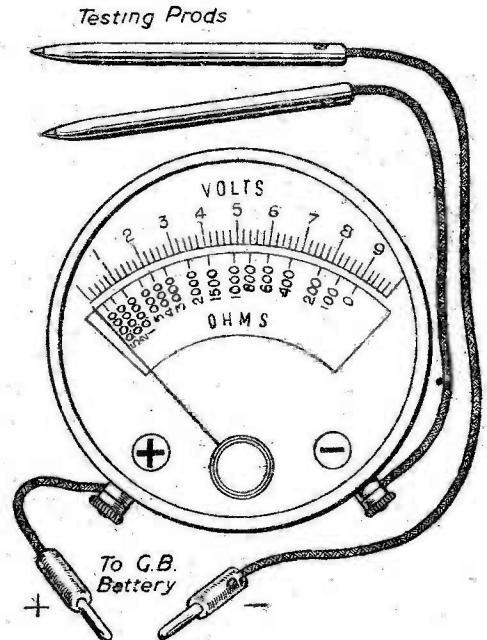
A zero reading indicates an infinite resistance; i.e., the resistance under test has either broken down or is of a value well outside the range of the instrument, e.g., 1 or 2 megohms. The table having been prepared, a curved strip of paper may be pasted on the face of the meter, and resistance values marked on it against the appropriate voltage readings, as shown in the diagram.

Higher resistances may be measured by substituting a high tension battery for the grid bias battery, and multiplying the observed value of the resistance by the appropriate factor. Thus if a 90-volt battery is avail-

able, readings will be multiplied by 10, and on the scale shown a reading of 0.5 volt (20,000 ohms) will now indicate 200,000 ohms. The high tension battery must of course not be used until it is certain from a preliminary test that the resistance is of high value, otherwise the voltmeter may be seriously damaged by excessive voltage across it.

Testing Resistances

When testing resistances in position on the chassis (power, of course, being disconnected) it is necessary to



A voltmeter with its scale calibrated for direct resistance reading.

make sure that there is no parallel path for the current. If a resistance which should be of the order of 5,000 ohms appears on test to be only 50 ohms, it should not be assumed without further examination that the resistance is faulty. It is much more likely that some component in parallel is responsible for the low reading. If the fault cannot be found elsewhere, and the resistance is definitely suspected, it must be removed from the set and tested.

A resistance is often found in parallel with a condenser. It is not necessary to disconnect this. The presence of the condenser, if of sufficiently large capacity, will be indicated by a momentary kick of the voltmeter needle, above the steady value to which it afterwards settles. Provided that no other direct current path is in parallel with the resistance the steady position of the needle will indicate the value of the resistance.

When for any reason the chassis is being examined, it is worth while to make a note of the values of all accessible resistances. Then, should trouble develop later on, a change in the value of any of the resistances will be quickly detected.

Diversity Receivers

A Simple System of Reception Which Overcomes Fading. A Fine Subject for Experimental Work

LITTLE mention has been made recently of "diversity receivers" and the large field of exploration they offer.

Prior to September, 1939, a certain interest was shown in "diversity reception," but since that date little has been published in these pages, except for the description of a suitable H.F. and detector unit, which appeared in May, 1940. The circuit described was designed for medium wave reception, and for the benefit of those interested in such an arrangement, it is reprinted here as Fig. 1. Before discussing it, a simple explanation of the scheme would be helpful to those not familiar with such circuits or their operation. A dictionary definition of "diverse" is *various; varied; different*, and if we think of these meanings applied to the reception of radio transmissions, the expression "diversity reception" becomes self-explanatory. A "diversity receiver" is simply a receiver capable of receiving various or different transmissions at the same time. This is not intended to mean various programmes so far as their composition is concerned, but the same programme when it is radiated on different wavelengths. The circuit shown in Fig. 1 is intended to handle two transmissions

—each on a different wavelength—and that is the usual number for a simple arrangement. To give an actual example, the B.B.C. Home programme is radiated on wavelengths of 203.5 metres, 391.1 metres, 449.1 metres and 49.34 metres. The Forces programme is also sent out on three different wavelengths, therefore, the circuit (Fig. 1) could be used to receive one of these programmes on two different wavelengths at the same time. The object of this duplication of the programme is to overcome or reduce certain defects which are often experienced in the reception of some transmissions.

To keep to the local example, i.e., the B.B.C. radiations, in many reception areas the signal strength varies over quite a wide range or, in other words, "fading" interferes with the reception to the extent that the speaker will be handling a good output one moment, and the next, hardly be audible. With a straight circuit, the trouble usually ends there, but with, say, a modern superhet incorporating A.V.C., the fading is accompanied by violent distortion and blasting. The fading itself is not, of course, anything like so pronounced as with a straight set—owing to the A.V.C. action, but the other two objectionable forms of interference, and these can be more annoying in the writer's opinion than pure

fading, are due to the very item which reduces the fading, namely, the A.V.C. action. On the surface, it seems rather a hopeless case; there is, however, one way, at least, of overcoming the trouble to the extent of making reproduction worth listening to, and this consists of receiving the programme on two different wavelengths and combining their rectified outputs from the two detector stages.

The whole scheme is based on the assumption that if both transmissions are subjected to fading, one will be at its minimum strength while the other is at its peak, thus allowing the combined signal to remain reasonably constant. It is highly probable that most readers have heard one of the finest examples of "diversity" reception, when they have listened to B.B.C. relays of American transmissions. When these are compared with some of their earlier efforts, the progress and efficiency of the system is most noticeable. It is very interesting to make a comparison on the spot, so to speak, by receiving the actual American transmission during the time when the B.B.C. are relaying the same programme. This is not now always possible, as some of the items are received and recorded before the time they are re-radiated over

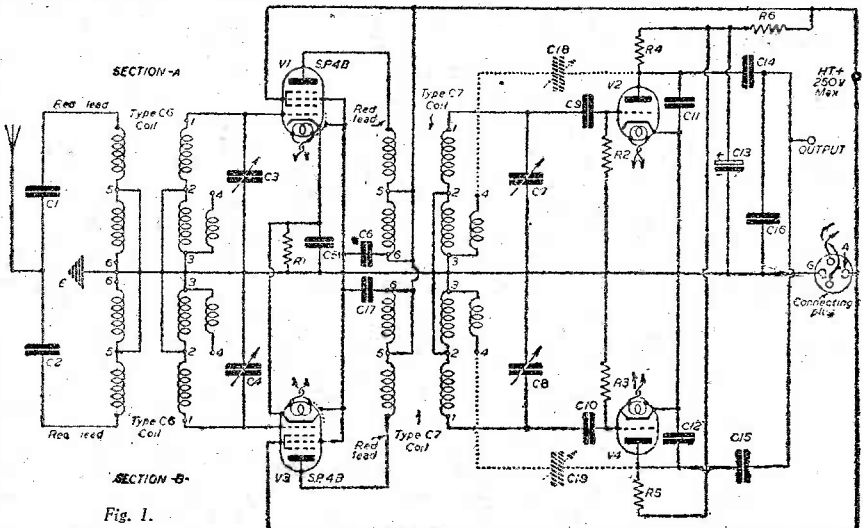


Fig. 1.

Coils (Bulgin).—C3, 4, 7 and 8, .0005 mfd. C1, 2, 9, 10, 11, 12 and 16, .0001 mfd. C5, 6 and 17, .01 mfd. C14 and 15, .02 mfd. C18 and 19, .0003 mfd. C13, 8 mfd. R1, 500 ohms. R2 and 3, 0.25 megohm. R4 and 5, 50,000 ohms. R6, 10,000 ohms.

here. From the above, it will be obvious that "diversity reception" can be employed for the short-waves, for the reception of those stations which radiate the same programme on two or more wavelengths.

Circuits

The present time may not seem an opportune moment to suggest circuits using more valves and components than those normally required; therefore, for experimental purposes it is suggested that the simplest arrangements are used. In those districts where, for example, the reception of the Home or Forces programmes are marred by blasting and distortion consequent upon fading, and where a multi-valve superhet is in use, it

would be a proposition to consider constructing a receiver similar to that shown in Fig. 1, and feeding its output into the L.F. side of the superhet. The valves preceding the L.F. portion could be turned to good account in the "diversity reception" section, the latter getting its H.T. and L.T. from the mains unit in the set.

For battery operation, the circuit would be fundamentally the same as Fig. 1, ignoring, of course, the cathode and bias circuits and using the usual arrangements common to battery sets.

A simple two-valver is shown in Fig. 2. It consists of two detector stages, each with its own aerial and reaction circuits. In the anode circuits, a normal resistance-capacity coupling in each case, the output sides of the two coupling condensers being made common to each other, and thus forming one side of the output from the two stages. The other side is taken from the common-negative-earth line.

The aerial coils required will depend on whether the set is to be used on medium or short-waves. If the former, the medium-wave section of any good dual-range coil, with reaction winding, can be used, or a simple coil made to one of the specifications which have appeared in past issues. For short-waves, the ordinary 4- or 6-pin coil can be used, and it is the latter which is shown in the diagram.

The aerial—common to both stages—is fed into the aerial coils through variable condensers (fixed can be used) of, say, .0001 mfd. maximum capacity. The remainder of each stage is perfectly orthodox.

The output from the two valves can be fed straight on to the grid-of and output pentode or the first valve of a two-valve L.F. amplifier, provided it has a grid resistor connected to it and can obtain its required bias. For test purposes, a pair of phones can be connected direct to the output terminal and the earth line.

Operation

There is little that can be said about the operation of such an arrangement, except for a tip about the tuning of each stage. To use the B.B.C. transmissions again for an example, we will assume that the programme required is the Home one, radiating on three medium-waves and one short. We will also assume that the circuits are designed for the medium-wave reception:

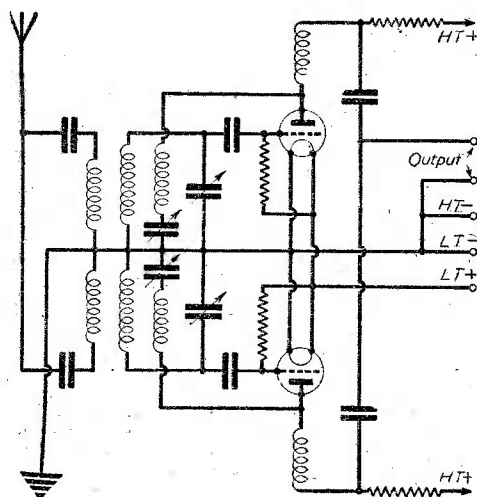


Fig. 2.—For S.W. diversity reception experiments this detector arrangement could be used.

the procedure is, remove valve 2 and on circuit 1 tune in, say, the 203.5 metre transmission, making the necessary adjustments of the reaction circuit, etc., in the normal manner. When satisfied, remove valve 1 and insert valve 2 in circuit number two, and on that circuit tune in the same programme on the 449.1 metre wavelength, or the 391.1 metre, if that gives better reception. Make all final adjustments as before, and then valve 1 can be plugged back into circuit 1, thus bringing both valves into action. The output should now be satisfactory and hold reasonably constant, provided care has been taken to ensure that neither of the circuits is oscillating or on the verge of oscillation, and that the individual outputs are, as near as one can judge by ear, the same as regards volume.

Notes from an Amateur's Log-book

Which is the Best "Straight" S.W. Circuit? 2CHW Gives His Views.

Based on Recent Experiments

I HAVE been making tests with r-v-o and o-v-i arrangements to determine the relative advantages of H.F. and L.P. amplification.

The subject is one which always serves as good material for debate when amateurs get together. There are three schools of thought; one which maintains that an H.F. stage is essential, another which takes an intermediate view and claims that it—an H.F. stage—is an asset, but only 100 per cent. efficient below a certain frequency. The third party maintains that a good detector followed by L.F. amplification to suit conditions, is the best all-round arrangement in the "straight" class of S.W. receiver. There seems little hope that the three schools will become reconciled to a single view or theory, which is a good thing, as each one can give practical proof to support its claims.

The tests I carried out were purely aural, and not in any way along the lines one would take if laboratory facilities were available. However, they were interesting and I would suggest that the subject is one which could be examined more thoroughly by those S.W. enthusiasts who wish to carry out some experimental work during the long black-out evenings.

The apparatus required can be the Rx in use, if it has

the following valve sequence, r-v-r, or if the circuit is a simple v-r, then the necessary additional components, will no doubt be available from most "spares" boxes. My work was simplified considerably by the design of the Rx in use, the theoretical circuit of which is shown in the diagram. Those who have followed my previous notes will remember that the H.F. stage included switching which enabled it to be used tuned or untuned. It is also a simple matter to transfer the aerial to the H.F. coupling and cut out the first valve. After the detector, one or two stages of L.F. can be used as desired, therefore the complete circuit lends itself to practically any combination.

Observations

To secure the most rapid comparison during any of the tests it is necessary to provide switching to enable the required circuit changes to be made quickly, otherwise it is possible for very confusing results to be obtained, fluctuating conditions which might be present during the testing period. Use switches having good contacts—especially on the H.F. side—and keep wiring reasonably short.

Prior to the actual tests, I had a general search

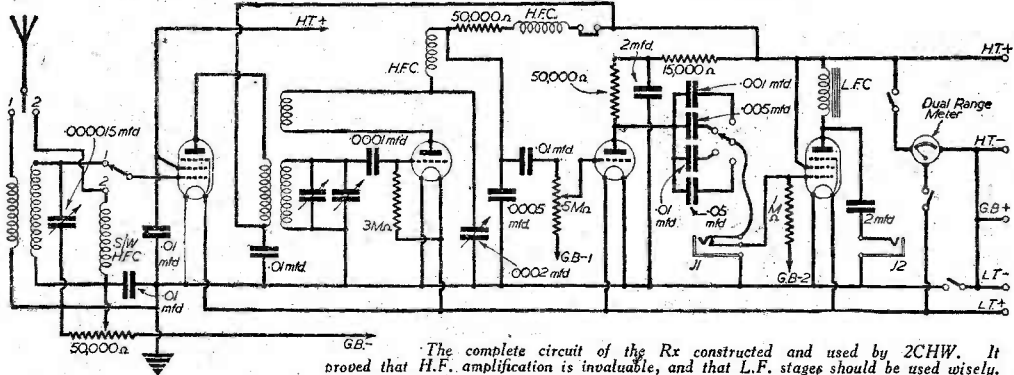
around the dial to see how conditions were and soon found that they could be classified as "fair to good." The W's seemed to be the best transmissions to work on, so with the circuit reduced to r-v-r I made a careful note of their reception, giving each transmission a reasonable period so that its average, so to speak, could be obtained.

Switching over the H.F. stage to "untuned" and readjusting the "spreader" across the detector tuned circuit, I found that the difference in signal strength was not worth noting, though there did seem to be a greater likelihood of interference. The reaction control could be increased slightly and this tended to balance matters. The tests were carried out on the 16 m., 19 m., 25 m. and 30 m. bands.

Going up on to the .45 m. band, the tuned H.F. stage offered an appreciable improvement over the untuned, and this becomes more marked as the wavelength is increased, therefore the results certainly supported the theory that there is little or no advantage to be obtained by tuning the H.F. stage on transmissions below, say, 40 metres.

1-v-0 versus 1-v-2

The signal-to-noise ratio, using the r-v-r arrangement,



The complete circuit of the Rx constructed and used by 2CHW. It proved that H.F. amplification is invaluable, and that L.F. stages should be used wisely.

was quite good, so the extra L.F. stage was brought into circuit just to note its effect. The signal strength was increased beyond comfortable value, but the background noise came up to a greater extent than with the one L.F., thus giving a worse signal-to-noise ratio.

Going to the other extreme, I then tried r-v-o, i.e., just the H.F. and detector stages. Signal strength dropped, noticeably, of course, but the ratio—S to N—was as good as one could wish, even if I did have to concentrate a little more on the actual listening. The combination was beautiful to work; reaction was as smooth as velvet, and the signal seemed to "stand out." This is not really surprising when one remembers what can be done with a single detector valve in the hands of an experienced enthusiast, and when it is used in conjunction with a good aerial. The results almost convince one that it would be worth while scrapping the L.F. stages and concentrating on the perfecting of H.F. amplification and the aerial. Whatever views are taken, it cannot be denied that the idea offers plenty of scope for winter experiments. Although it will appear to be a contradiction, during the above test I would say that the best results were obtained with the H.F. stage tuned.

0-v-1 and 0-v-2

The simple, well-tryed o-v-r arrangement gave quite good results, but its defects were obvious when rapid comparison was made with the r-v-o and r-v-r circuits. The signal strength and signal-to-noise ratio was, speaking generally, satisfactory, but it soon became evident that the loading of the aerial directly on the grid circuit introduced some of those defects which can become the bugbear of the amateur's activities.

"Dead spots," loss of reaction or erratic operation, poor selectivity and attendant problems are likely to be experienced; in fact, I only eliminated, or should I say reduced, the first two by careful and frequent adjustments of the aerial coupling coil and a 50 mmfd. variable condenser I tried in series with the aerial. Fortunately, the aerial in use is an ordinary inverted "L" type, and not designed or cut to resonate on any one particular wave-band; therefore, I did not have too much trouble. Many amateurs, thinking to improve matters, will often take the trouble to erect a tuned aerial system. This is all right up to a point, but it must not be overlooked that at resonance, or harmonics, the aerial will impose a heavy load on the detector circuit, a load often sufficient to stop the circuit oscillating. Given reasonable aerial and earth systems, and provided care is taken in "hotting-up" the circuit, there seems every justification for the claim of the o-v-r school, that such a set can pull in the DX transmissions.

Bringing in the other L.F. stage gave excessive volume, and spoilt the signal-to-noise ratio. While admitting that there are times when one wants just that little extra amplification, it seems that if two L.F. stages are to be included, inter-valve switching and/or some form of volume control must be incorporated.

Summing Up

From these simple tests one thing stands out most prominently, namely, the real value of an H.F. stage, whether it is tuned or untuned. Even if little or no amplification is obtained below 40 metres the stage serves the very useful purpose of "buffer" between the aerial load and the detector grid circuit, thus reducing, if not eliminating, "dead-spots," unsatisfactory reaction control, loss of sensitivity and poor selectivity. An arrangement of the r-v-r type seems to be the best in the "straight" class of S.W. receiver.

A r-v-o combination has possibilities well worth considerable attention from those interested in DX'ing at headphone strength.

The o-v-r circuit is best classified as a very good line-up when in the hands of an experienced enthusiast and operated in conjunction with a good aerial and earth.

More depends on the overall efficiency of the station or installation—and this includes the skill of the operator—than many amateurs think. It is not unknown for a really good Rx, in some cases a reliable commercial product, to be condemned by an owner as being far below par, whereas, in actual fact, the fault quite possibly is in the operator and/or the aerial and earth system. This brings forth the justified argument that all S.W. enthusiasts should serve a thorough apprenticeship with Rx's of the o-v-o and o-v-r types. With such simple receivers, one has, of necessity, to acquire a reasonably high degree of skill and touch; perfect aerial and earth arrangements and a knowledge about local and atmospheric conditions with relation to the reception of DX transmissions.

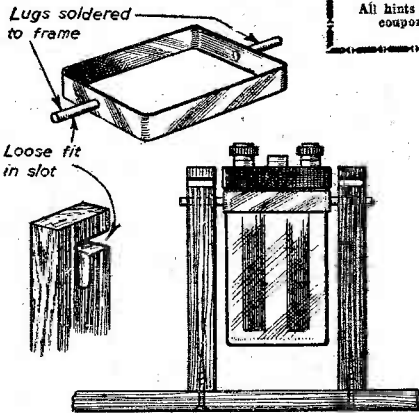
Practical Hints

An Accumulator Support

AFTER having an accumulator tipped over in my radio set I have fitted the supporting device shown in the sketch. The materials required are:

Two pieces of hard wood $\frac{3}{4}$ in. \times $\frac{1}{4}$ in. thick. The height of the stand is made to suit accumulator, and allowing $\frac{1}{4}$ in. for clearance at the bottom.

Two pieces of brass rod $\frac{1}{4}$ in. diameter and 1in. long are soldered to a strip brass frame, which fits the

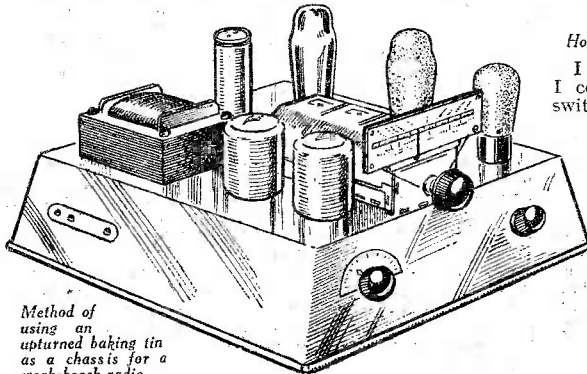


A useful dodge for preventing the spilling of an accumulator.

accumulator like a carrier. Slots are cut in the top ends of the frame to take the short rods, as indicated.—A. A. HEAD (Writtle)

Improved Tinplate Chassis

AT the present time there is a great shortage of aluminium and sheet iron with which to make chassis for wireless sets. I have found that a good substitute is an upturned tinplate baking-tin, the components being mounted on it, as shown in the accompanying sketch. This forms an effective screen for a work bench job, and will, of course, take solder easily.—J. M. FIRTH (Beckenham).



Method of using an upturned baking tin as a chassis for a work-bench radio.

THAT DODGE OF YOURS!

Every Reader of "PRACTICAL WIRELESS" must have originated some little dodge which would interest other readers. Why not pass it on to us? We pay £1-10-0 for the best hint submitted, and for every other item published on this page we will pay half-a-guinea. Turn that idea of yours to account by sending it in to us addressed to the Editor, "PRACTICAL WIRELESS," George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. Put your name and address on every item. Please note that every notion sent in must be original. Mark envelopes, "Practical Hints." DO NOT enclose queries with your hints.

SPECIAL NOTICE

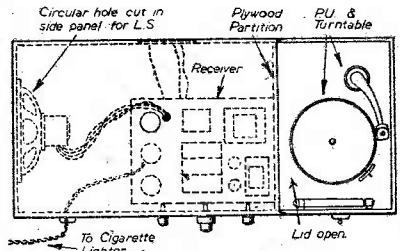
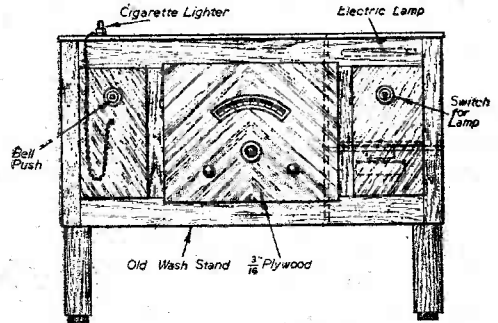
All hints must be accompanied by the coupon cut from page lit of cover.

A Radiogram Conversion

I RECENTLY had an old washing stand given to me for use as a bench, but I hit upon the following idea for converting it into a radiogram.

I removed the marble top and door, and replaced the top with a piece of $\frac{3}{16}$ in. plywood. I next fitted a $\frac{3}{16}$ in. plywood panel where the door used to be. I then took my 4-valve commercial mains receiver chassis and loudspeaker out of their original casing and fixed them to the inside of the washing stand by means of nuts and bolts, after which I took my clockwork motor and turntable, etc., and put them in the washstand, in the position shown. With a short piece

of screened twin flex I connected the pick-up to the pick-up terminals, and, of course, connected my mains and A.E. leads to their appropriate terminals.



How an old washing stand was converted into a radiogram.

I found that the P.U. was a little in the dark, so I connected a 2rov. 30w. 22mm. Striplite and switch in position. (See sketch.)

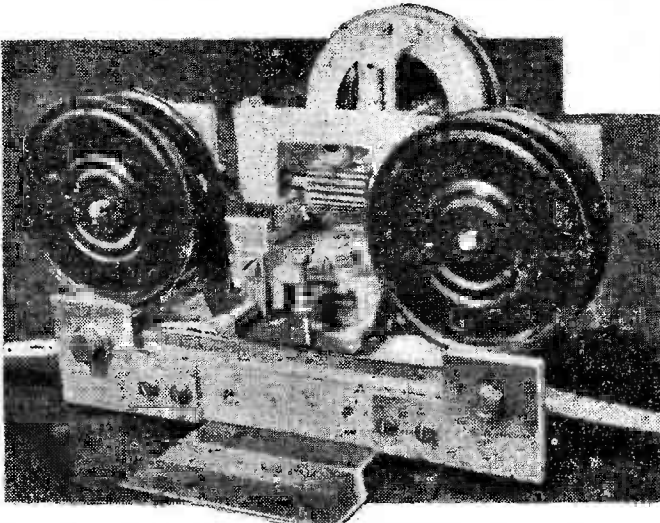
As a refinement, I fitted a novel electric cigarette lighter, which can be used only when the set is in operation.

I took a double-pole tapped filament valve-holder to use with one of the valves in the set, and connected it to a 5 amp. 2-pin plug, and across the two pins I connected a piece of nickel chrome element wire 26 S.W.G., about $\frac{1}{4}$ in. long, and wound into a small coil. The lighter is placed on top of the radiogram, the flex connecting lead passing through a hole in the left-hand panel, as indicated in the sketch.—W. WILLIAMS (Bristol).

A Morse

The Construction and Operation of a

By D. McM



A front view of the completed instrument, with tape in position ready for operation.

THE morse recorder described below should be of great use to all those who are learning the morse code, whether singly or in groups. It can be made almost entirely from material found in the junk box, and the total cost should not be more than about five shillings for the parts that have to be purchased. A lathe is not necessary, and the only tools needed are those found in the average amateur's workshop. The recorder has been tested at speeds up to about 30 w.p.m., but it is estimated that speeds of at least 100 w.p.m. can be recorded satisfactorily.

The recorder operates in the following manner. The paper tape C (Fig. 1) is pulled through the machine at a constant rate by means of an external tape puller. Between the tape and the striker D there passes the typewriter ribbon B, which runs between the typewriter spools A.A. These spools are driven by a motor F via the worm gear G and the bevel gears H.H., which are mounted on the shaft L and located behind the spools (the gears are clearly shown in Fig. 2). The direction of travel of the ribbon is changed by moving the shaft L laterally and so engaging one of other of the pairs of bevel wheels.

The striker D and the armature M (Fig. 3) is actuated by the electromagnet J, which is energised by an alternating current (50 c.p.s.) keyed by a suitable relay, or directly from a telegraph key. It was found necessary to use alternating current in order to obtain a clear impression on the tape.

Each of the bobbins are wound with 80 turns of 28 S.W.G. enamelled copper wire, the windings being connected in series and energised by a transformer giving 3 volts R.M.S.

It was found that when using D.C. to energise the windings, the pressure of the striking screw, when making an impression, was sufficient to stop the typewriter ribbon. The result of this was that at slow speeds or on long dashes, the imprint on the tape, although black at the beginning of a dash, speedily became weaker until it was almost invisible due to the fact that no fresh ribbon was moving under the striker. On the other hand, with A.C. this effect does not occur since the striker is not in contact with the ribbon throughout a dash, thus allowing the ribbon to move.

A clear impression results, however long a dash is made.

Constructional Details

The construction of the instrument should be clear from the illustrations, and the design can be modified to suit the materials on hand. The base, the electromagnets, and the armature were taken from an old moving-iron loudspeaker, the bobbins being rewound to suit the transformer used for supplying the current. The typewriter ribbon may be obtained from any stationers, and an extra spool should be asked for at the same time. The spools are attached to their shafts in the following manner. Remove the side of the spool and solder a collar on its inner face. A locking screw should be fitted to the collar. The side is then replaced, the shaft pushed through and the locking screw tightened.

Brass gears were used, and the motor, F, was a low voltage motor of the type used for driving small model boats: any small motor would be suitable. There is one point to note, however, and that is that the motor should not run too fast, otherwise a very short time will elapse before the direction of travel of the ribbon has to be changed. As previously stated, the reversal is made

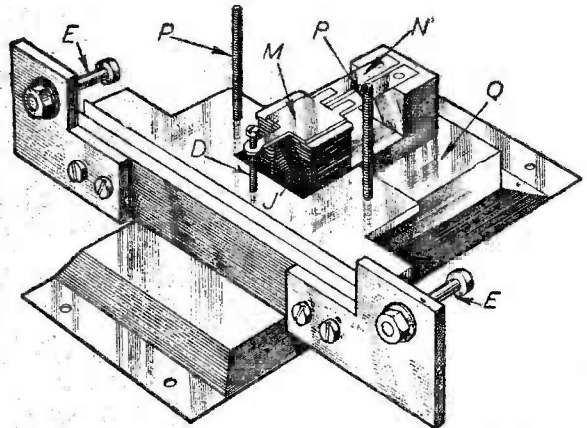


Fig. 3.—Showing the magnet, armature and striker assembly in position on the bedplate.

by moving the shaft L laterally, and it is in one position or the other by means of a movable collar held on the shaft by a grub screw. This screw is loosened whenever it is desired to reverse the ribbon, and the other pair of bevel gears engaged. A small lever could be fitted instead of the collar to move and lock the shaft, and in many respects would be more convenient, especially if the motor runs rather fast.

e Recorder

a of a Useful Unit for the Experimenter

McMULLAN

The springs N were taken from an old 'phone jack, and these were soldered to the armature M. The rest of the instrument may be constructed from scrap metal—aluminium was actually used in the model illustrated, although brass would do equally well. The whole unit is held together by means of the long screws PP. The end of the striking screw should be filed to a chisel point, but should not be too sharp or it will tear the ribbon.

Paper Tape

The paper tape (1/4 in. wide) may be obtained from Webb's Radio, of London. Both sides of the tape may be used and, if the striker is attached in such a way that it can be moved across the tape, two or more impressions may be recorded on the same side of the tape. One reel will last a long time, especially if this procedure is adopted.

The tape puller was made from an old gramophone motor by removing the turntable, and slipping a piece of rubber tubing over the spindle. A spring-loaded jockey wheel was also fitted, and the tape was threaded between it and the rubber-covered spindle. An electric gramophone motor would be best but a clockwork one will answer the purpose.

The instrument may be used for checking the accuracy of one's key work, and for this it has the advantage over the "wavy line" recorder that it records actual dots and dashes which are more easily read.

Radio Transmission

For recording radio transmissions, those stations not employing modulated C.W. are first heterodyned with a B.F.O. to produce an audible note. The A.F. alternating current is then rectified and the resulting D.C. used to energise the relay. The relay was constructed from an old buzzer and is satisfactory up to speeds of about 30 w.p.m. I have not yet had time to construct a relay suitable for higher speeds, and the present relay does not merit description.

Morse Practice

When undertaking morse practice, it is vitally important to acquire correct timing and spacing, and even if the test signals are being received by another person, it is not always easy to correct faults in these directions.

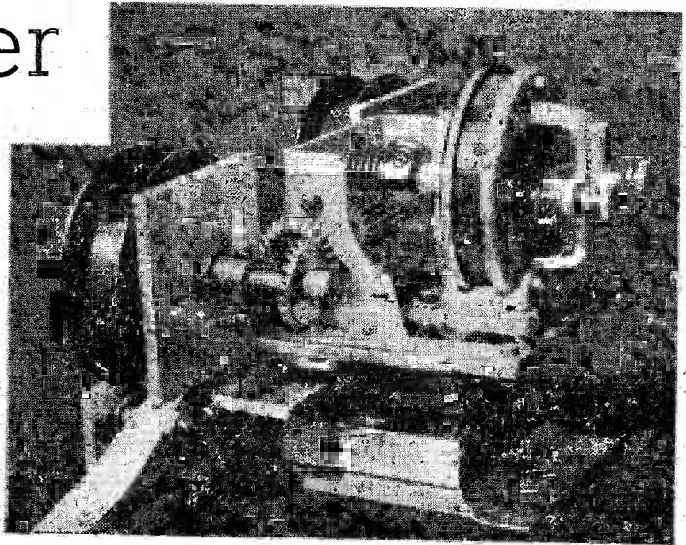


Fig. 2.—The shaft "L" bevel gears "HH" and the worm drive are exposed in this view.

When the student is operating alone, it is practically impossible for him to check up on the length of the dots and dashes and the pauses between letters, etc., and words, with the result that he may develop a far from perfect style. A morse recorder, such as that described above, enables one to have a permanent record—in black and white—of the signal as it was keyed, thus allowing faults to be revealed and corrected.

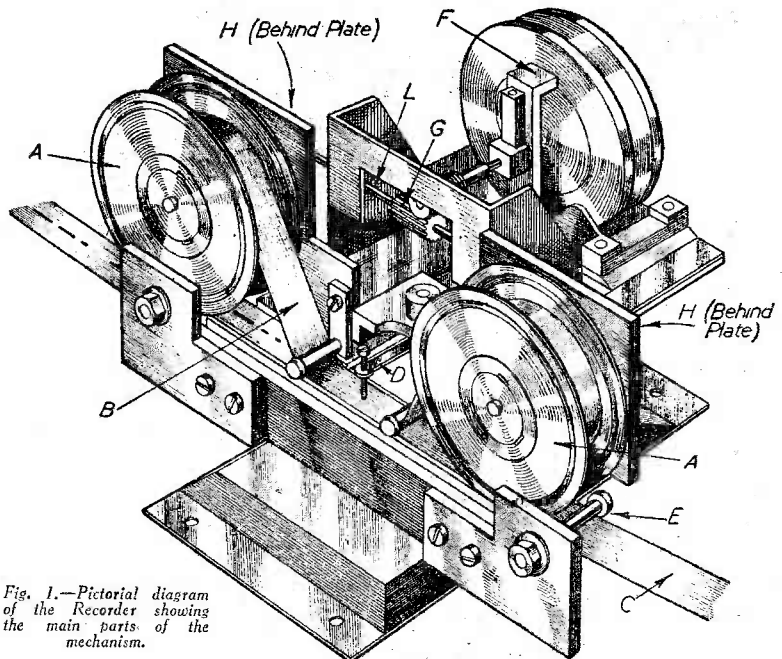


Fig. 1.—Pictorial diagram of the Recorder showing the main parts of the mechanism.

Radio Examination Papers—13

Another Set of Random Questions, with Suitable Answers by THE EXPERIMENTERS

1.—Tuning with A.V.C.

WHEN tuning a receiver by aural methods, that is by listening to the speaker output, it is customary to tune for the maximum volume. When A.V.C. is not provided, and sometimes when a measure of A.V.C. is available, this is quite sound practice. But when a good measure of A.V.C. is obtained this cannot give satisfactory results because the sensitivity of the controlled stages (or more correctly, the gain of these stages) increases as the input to the A.V.C. valve decreases.

Thus, when the receiver is slightly de-tuned the gain of the controlled valves rises, and in many cases the output increases, so that the volume of reproduction is greater than when the set is accurately on tune. Sometimes this change in output is very pronounced, in which case fairly accurate tuning may be possible by choosing the point midway between the two "peaks." In general, however, this is impracticable, possibly because one "peak" is more pronounced than the other.

In such circumstances a visual tuning indicator is very desirable. This operates "in step" with the A.V.C. voltage, and shows the proper tuning point when the A.V.C. voltage reaches its peak. And that peak is reached when the tuning circuits are accurately tuned to the required transmission, or to the I.F. in the case of the I.F. stages of a superhet.

It may be argued that aural tuning can be used if one listens for distortion instead of for maximum volume, bearing in mind that side-band distortion occurs unless the tuning is correct. In practice, however, it is almost impossible to use this method effectively.

2.—Eliminator Switching

The output voltage of an eliminator varies with the current load, being highest when the current is zero. This is especially the case with an A.C. eliminator which incorporates a rectifier. Thus, if the H.T. were switched on before the L.T. it would have a much higher voltage than that at which it was rated. In consequence, the voltage applied to the various smoothing and by-pass condensers would be excessive, and these components may be damaged.

Further, when the L.T. is switched on the anode voltage would be excessive for a fraction of a second during the time the filaments were heating up. As a result, the rare-earth oxide with which

the filaments are treated would be "sucked off" and the filament might even collapse.

The results would be similar, but "in reverse" if the L.T. were switched off before the H.T., since the anode voltage would rise while the filament current was quickly falling to zero.

QUESTIONS

1. Why is it extremely difficult to tune accurately by the aural method a receiver fitted with amplified A.V.C.?
2. In the case of a battery set operated from an H.T. eliminator it is important that the L.T. should be switched on before the H.T. and off after the H.T. State why.
3. Explain the principle of the Wheatstone Bridge, and show how it is used in the measurement of resistance.
4. What would be the effect on reproduction if the by-pass condenser across the bias resistor of an output pentode became open-circuited?
5. What do you understand by the "kink" in the characteristic curve of an S.G. valve?
6. If it were required to operate a four-valve "all-dry" receiver from a L.T. accumulator how would you make the necessary resistor?

Details of a few gauges of Eureka resistance wire are given in the following table:

S.W.G.	Current Capacity (amps.)	Ohms/Yard
24	1.0	1.8
26	.5	2.6
28	.25	4.0
30	.2	5.7

3.—The Wheatstone Bridge

The Wheatstone resistance bridge consists of a network of resistors through which a current is passed from a D.C. source of supply. If the resistors are arranged as the sides of a square as shown in Fig. 1, and a galvanometer connected between two diagonally-opposite corners of that square, a battery being connected between the other corners, it is possible to adjust the values of the resistors so that there is no current flow through the galvanometer. This is known as balancing the bridge.

The condition necessary for balance is that the potential at the two points to which the meter is connected shall be the same. This means that the ratio between the values R_1 and R_2 , and R_3 and R_x must be the same. Expressed

differently: R_1/R_2 must equal R_3/R_x , in Fig. 1.

It can be seen that if R_x is the resistor whose resistance it is required to find, the bridge could be balanced by variation of R_3 .

In practice, a simpler method of balancing is used. A length of resistance wire (generally one metre long and mounted on a metre rule) is used to replace R_1 and R_2 , and a fixed resistor of the same order as the resistor to be measured, is used in place of R_3 . The practical connections then become as shown on the right in Fig. 1. It will be seen that although the various parts are shown in

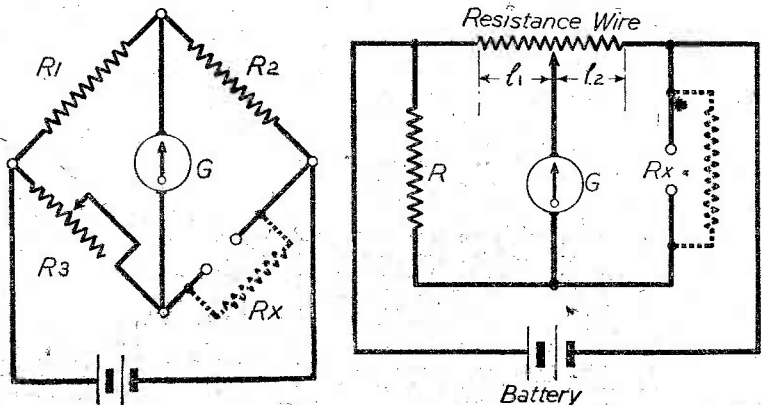


Fig. 1.—The Wheatstone resistance bridge shown in theoretical form (left) and in its practical form (right).

different physical positions, the circuit is exactly the same as before.

There is a slider which moves over the length of resistance wire, and this is moved from end to end until the bridge is balanced; that is, until the centre-reading galvanometer shows a zero reading. As the resistance wire has a uniform resistance per centimetre over its whole length, the two distances from the ends of the wire to the slider can be used in place of the exact resistance (in ohms) of the two parts of the wire. We can then write our equation: $l_1/l_2 = R/R_x$. Since we know the two lengths and also the value of R, we can find the value of the unknown resistance R_x . This is simplified by rewriting our equation as: $R_x = \frac{R \times l_2}{l_1}$

For example, if l_1 were 75 cm. and l_2 25 cm., while R had a value of 5 ohms, the value of R_x would be 15 ohms.

4.—Open-circuited Condenser

In the first place it would probably be found that there would be a certain amount of mains hum, due to an A.C. potential developing across the resistor. This would not always be in evidence, however, especially if the resistor were of low value. But there would be a reduction in output volume due to the introduction of a form of negative feed-back.

This negative feed-back would occur due to the automatic bias across the resistor acting in "opposition" to the bias applied to the grid by the audio-frequency input. In this case, the automatic bias would be varying at audio frequency due to the absence of the by-pass condenser.

Suppose the grid were going more negative at any instant under the effect of the audio voltage. This would have the effect of reducing the anode current. But as the anode current fell, so would the current through the bias resistor. That would mean that the voltage across that resistor—which is used as automatic bias—would also fall. In other words, the grid would tend to become more positive in respect of the cathode. This would be equivalent to reducing the amplitude of the A.F. on the grid, so bringing about the reduction in volume.

5.—S.G. Characteristic Curve

A representative anode voltage-anode current characteristic curve for a screen-grid valve is shown by a full line in Fig. 2, where a corresponding curve for a triode valve is indicated by a broken line. In the case of the curve for the S.G. valve, it will be seen that, as the anode voltage begins to rise from zero, the anode current also rises. But after the voltage has reached about 15 (the exact voltage varies with different valves and different operating conditions) the current starts to fall in spite of the continued rise in anode voltage. After the voltage has reached about 30, the current again starts to rise, and continues to do so up to the maximum anode voltage.

The irregularity in the shape of the curve is described as the "kink," for obvious reasons. The cause of the "kink" is the release of secondary electrons by the anode to the screen grid. This is due to the fact that the primary electrons are accelerated by the screening grid, strike the anode with such velocity that they cause other electrons to be knocked off; these are attracted to the screen, which has a higher positive potential. As the anode voltage is increased slightly above a certain critical figure, a negative space charge

is built up between the anode and screening grid, and this resists the return of the electrons to the screen. Once the anode voltage becomes equal to the screen voltage, the anode can "hold" all the electrons which strike it.

To avoid the effects of the "kink" it is necessary to use an anode voltage at least 50 per cent. higher than the screen voltage.

6.—Limiting Resistor

Since "all-dry" valves work at a filament voltage of 1.4, it is necessary to use a dropping resistor to bring down the voltage of the 2-volt accumulator from 2.0 to 1.4; thus it is necessary to drop .6 volt. Before we can find the value of a resistance suitable for this we must know the total L.T. current taken by the receiver.

The average modern four-valve battery receiver has a frequency-changer followed by a screen pentode, double-diode-triode and then by a pentode output valve. The first three of these will each have an L.T. consumption of .05 amp., while the output valve will take .1 amp. Thus, the total consumption will be .25 amp.

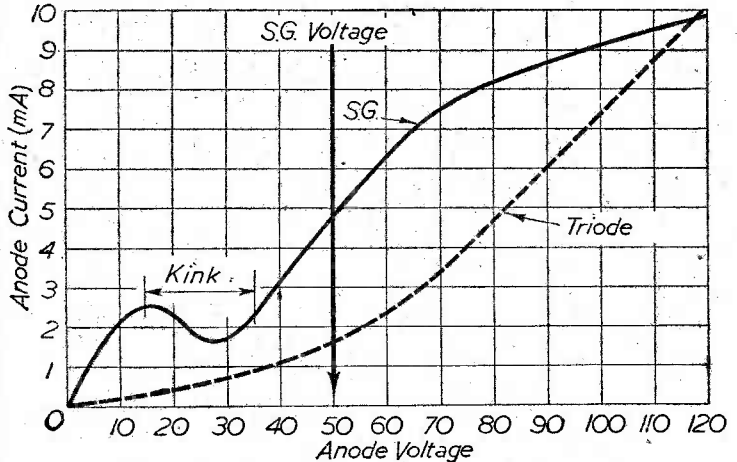


Fig. 2.—The anode current-anode voltage characteristic curve for an S.G. valve is shown by the full line. The broken line shows a corresponding curve for a triode.

It is an easy matter to find the value of resistor required to drop .6 volt at .25 amp. by dividing the voltage by the current. Thus the value (R) of our resistor should be .6/.25, which works out very slightly over 2 ohms. In practice, it would be quite sufficiently accurate to use a value of 2 ohms.

Any of the gauges of Eureka resistance wire shown in the table could be used, but since the 30-gauge wire is rated at only .2 amp. it would probably warm up in use. As changes in temperature affect the resistance, it is therefore better to use wire of one of the other gauges; we could use whichever was more readily obtainable. Thus, we could use 1/2 yd. of 28-gauge wire, or 27in. of 26-gauge, or 40in. of 24-gauge.

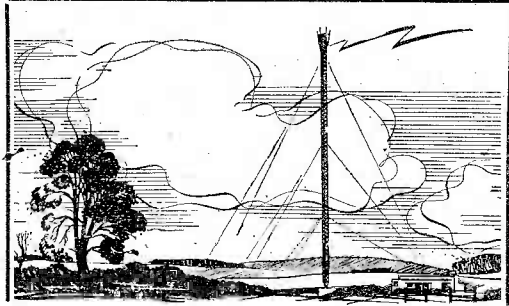
The resistor could most conveniently be made by winding the wire on a strip of paxolin. As the wire would probably be bare, the turns would have to be slightly spaced, either by making "nicks" in the edges of the paxolin with a file, or by winding the wire with a length of string running alongside it.

ARE YOU ON "PIECE" WORK and Making a "Pile"?

Every piece of waste paper helps to make the huge quantity which the country still requires. Do your bit and find those bits and pieces of paper.

YES! BE PREPARED

Times are difficult, but that is no reason why you should not be looking confidently forward to the future. Your future will be what you make it. Use your spare time to increase your earning power, then war or no war your future will be secure.

EARNING POWER IS A SOUND INVESTMENT

DO ANY OF THESE SUBJECTS INTEREST YOU ?

- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--------------------------|----------------------------------|-------------|-----------------------------|-------------------|-------------------|-------------------------------|----------------------|-------------------|---------|-------------|---------|---|--------------|---|----------------------|-------------------------------------|-------------------|---------------|-------------------------|----------------|-------------------------|-------------------------------------|-------------------------------|--|-------------------|-------------------|-------------------------|----------------------|----------------------|-----------|------------|-----------|-------------|---------------|------------|----------------------|--------------------------------|-------------------|-------------|--------------------------------|--------------------|---------------|----------------|--------------|------------------------|--|------------------------|-----------------------------|---------------------|---------------------------|------------------------|-----------------------------|------------------------|------------|---------------------------|--------------------|------------------|--------------|----------------------|---------------------|------------------|--------------------|------------------------|-----------|-------------------------|--------------------------|------------|------------------------|------------------------------|----------------------|-----------|---------|-----------------------------------|----------------|
| Accountancy Examinations | Advertising and Sales Management | Agriculture | A.M.I. Fire E. Examinations | Applied Mechanics | Army Certificates | Auctioneers and Estate Agents | Aviation Engineering | Aviation Wireless | Banking | Blue Prints | Boilers | Book-keeping, Accountancy and Modern Business Methods | B.Sc. (Eng.) | Building, Architecture and Clerk of Works | Builders' Quantities | Cambridge Senior School Certificate | Civil Engineering | Civil Service | All Commercial Subjects | Commercial Art | Common Prelim. E.J.E.B. | Concrete and Structural Engineering | Draughtsmanship, All Branches | Engineering, All branches, subjects and examinations | General Education | G.P.O. Eng. Dept. | Heating and Ventilating | Industrial Chemistry | Institute of Housing | Insurance | Journalism | Languages | Mathematics | Matriculation | Metallurgy | Mining, All subjects | Mining, Electrical Engineering | Motor Engineering | Motor Trade | Municipal and County Engineers | Naval Architecture | Novel Writing | Pattern Making | Play Writing | Police, Special Course | Preceptors, College of Press Tool Work | Production Engineering | Pumps and Pumping Machinery | Radio Communication | Radio Service Engineering | R.A.F. Special Courses | Road Making and Maintenance | Salesmanship, I.S.M.A. | Sanitation | School Attendance Officer | Secretarial Exams. | Sheet Metal Work | Shipbuilding | Shorthand (Pitman's) | Short-story Writing | Short-wave Radio | Speaking in Public | Structural Engineering | Surveying | Teachers of Handicrafts | Telephony and Telegraphy | Television | Transport Inst. Exams. | Viewers, Gaugers, Inspectors | Weights and Measures | Inspector | Welding | Wireless Telegraphy and Telephony | Works Managers |
|--------------------------|----------------------------------|-------------|-----------------------------|-------------------|-------------------|-------------------------------|----------------------|-------------------|---------|-------------|---------|---|--------------|---|----------------------|-------------------------------------|-------------------|---------------|-------------------------|----------------|-------------------------|-------------------------------------|-------------------------------|--|-------------------|-------------------|-------------------------|----------------------|----------------------|-----------|------------|-----------|-------------|---------------|------------|----------------------|--------------------------------|-------------------|-------------|--------------------------------|--------------------|---------------|----------------|--------------|------------------------|--|------------------------|-----------------------------|---------------------|---------------------------|------------------------|-----------------------------|------------------------|------------|---------------------------|--------------------|------------------|--------------|----------------------|---------------------|------------------|--------------------|------------------------|-----------|-------------------------|--------------------------|------------|------------------------|------------------------------|----------------------|-----------|---------|-----------------------------------|----------------|

If you do not see your own requirements above, write to us on any subject. Full particulars free.

IF YOU ATTEND TO THIS NOW IT MAY MAKE A WONDERFUL DIFFERENCE TO YOUR FUTURE

COUPON

CUT THIS OUT



To DEPT. 104, THE BENNETT COLLEGE, LTD., SHEFFIELD.

Please send me (free of charge)

Particulars of..... } (Cross out line
Your private advice } which does
about..... } not apply.)

PLEASE WRITE IN BLOCK LETTERS

Name.....

Address.....

Things to come



IN 1939 we were able to claim to be the largest U.K. suppliers of fixed condenser replacements, with unequalled range and variety of products.

In nineteen.... when radio and other electrical services return to their right use for the benefit of mankind and when the pace of technical improvement will be greatly accelerated, we shall be immediately ready to resume our cordial co-operation with the distributing trade in meeting the great public demand.

TRADE **HUNTS** MARK

The
Home of Condensers

Established 1901

Adv. of A. H. HUNT, LTD., LONDON, S.W.18.



FOR THE RADIO SERVICE MAN, DEALER AND OWNER

The man who enrolls for an I.C.S. Radio Course learns radio thoroughly, completely, practically. When he earns his diploma, he will KNOW radio. We are not content merely to teach the principles of radio, we want to show our students how to apply that training in practical, every-day, radio service work. We train them to be successful!

INTERNATIONAL CORRESPONDENCE SCHOOLS

Dept. 24, International Buildings,
Kingsway, London, W.C.2.

Please explain fully about your instruction in the subject marked X.

- Complete Radio Engineering
 - Radio Service Engineers
 - Elementary Radio
 - Television
- If you wish to pass a Radio examination, indicate it below.
- British Institute for Radio Engineers
 - P.M.G. Certificate for Wireless Operators
 - Provisional Certificate in Radio Telephony and Telegraphy for Aircraft
 - City and Guilds Telecommunications
 - Wireless Operator, R.A.F.
 - Wireless Mechanic, R.A.F.

Name..... Age.....

Address.....



(Use penny stamp on unsealed envelope.)

CELESTION

CELESTION-AMPHENOL
valveholders are preferred by radio engineers because of their Strength, Efficiency, Uniform Contact and exceptional Insulation

All standard British and American types are available.

BRITISH MADE

CELESTION LTD.

Engineers
KINGSTON-UPON-THAMES, SURREY

Telephone: Kingston 5547

Joining the R.A.F.?

ARMY - NAVY - MERCANTILE MARINE OR TAKING UP WORK OF NATIONAL IMPORTANCE in which a thorough knowledge of the Morse Code is essential for becoming a skilled W/T operator? Then investigate the proved Candler method of

MORSE CODE TRAINING

There are courses for beginners and operators.

A Candler-trained operator now serving in the R.A.F. says:

"I should like to thank both yourself and the company for the great start which I obtained through taking your Junior Code Course. The experience which I gained from that, has kept me 'miles in front' of others who relied on obsolete means of learning code." - F. W. M.

Fill in the Coupon and learn more about this highly efficient Candler method of Code training in your own home.

JUNIOR Scientific Code Course for beginners. It teaches all the necessary code fundamentals scientifically.

ADVANCED and High-Speed Telegraphing Course for operators who want to increase their w.p.m. speed and improve their technique.

TELEGRAPH Touch - Typewriting Course for W/T operators who wish to use a typewriter for recording messages.

Courses supplied on Cash or Monthly Payment terms.

COUPON

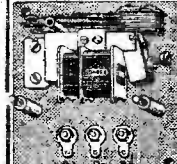
Please send me a Free Copy of Candler "Book of Facts."

NAME

ADDRESS

Post Coupon in 1d. unsealed envelope to
CANDLER SYSTEM CO. (5.L.O.)
121, Kingsway, London, W.C.2.
Candler System Co., Denver, Colorado, U.S.A.

BATTERY CUT-OUT



TYPE LF/C

Simple, robust and sensitive. Works in any position.

Ask for leaflet 98 PEW.

LONDEX LTD.

Anerley Works, 207, Anerley Road, London, S.E.20. Phone: SYD 6258/9.

BOOKSELLERS TO THE WORLD

★FOYLES

FOR BOOKS ON WIRELESS AND EVERY OTHER SUBJECT

119-125, CHARING CROSS ROAD, LONDON, W.C.2.

Open 9 a.m.—5 p.m. including Saturday
Tel.: Gerrard 5660 (16 lines)

TESTOSCOPE



Makes 30 important tests, 100 to 750 volts.

A.C. or D.C. Used everywhere by Electricians, Wiremen, etc. From Wholesalers or direct. Send for leaflet "A.24."

RUNBAKEN - - MANCHESTER - -

ARE YOU MINUS MATHS?

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

Our new Mathematics Courses have proved an outstanding success. We have already helped many men in the Forces and in other war-time occupations to qualify for promotion. We can help you too. By our simplified method of Home-Studying, you can now learn maths really thoroughly in your spare-time.

RADIO. If you wish to qualify for radio duties with the R.A.F., or for full-time or part-time radio work, we can train you. Hundreds of men now serving in the Forces, or doing other important radio work, have been accepted solely as a result of our training.

Post coupon now for free details

T. & G. RADIO COLLEGE 29, Market Place, READING

(Post in unsealed envelope, 1d. stamp.)

Please send me free details of your Home-Study Mathematics and Radio Courses.

NAME

ADDRESS

P34:

of figures before the decimal point in the divisor, unless the quotient appears to the left of the original position of the cursor, in which case the number so determined is increased by 1.

Multiplication or division on the slide rule should always be accompanied by mental addition and subtraction, so that the position of the decimal point in the result is known even before the figures are read from the scale. This applies particularly when a calculation involves a number of such steps, as, for example, in evaluating

$$16.1 \times 25.3 \times 0.063$$

$$247 \times 3.3 \times 0.179$$

It may be noted that in the case of a decimal the equivalent to the "number of figures before the decimal point" is minus the number of 0's between the decimal point and the first figure. For example 0.0031 is classed as -2.

In dealing with logarithms, the "characteristic" is 1 less than the number of figures before the decimal point. When using the slide rule, this fact is best forgotten as it may lead to some mental confusion.

Accuracy of Slide Rule

The slide rule is obviously an instrument of limited accuracy, whereas the corresponding arithmetical processes may, if desired, be carried out with perfect accuracy. What must be remembered, however, is that for many engineering calculations the slide rule is accurate enough. In other words, the figures upon which the calculation is based often include unavoidable errors, probably much greater than those introduced by the slide rule, and so its defects are unimportant.

Modification of Formulae

It sometimes happens that modification of a formula will make it possible for the slide rule to evaluate it in some particular case with much higher accuracy than could be done at first.

Thus, if it be required to evaluate $\frac{17.313}{13.792}$, direct division by slide rule gives 1.256, but the last figure 6 is uncertain, and might be read as 5 or 7. Higher accuracy, with little extra time, can be achieved by writing

$$\frac{17.313}{13.792} = \frac{13.792 + 17.313 - 13.792}{13.792} = 1 + \frac{3.521}{13.792}$$

$= 1 + 0.2555 = 1.2555$ and this is correct to ± 0.0002 . The principle involved here is to subtract unity from the given quantity, and then to use the slide rule to evaluate the remaining fraction.

Similarly, the slide rule is used in the ordinary way to show that $\frac{55.314}{18.052} = 3.065$, but the last figure is uncertain. This result is equal to about 3, and in order to attain a more accurate result the given quantity is therefore reduced by 3, thus,

$$\frac{55.314}{18.052} = \frac{3 \times 18.052 + 55.314 - 3 \times 18.052}{18.052}$$

$$= 3 + \frac{55.314 - 54.156}{18.052} = 3 + \frac{1.158}{18.052} = 3.0641$$

and this is correct to ± 0.0002 .

Again $\frac{11.413}{2.912} = 3.92$ and, as this is a little less than 4, the difference between the original quantity and 4 is determined thus:

$$\frac{11.413}{2.912} = \frac{4 \times 2.912 + 11.413 - 4 \times 2.912}{2.912}$$

$$= 4 + \frac{11.413 - 11.648}{2.912} = 4 - \frac{0.235}{2.912} = 4 - 0.0807 = 3.9193$$

and this is correct to ± 0.0002 .

These methods, it will be noted, include first a quick determination of the result by straightforward slide rule working, and then a more accurate determination by a different method. The total time occupied is less than would be required for long division, and, in addition to this, the two-way method affords the valuable safeguard

of an independent check, so that an accidental error is fairly sure to be noticed.

The same principle of using the slide rule to calculate the difference between the desired quantity and some slightly different quantity that can be determined quickly and accurately may be used in other cases. For example, it may be desired to evaluate the expression

$\sqrt{\frac{a}{a^2 + b^2}}$ in a case where b is small compared with a . To adapt this expression to accurate slide rule calculation in such circumstances it is transformed thus

$$\sqrt{\frac{a}{a^2 + b^2}} = \sqrt{\frac{1}{\left(1 + \frac{b^2}{a^2}\right)}} = \left(1 + \left(\frac{b}{a}\right)^2\right)^{-1/2}$$

By use of the binomial theorem, this last quantity is expressed in a series of terms thus:

$$\sqrt{\frac{a}{a^2 + b^2}} = 1 + \left(-\frac{1}{2}\right)\left(\frac{b}{a}\right)^2 + \frac{\left(-\frac{1}{2}\right)\left(-3/2\right)\left(\frac{b}{a}\right)^4}{1 \times 2} \dots \text{etc.}$$

If $\frac{b}{a}$ is much less than unity, successive terms in this series become rapidly smaller, and only the first one or two need be considered. If, for example, $a = 14.72$ and $b = 2.31$, the original expression is

$$\frac{14.72}{\sqrt{(14.72^2 + 2.31^2)}} = \frac{14.72}{222.35} = \frac{14.72}{14.91} = 0.987$$

but there is some doubt about this, because the 14.91 might be 14.90 or 14.92.

Using the modified form of the expression, its value is

$$1 + \left(-\frac{1}{2}\right)\frac{(2.31)^2}{14.72} + \frac{\left(-\frac{1}{2}\right)\left(-3/2\right)\left(2.31\right)^4}{1 \times 2 \times 14.72} \dots \text{etc.}$$

$$= 1 - 0.0123 + 0.000227 \dots \text{etc.}$$

$$= 0.9879.$$

This is correct to ± 0.0001 for the terms considered, and it is clear from the rapid reduction in passing from the first to the third that all others will be negligible.

Application of the binomial theorem succeeds here, because it is used for the expansion of an expression of the form $(1+x)^n$ where x is much smaller than unity. This means that succeeding terms diminish rapidly, so that all beyond the first few are negligible. If this were not the case the method would be useless, as the whole expansion involves an infinite number of terms.

For convenience of reference the expansion of $(1+x)^n$ is given here in general terms. It may be noted that the more general form $(a+x)^n$ is equal to $a^n [1 + (x/a)]^n$, so that if x/a is small the theorem can still be usefully employed in this way:

$$(1+x)^n = 1 + nx + \frac{n(n-1)x^2}{1 \times 2} + \frac{n(n-1)(n-2)}{1 \times 2 \times 3} x^3 + \text{etc.}$$

Succeeding terms are easily added. The power of x in any term is 1 more than that of the preceding term. The numerator of the coefficient includes all the terms of the preceding coefficient and an extra one that is 1 less than its predecessor. The denominator of the coefficient includes all the terms of the preceding coefficient and an extra one that is 1 more than its predecessor.

Some common occurring examples of this application of the binomial theorem are given below for convenient reference:

$$\frac{1}{1+x} = 1 - x + x^2 - x^3 + x^4 - \dots \text{etc.}$$

$$\sqrt{1+x} = 1 + \frac{x}{2} - \frac{x^2}{8} + \frac{x^3}{16} - \frac{5}{128} x^4 + \dots \text{etc.}$$

$$\frac{1}{\sqrt{1+x}} = 1 - \frac{x}{2} + \frac{3x^2}{8} - \frac{5x^3}{16} + \frac{35}{128} x^4 - \dots \text{etc.}$$

$$(1+x)^2 = 1 + 2x + x^2 \text{ (complete).}$$

$$\frac{1}{(1+x)^2} = 1 - 2x + 3x^2 - 4x^3 + 5x^4 - \dots \text{etc.}$$

$$(1+x)^{3/2} = 1 + \frac{3x}{2} + \frac{3x^2}{8} - \frac{x^3}{16} - \frac{3x^4}{128} - \dots \text{etc.}$$

$$1/(1+x)^{3/2} = 1 - \frac{3x}{2} + \frac{15x^2}{8} - \frac{35x^3}{16} + \frac{315x^4}{128} - \dots \text{etc.}$$

Small Differences

The calculation of a quantity by means of a formula that expresses it as a relatively small difference between two large quantities tends to be inaccurate and for that reason an endeavour should always be made to modify the formula in such a way as to minimise this defect.

For example, suppose that a quantity c is the difference between the square of two quantities d and e , that is

$$c = d^2 - e^2$$

Now in a particular case let $d = 12.31$ and $e = 11.69$.
By slide rule

$$12.31^2 = 151.6 \pm 0.2$$

$$11.69^2 = 136.6 \pm 0.2$$

Subtracting,

$$c = (151.6 + 0.2) - (136.6 - 0.2) = 15.4$$

$$\text{or } c = (151.6 - 0.2) - (136.6 + 0.2) = 14.6$$

These results represent the limiting values of c corresponding to the uncertainty of ± 0.2 in the slide rule reading.

Higher accuracy can, however, be achieved by using the modified formula

$$c = d^2 - e^2 = (d - e)(d + e)$$

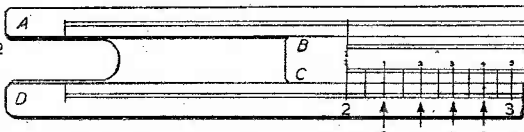
In this case

$$c = (12.31 - 11.69)(12.31 + 11.69)$$

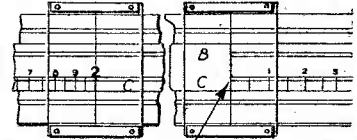
$$= 0.62 \times 24.00$$

$$= 14.88 \pm 0.02.$$

(left)
Multiply by 2
(right)
Multiply
 $2 \times 2 \times 2$
To Divide
reverse the above



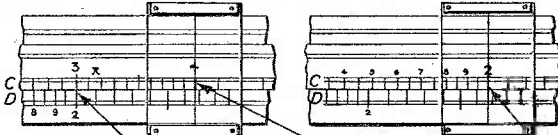
Set left index to 2 on D and below 1,2,3,4, read 2,4,6,8



Set Cursor to 2 on C Left index to Cursor a below 2 on C, read B at right end of D.

Combined X & ÷
eg.

$$\frac{2 \times 4 \times 6}{3 \times 2}$$



Set 3 on C, to 2 on D

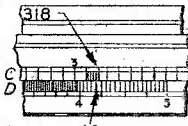
Set Cursor to 4 on C, then set 2 on C to Cursor.



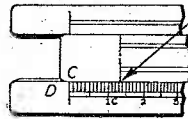
At 6 on C, read 8 on D

Percentage

eg.
Goods cost £318
Sold for £360
Find % on cost
 $= \frac{42}{318} \times 100$

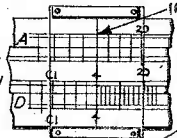


Set 318 on C, to 42 on D

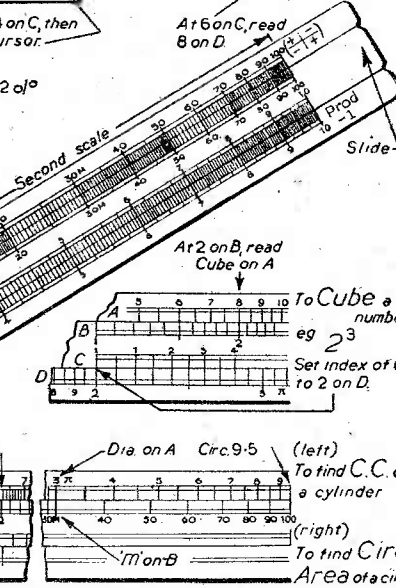


Under L index, read 13.2

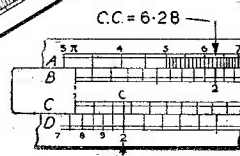
To find
Squares
Set value on D, and its square is read above A
To find
Square root
reverse the above



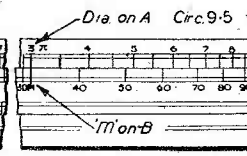
Set 16 on D, read 256 on A



At 2 on B, read Cube on A
To Cube a number
eg 2^3
Set index of C, to 2 on D.

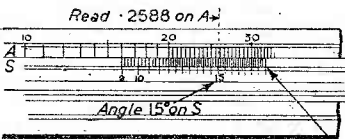


Set C on slide C to dia on D & over length on B, read CC on A

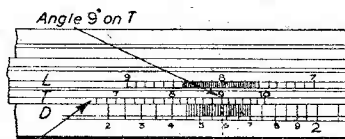


Set M on B, to dia on A Read Circ over right index on A.

To find the Sine of angle



Read the Sine off on A, over the angle on S.



Read off on D, the Tangent of the angle on T.

To find the Tangent of an angle
Logarithms (see text)

Examples in Slide-rule Calculations.

By this method, slide rule working is reduced to a simple multiplication and the unavoidable error in reading is confined to the final result. It is only one-twentieth of the possible error by the obvious method.

Similarly such expressions as $(d^3 - c^3)$, $(d^4 - e^4)$ and so on, may be transformed to give higher accuracy in slide-rule computation, and for convenience, a number of the more commonly occurring cases are tabulated below:

$$\begin{aligned} a^2 - b^2 &= (a-b)(a+b) \\ a^3 - b^3 &= (a-b)(a^2 + ab + b^2) \\ a^4 - b^4 &= (a-b)(a+b)(a^2 + b^2) \\ a^5 - b^5 &= (a-b)(a^4 + b(a^3 + a^2b + ab^2 + b^4)) \end{aligned}$$

Trigonometrical Quantities

The slide rule is not always used as freely as it might be for evaluating trigonometrical functions of angles. This is largely the result of lack of practice, but once that has been overcome, and confidence attained, the slide rule within its limits of accuracy is much quicker and easier to use than are trigonometrical tables.

It has some limitations, but they can be overcome without much trouble. For example, it does not show the tangent of any angle less than $5^\circ 43'$, but it does show the sines of angles down to $0^\circ 34'$, and for angles between that and $5^\circ 43'$ the tangent may, for most purposes, be regarded as equal to the sine.

More accurately, for angles less than $5^\circ 43'$

$$\tan A = \sin A + \frac{\sin^3 A}{6}$$

For example, the slide rule shows that $\sin 4^\circ = 0.0695$ and therefore, using the formula given above,

$$\begin{aligned} \tan 4^\circ &= 0.0695 + \frac{(0.0695)^3}{6} \\ &= 0.0695 + 0.00006 = 0.06956. \end{aligned}$$

It will be realised, however, that the last figure in 0.0695 (read as the sine of 4°) cannot be guaranteed, so that this correction is a fine one.

For all angles less than $0^\circ 34'$ the sine and tangent may be taken as equal to the number of minutes divided by 3440.

Another range in which the slide rule fails to give accurate direct readings is for cosines of small angles. This defect is overcome by making use of the trigonometrical transformation.

$$\cos A = 1 - 2 \sin^2 \frac{A}{2}$$

This is true for all values of A . For the case $A = 10^\circ$, the relation becomes

$$\begin{aligned} \cos 10^\circ &= 1 - 2 \sin^2 5^\circ = 1 - 2x(0.087)^2 \\ &= 1 - 0.01514 \\ &= 0.98486. \end{aligned}$$

Again, it may be desired to determine the secant of a small angle. At first sight this appears to be determinable by taking the reciprocal of the cosine, calculated as above. It will be realised, however, that the degree of accuracy in the value of the secant obtained in this way would be much lower than that of the cosine. In the particular case of 10° , the cosine is 0.98486 (correct to fourth figure), but it is impossible to set the slide rule to anything finer than 0.985 for this purpose and the secant is then 1.015 ± 0.001 .

An alternative is to make use of the transformation

$$\begin{aligned} \text{Sec. } A &= \sqrt{(1 + \tan^2 A)} \\ &= 1 + \frac{\tan^2 A}{2} - \frac{\tan^4 A}{8} +, \text{ etc.} \end{aligned}$$

$$\begin{aligned} \text{For } A = 10^\circ \\ \text{Sec. } 10^\circ &= 1 + \frac{\tan^2 10^\circ}{2} - \frac{\tan^4 10^\circ}{8} +, \text{ etc.} \\ &= 1 + \frac{(0.1763)^2}{2} - \frac{(0.1763)^4}{8} +, \text{ etc.} \\ &= 1 + 0.01552 - 0.00012 +, \text{ etc.} \\ &= 1.01540 \end{aligned}$$

and this may be accepted as correct to the fourth figure after the decimal point.

These random examples of application of elementary mathematics to increase the utility of the slide-rule are not by any means exhaustive, but familiarity with them will often be found useful and will also suggest how similar methods may be developed to deal with other forms of slide rule calculation.

USEFUL SLIDE-RULE GAUGE POINTS

Known Value on Slide	Required Value on Rule	Set to	
		On Slide	On Rule
Square inches	Square centimetres ..	31	200
Square feet	Square metres ..	140	13
Square miles	Square kilometres ..	112	290
Aeres	Hectares ..	42	17
Cubic inches	Cubic centimetres ..	36	590
Cubic feet	Cubic metres ..	106	3
Square, side	Square, diagonal ..	70	99
Inches	Centimetres ..	50	127
Inches, eights	Millimetres ..	40	127
Feet	Metres ..	292	89
Yards	Metres ..	35	32
Miles	Kilometres ..	87	140
Circle, diameter	Circle, circumference ..	225	710
Circle, diameter	Circle, side of inscribed square ..	99	70
Circle, diameter	Circle, side of equal square ..	79	70
Circle, diameter	Circle, side of equal equilateral triangle ..	72	97
Circle, circumference	Circle, side of inscribed square ..	40	9
Circle, area	Inscribed, square area ..	300	191
Pounds per square inch ..	Atmospheres ..	485	33
Pounds per square inch ..	Water, head, feet ..	13	30
Pounds per square inch ..	Inches, mercury gauge ..	33	25
Inches, water gauge	Pounds per square inch ..	360	13
Inches, water gauge	Inches, mercury gauge ..	14	1
Inches, mercury	Atmospheres ..	30	1
Atmospheres	Kilos per square centimetre ..	89	92
British thermal unit	Calories ..	250	63
British thermal unit ..	per pound	9	5
Foot Pounds	Kilogrammetres ..	340	47
Horse-power	Force de cheval ..	72	73
Pounds per H.P.	Kilos per cheval ..	300	134
Horse-power per hour ..	Kilowatts (B.T.U.) ..	134	100
Watts	Horse-power ..	5	0067
Pounds per square foot ..	Kilos per square metre ..	87	425
Pounds per lineal foot ..	Kilos per lineal metre ..	41	61
Pounds per lineal mile ..	Kilos per Kilometre ..	71	20
Pounds, per cubic foot ..	Kilos per cubic metre ..	30	625
Cubic feet of water	Weight in pounds ..	17	1060
Cubic feet of water	Gallons (Imperial) ..	17	106
Gallons of water	Weight, kilos ..	108	490
Pounds of water (fresh) ..	Pounds of water (sea) ..	38	39
Feet per second	Metres per minute ..	7	128
Feet per second	Miles per hour ..	22	15
Feet per minute	Miles per hour ..	264	3
Yards per minute	Miles per hour ..	88	3
Miles per hour	Metres per minute ..	12	322
Knots (nouts) per hour ..	Metres per hour ..	33	38
Pounds per square inch ..	Kilogrammes per square centimetre ..	128	9
Cubic feet	Litres ..	3	85
Cubic yards	Cubic metres ..	51	39
Gallons	U.S. Gallons ..	5	6
Bushels	Cubic metres ..	110	4
Ounces (Avoirdupois) ..	Grammes ..	67	1900
Ounces (Avoirdupois) ..	Kilogrammes ..	670	19
Pounds (Avoirdupois) ..	Kilogrammes ..	230	127
Hundredweights	Kilogrammes ..	5	254
Tons	Tonnes ..	62	63

It is wise to purchase a good quality slide-rule with clear calibrations. Some of the cheaper models warp badly, making movement of the slide difficult, and accurate reading almost impossible.

For pocket use the circular watch-type of slide-rule is handy and quite accurate. The Halden Calulex and the Fowler circular slide-rules are good examples of this type.

For those whose eyesight does not permit them easily to distinguish the scale markings, magnifying cursors are available, such as the Goulding.

(To be continued.)

Battery-operated Amplifiers

"Voltage" and "Power" Amplifiers. Single and Two-valve Units.
 Push-pull and Parallel Outputs Compared. By THE TECHNICAL STAFF

GREAT interest is being shown in circuits for low-power battery-operated amplifiers, and, as blueprints are not available, we are giving the details of those arrangements which we feel will have the widest appeal.

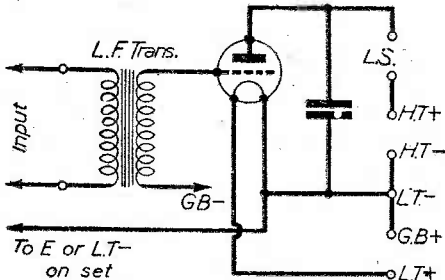


Fig. 1.—A suitable circuit for a power or super-power valve.

The stipulation "low-power" is made because we do not recommend to our readers the use of circuits having an output which would bring them within the medium-power class, when such circuits have to depend on normal dry H.T. batteries for high tension. It is not an economical proposition—especially at the present time—to think of 2 watt and 2½ watt outputs. For normal domestic use, and this includes pick-up work, such outputs are really unnecessary; many constructors talk about watts in the output stage as if they were free for the asking. Much of this is due to their inability to judge an output of, say, 1 watt, and their lack of understanding of the power actually required for loud reproduction in a normal room.

We do not propose to discuss the claims of the super-quality enthusiasts; the majority of inquirers seem more concerned with satisfactory reproduction and economical upkeep.

Single Valves

When it is required to increase the output from a one- or two-valve receiver, it is often sufficient to pass the signal through an additional L.F. stage. In fact, if two valves are already in use, it is not advisable to attempt to add, say, another two stages when utilising battery-operated valves. The reason for this is that the output valve is likely to be overloaded, and the possibility of introducing L.F. instability unless very thorough decoupling arrangements are incorporated. The latter is, however, limited in its applications by the normally low H.T. voltage available from batteries.

Assuming the extra stage is wanted to follow on an existing receiver, then a "power" amplifier will be required; this necessitates the use of a super-power valve or an output pentode, as these can handle a reasonably large input—the former better than the

latter—and produce a great increase in power in their anode circuits. On the other hand, if it was desired to amplify, say, the output of a microphone or pick-up before feeding it into an existing amplifier, one would be concerned with securing maximum amplification of the signal, i.e., the input voltage, therefore, a "voltage" amplifier would be required. The difference between these two forms of amplifier is, a power amplifier is solely concerned with delivering a large amount of power—high wattage, while a voltage amplifier has, as its chief purpose, the high magnification of its input signal, without being concerned about power. Such stages make use of valves having a high magnification factor (high mu), which by virtue of their characteristics cannot accept a large input (grid-swing), neither can they supply any great power from their anode circuit. Power amplifiers, on the other hand, can accept a large input, i.e., that passed on by the preceding voltage amplifiers, but their actual voltage amplification is low. For example, the ratio of the input voltage to the output voltage might be less than 3 : 1. If, however, their power amplification is considered—the ratio of the power supplied to the grid to power output—the figure will be found to be high, as the type of valve used in a power output stage requires a very low power input to produce a large amount of power in its output.

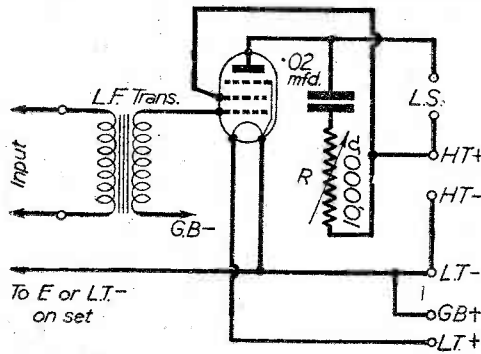


Fig. 2.—If a higher gain is required, the pentode circuit is recommended. R should be increased to 20,000 ohms if made variable.

Circuits

Figs. 1 and 2 show power amplifiers employing super-power and pentode valves respectively; the latter will give a greater magnification, but, generally speaking, will not handle as large an input as a super-power valve. If, therefore, the receiver preceding this amplifying stage consists of a single valve, it would be advisable to use a pentode to secure the greater magnification. A simple tone corrector is connected across the L.S. terminals in Fig. 2; this is necessary to correct the slightly rising characteristic, as regards tonal response, of the pentode. The resistance

R can be fixed or variable, the latter allowing the response to be controlled over a reasonable band width. If a voltage amplifier is required, the circuit shown in

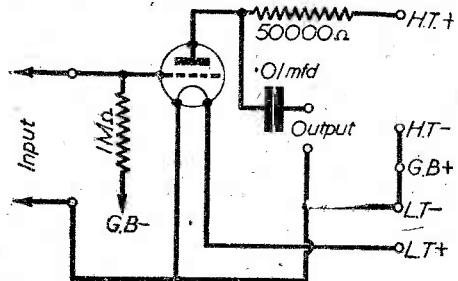


Fig. 3.—A pre-amplifier stage for use where "voltage" amplification is the chief aim.

Fig. 3 can be used in conjunction with a valve of the H.L. or H.F. type. A stage such as this is often required to amplify the signals from a pick-up or microphone before feeding them into the main amplifier.

It should be noted that Figs. 1 and 2 make use of an L.F. transformer for the coupling; its primary can be connected directly to the headphone or L.S. terminals of the preceding set, but if the receiver is of the two-valve type, its existing output valve must be withdrawn and replaced by a valve of the H.L. or H.F. type, and the bias adjusted to suit. The output valve should then be plugged into the new output stage. If one wishes to use resistance-capacity coupling instead of the L.F. transformer, the input circuit of the amplifiers must be modified to that shown in Fig. 4.

Two-valvers

Two valves is the minimum number for an amplifier, when one is considering a unit capable of satisfying the experimental needs of the amateur. A high-gain triode, transformer coupled to a steep-slope pentode, will give a very satisfactory overall amplification, quite sufficient for use with microphones of the carbon class and the majority of pick-ups, and, of course, a H.F. and Det. arrangement or a plain detector stage.

The output obtainable from the majority of battery-operated pentodes is adequate for any normal room, when an efficient speaker—preferably of the moving-coil type—is used.

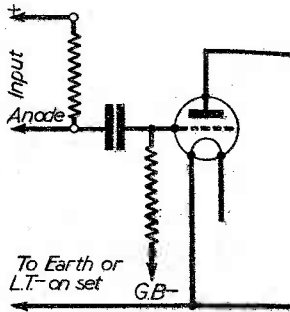


Fig. 4.—The modification necessary if R.C. coupling is required between set and amplifier.

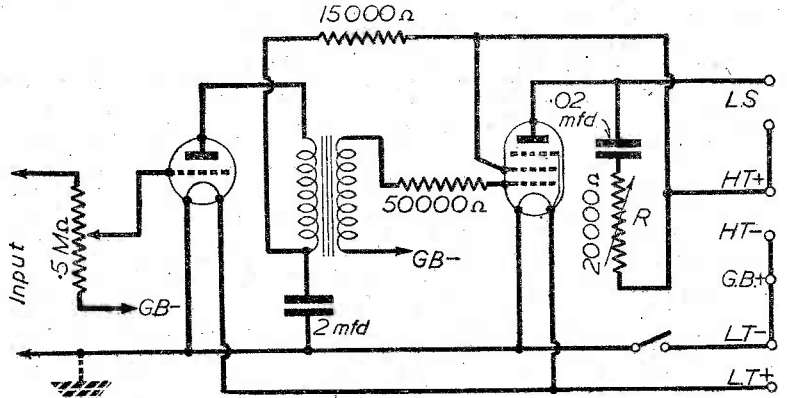


Fig. 5.—A useful two-valve L.F. amplifier suitable for use with a small receiver, pick-up or microphone.

A suitable circuit is shown in Fig. 5, the valves being a Cossor 210 HL and a Cossor 220 HPT. A volume control is connected across the grid circuit of V₁, thus allowing the strength of the input signal to be kept within the satisfactory operating limits of the combination and the output of the amplifier to be controlled. The input circuit, as shown, is satisfactory for direct connection to a pick-up or the secondary of a microphone transformer. If the amplifier is to follow a detector or a H.F. and detector unit, then it will be necessary to use the transformer or resistance-capacity coupling between the set and the amplifier. If one is prepared to sacrifice a little volume, the pentode valve can be replaced by a power or super-power valve, in which case a four-pin valveholder would be used, and the connection from the H.T. line to the auxiliary grid of the pentode ignored. The layout of a two-valve amplifier is so simple that there is hardly any need for us to show a plan drawing. However, here are a few hints for those not familiar with such constructional work. Chassis assemblies are certainly neat, but not essential for this type of circuit. Select a baseboard, say, 7in. by 4in. Fix a valveholder each end of the base—keeping them on a centre line which should be marked beforehand—leave between the valveholders sufficient space for the L.F. transformer, thus allowing the three components to be fixed neatly in line. This will ensure the wiring being short and direct and the anode and grid circuits kept well apart.

A small panel can be fixed to one of the longest sides of the baseboard, and used to mount the input and output terminals, the volume control and the variable

tone control, if a variable resistance is used for that circuit. As mentioned before, the resistance can be fixed if the other type of component is not to hand. When the amplifier has been assembled and tested, it would not be a difficult matter to make a small case to house it.

Push-pull and Parallel Outputs

If the components and valves are available, and amplifier having a push-pull output stage forms an ideal arrangement, provided one is not too concerned about H.T. current consumption, as might be the case when a good H.T. eliminator is in use.

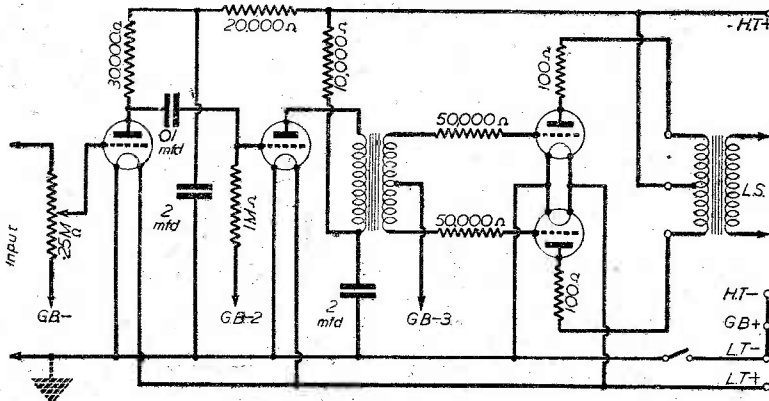


Fig. 6.—A push-pull output amplifier capable of giving very satisfactory results.

A circuit is shown in Fig. 6, suitable valves being H.L., H.F. or L.F., and two super-powers. The two voltage amplifiers are advisable to ensure full loading of the output valves under all input conditions, the volume control being provided to prevent overloading and, of course, normal control of the signal from the point of view of volume.

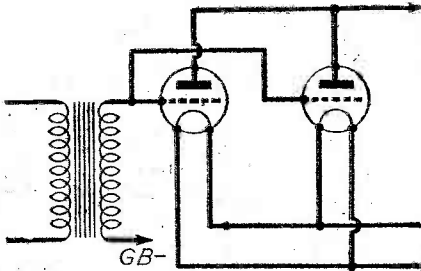


Fig. 7.—Showing the connections necessary for coupling two valves in parallel.

Resistance-capacity coupling is used between V_1 and V_2 , but the output from the latter is fed to the output valves by means of a suitable push-pull input transformer. This component has a centre-tapped, or, as in some models, a split secondary winding, and a low ratio

between secondary and primary. If such a transformer is not obtainable, use can be made of an ordinary L.F. transformer having a ratio of, say, 3:1, by connecting across its secondary winding two 0.25 megohm resistors—connected in series. The junction point formed between these two components is then used in the same manner as the centre-tapping on the correct type of transformer.

The output obtainable from a push-pull stage is, approximately, just over twice that of one valve of the same type; the same result as regards power output can be achieved by connecting valves in parallel, Fig. 7, and it is interesting to note that, assuming the same operating conditions to exist in each case, the parallel arrangement would require only half the input of those in push-pull or, the other way round, valves in push-pull will give the same output as two valves in parallel, provided twice as much input is applied.

Before it is thought that this comparison shows a cheap way of obtaining a large output by using valves in parallel, the additional details should be noted. When using triodes in push-pull, second harmonic distortion is eliminated, and as this is a troublesome factor in L.F. amplifiers, the advantage offered by the push-pull system is, therefore, greatly enhanced. In practice, it means that valves in a well-designed push-pull output stage can be made to deliver much more power before distortion creeps in than an output using a single valve or two valves in parallel; therefore, to come back to our original comparison, it must be modified to read: "Valves in push-pull have a greater undistorted output than valves in parallel."

BRITISH LONG DISTANCE LISTENERS' CLUB

DURING the past month correspondence from members has not been so heavy as previously.

This does not mean that interest is lagging; as we see it—guided by our own experiences, and remarks in those letters we have received—it indicates, that service in the Forces, war work and Civil Defence duties leave little time these days for correspondence. In spite of these arduous essential duties, members still find the time to keep their hand in, their interest alive and in step with such progress as is possible. This is a good sign. It shows that, however hard are our tasks, war restrictions and conditions, we are still able to retain—without sacrificing one atom of our war efforts—the right sense of proportion and the true amateur spirit.

If your letters to us have to be fewer, make up the deficiency by making them as *interesting—to all members—as possible.*

Swaythling, Member No. 6,410

I FEEL that it is time I wrote to you relating my activities in the short-wave sphere. My den is housed in my bedroom, so I have to make the utmost use of the little available space. To this end I use a three-tier dinner wagon for my table, etc. On the top I have arranged a microphone, mixer of my own design, battery-operated Class B one-valve short-wave receiver (which has provision for H.F. unit later) and a Morse oscillator. The second shelf carries battery charger, cabinet containing stand-by s.w. Rx and some tools. On the third shelf there is a large box of spares and many tins of nuts, bolts and washers, etc.

To the left of the dinner wagon stands a home-made bookcase containing PRACTICAL WIRELESS and many other books. On top of the case is a large cabinet of spares, and also a two-valve all-wave receiver and a two-valve medium-wave set. All apparatus, except the battery charger, is home-constructed.

My friend and I have spent several all-night listening periods together, but without good results. From experience gained I find the best listening period to be from 16.00 to 01.30 hours. I am not in a good locality, being in a valley, but have tried to overcome this with the following aerial arrays, all of which are running, approximately, west to east: (1) 66ft. C.T. 33ft. lead in; (2) doublet 16ft. 6in. sections and, lastly (3) 33ft. tapped 8ft. 3in. from west end. All these are connected to a three-way switch which simplifies aerial changing. On these arrays I have received the following: WNBI, WRCA, WGEA, WGOE, WCBX, WRUL, WLWO, WCW, FET23, HVJ, OIE, OFD, SBO, RW96, RNB, RAL, JZI, JZJ, MTCY, XGOY, TAO, TAP, VLQ, VLQ2, FZR, FZI, CSW6, VUD4, CR7BE. Best wishes to all concerned in keeping PRACTICAL WIRELESS going.

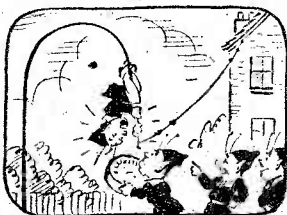
[Your drawing, showing the lay-out of your gear, arrived too late for inclusion with your letter. However, it may be possible to reproduce it in the next issue. You have certainly made the most of the small amount of space available.—HON. SEC.]

Suffolk, from Member No. 8,095

HERE are a few details of my s.w. receiver, which I have just completed. Like many other members, I now have very little time for experimenting, but having been without a short-wave set for several months I decided to make up a simple set, which I am pleased to say gives quite good results.

The set is constructed on an old Corsor 234 Melody Maker chassis, utilising some of the original components. Apart from substituting a pentode for the output triode, the L.F. section was not changed. The detector is resistance-coupled to the first L.F. valve, as shown in the circuit (Fig. 1). Both of the original tuning condensers (.0005 mfd.) are used for tuning and reaction. As previous experiments with commercial short-wave

(Continued on page 36.)



The "Fluxite Quins" at work.

"I shall have to climb down!" OI yelled out.

"Sixty feet to the ground—just about,"

Said EH in his car.

"Here's the FLUXITE—don't fear.

"Just stay where you are—you young scout."

See that FLUXITE is always by you—in the house—garage—workshop — wherever speedy soldering is needed. Used for 30 years in government works and by leading engineers and manufacturers. Of Ironmongers—in tins, 4d., 8d., 1/4 and 2/8.

Ask to see the FLUXITE SMALL-SPACE SOLDERING SET—compact but substantial—complete with full instructions, 7/6. Write for Free Book on the art of "soft" soldering and ask for Leaflet on CASE-HARDENING STEEL and TEMPERING TOOLS with FLUXITE.

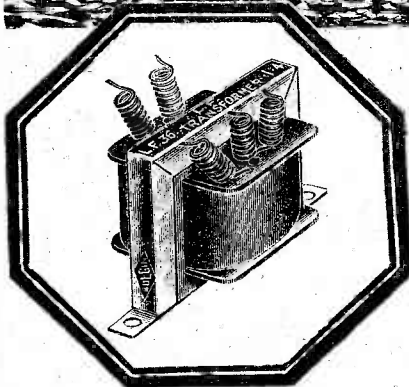
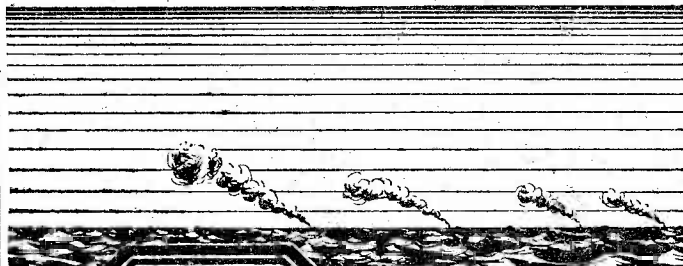
To CYCLISTS! Your wheels will NOT keep round and true unless the spokes are tied with fine wire at the crossings and SOLDERED. This makes a much stronger wheel. It's simple—with —FLUXITE—but IMPORTANT.

THE FLUXITE GUN puts FLUXITE where you want it by a simple pressure. Price 1/6; or filled, 2/6.

FLUXITE LTD. (DEPT. W.P.), BERMONDSEY ST., S.E.1.

FLUXITE
SIMPLIFIES ALL SOLDERING

COMMUNICATIONS DEPEND ...



ON SMALL PARTS...

IN countless instances quite intricate pieces of apparatus are wholly dependent on the proved reputation and reliability of their component parts.

All products from the House of Bulgin are pre-eminent for superior design and workmanship, and every article bearing our Trade Mark has to pass exacting and exhaustive tests during the course of its production.

We ask the kind indulgence of the public in delivery until peaceful conditions return.

The Choice of Critics

BULGIN FOR TRANSFORMERS

THE largest and most extensive range of midget and ultra small intervalve (voltage) transformers in the world. Provided with high- μ cores and carefully proportioned windings of finest enamelled-copper wires. All joints welded; mono-metallic from start to finish for long life under all conditions.

ALWAYS DEPEND ON

BULGIN

REGISTERED TRADE MARK

A. F. BULGIN & CO., LTD., BY-PASS RD., BARKING, ESSEX
TEL. RIPPLEWAY 3474 (4 lines).

coils have not proved very satisfactory, I decided to make one of my own. A suitable coil-former was not to hand, so I utilised a piece of ebonite 6in. by 2½in. by ½in. (Fig. 2). The grid winding consists of 13 turns of .028 tinned copper wire (22 s.w.g.), the turns being spaced ½in. apart. The reaction is wound between the turns of the grid winding, and consists of 13 turns of (.26 s.w.g.?) enamelled wire taken from the secondary winding of an old output transformer. The leads connecting the coil are short and thick, and also act as supports. A

should strictly adhere to the designer's layout and wiring when constructing a short-wave receiver. It is also pointed out that an efficient earth connection is very desirable, when listening on the short wavebands. A bad earth connection causes hand-capacity effects and instability.

Electric Soldering Irons

WHEN receiver construction is being carried out and an electric soldering iron is used, some constructors place the iron on a sheet of metal or other metal support during the wiring process. It may be found that the metal will, in such a case, conduct away a large portion of the heat of the iron with the result that when a connection has to be made the iron is not sufficiently hot and has therefore to be held in contact with the component being soldered for an undue period, with possible damage to that component. A better plan is to rest the iron so that the tip and a portion of the iron which carries the heating element, is surrounded by air, but if the iron is not wanted for fairly long periods of time, a series resistance should be included to avoid undue waste of current and possible damage to the iron.

Wiring Supports

IN some receivers a long bare wire is sometimes called for to act as a common connecting point—bus-bar is the name generally applied to this. If thin-tinned copper wire is being used there are two schemes which will give rigidity and avoid risk of damage due to a sagging wire. In the first case small stand-off insulators may be attached to the chassis and the wire stretched between them. An alternative scheme is to use two strands of the thin wire and twist these by holding in the jaws of a twist drill. Stretch them slightly while twisting, and they will provide a rigid connecting link which can run for quite a considerable distance without risk of damage.

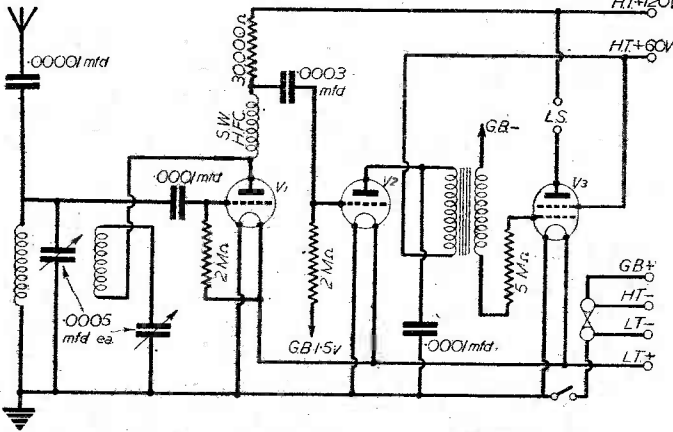


Fig. 1.—The three-valve described by Member 8,095. It utilises a home-made coil and H.F. choke.

crocodile clip, on a short earth lead, is used to clip on to the coil for various wavebands. Although crude, the coil is reasonably selective, and covers a range of about 17 to 60 metres.

"The H.F. choke is based on suggestions made in an old issue of PRACTICAL WIRELESS, and is wound in five sections of 30 turns each on a cardboard case of an old No. 8 torch battery.

"The American stations come in well from early afternoon to late evening. Among the various stations received are WLWO, Cincinnati, Ohio, 25.6 m.; WRUL, Boston, 25 m.; WGO, New York City, 20 m.; Radio Centre, Kuibishev, U.S.S.R., 20 m.; Radio Centre, Moscow, U.S.S.R., 41.1 m.; WGEA, Schenectady, 19 m. I heard WGO for the first time the other day, giving a news bulletin in English, at about 2 p.m. B.S.T. WCBA was also heard round about the same time. This station is testing on 25.3 m.

"Here are the latest times, etc., of English transmissions from Moscow, which came into operation on October 1st: 4 p.m., 25.36 m.; 5 p.m., 42.98 m.; 6 p.m., 8 p.m., 9 p.m., 10 p.m. (all B.S.T.), 41.1 m.; 11 p.m. B.S.T., 39.68 m., 40.76 m., 41.1 m., 42.98 m., 50.93 m."

Short-wave Receivers

IT is a well-known fact that much greater care must be exercised in the construction of short-wave receivers than in that of sets designed for reception of the normal broadcast bands. This is particularly true with respect to the various earth connections. While experimenting with a S.W. receiver it was found that the circuit proved very unstable unless a lead was connected direct from the terminal attached to the moving vanes of the tuning condenser to the earth terminal of the coil. When the set was first assembled this terminal was unused, it being assumed that a sufficiently good contact between the coil and condenser was effected through the metal bracket attached to the condenser spindle. This method of connection proved quite satisfactory for medium and long-wave reception, but immediately the receiver was switched over to the short waveband marked instability was experienced. It is therefore emphasised that members

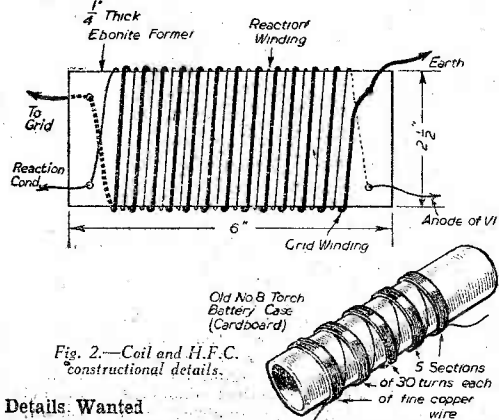


Fig. 2.—Coil and H.F.C. constructional details.

Details Wanted

MANY members may wonder why their circuits have not been reproduced on these pages. To avoid any misunderstanding, we wish to stress the following. The bare theoretical circuit of a receiver is not of general interest. All component values *must be given*, and, if any particular section of the set is of special importance, full details are essential. If home-made coils are used, their constructional data must be provided. We will welcome details of members' sets, *provided* that full information is given.

Impressions on the Wax

Review of the Latest Gramophone Records

H.M.V.

TWO 12in. records in the DB series open up my list of selected recordings for this month. The first is *DB2846*, which gives the two latest of the many famous recordings by that great artist of the violin Heifetz. For these outstanding performances he selected "Chant De Roxane" from the Opera "Le Roi Roger" (Szymanowski trans. Kochanski) and "Dance Espagnole" from "La Vida Breve" (de Falla trans. Kreisler). He is accompanied on the piano by Emanuel Bey. The artistry and technique of Heifetz are superb, and the two compositions he renders gives him ample scope to reveal in detail these outstanding qualities. *H.M.V. DB2846*.

The other record, *H.M.V. DB6135*, is a fine recording by the San Francisco Symphony Orchestra—conducted by Pierre Monteux—playing "Pièce Héroïque"—Part 1 and Conclusion. The roin. records included in my selection form what might be classified as a light "wide appeal" programme. For example, I open up with a selection which should meet with general approval. I am referring to *H.M.V. B9294*, on which will be found Parts 1 and 2 of "Wild Rose." Selection—Jerome Kern—played by the New Mayfair Orchestra under the direction of Debroy Somers. I found it pleasant entertainment, easy to listen to and enjoy. It introduces Overture; You Can't Keep a Good Girl Down; Look For the Silver Lining; On With the Dance; Whip-poor-will; Sally; The Church Round the Corner, and Finale. Remember the number, *H.M.V. B9294*.

For a vocal with piano, I include Joyce Grenfell singing "I'm Going to See You To-day" and "There is Nothing New to Tell You," with Richard Addinsell at the piano. *H.M.V. B9295*. For the dance enthusiasts; I would suggest The R.A.O.C. Blue Rockets Dance Orchestra playing "Desert Patrol"—a quick-step, and "The Great Little Army," a fox-trot march. These are two good numbers—the last being a rhythmic arrangement by Tommy Keith—played in that fine manner for which the Blue Rockets are becoming so well known. *H.M.V. DB5775*. A waltz is on the next record for the turntable, and it has been recorded by Joe Loss and his Orchestra, the piece being "Where the Waters Are Blue," and this is followed by a slow fox-trot entitled "Where In the World," both being on *H.M.V. BD5773*.

To finish off this little H.M.V. programme I have picked "Red Lips"—rumba fox—and "London Conga," two distinctly attractive pieces played by Don Marino Barreto and his Cuban Orchestra and recorded on *H.M.V. BD5776*.

Columbia

TWO superb artists have collaborated for their first solo recording, and it is given on *Columbia DX1094*. They are Henry Holst—violin—and Gerald Moore—piano—therefore there is little call for me to make any comment, as their performance is all that one would expect from such talented artists. Holst selected for his Columbia début—as a soloist—that lovely piece by Delius, "Legende," and he plays it with masterly understanding of Delius's magic. Gerald Moore, the pianist in this recording, forms the perfect collaborator, and his performance reflects his high qualities as a musician. *Columbia DX1094*: "Delius—Legende in E Flat for Violin and Pianoforte," Two Parts.

Schubert's "Impromptu in A Flat" forms the subject of Louis Kentner's latest record. The A Flat Impromptu is delightfully Schubert. It takes one through the whole range of emotions; one moment sadness, then meditation, but only to pass on to passion yet—all the time there is the melodiousness which could only come from the great Schubert. The performance of Louis Kentner leaves nothing to be desired. *Columbia DX1093*. Two

Parts. In the DB series I recommend the following: *DB2093*, on which that lovely soprano Isobel Baillie has recorded—with Gerald Moore at the piano—"Strip of Their Green" and "I Saw That You Were Grown So High."

From "Wild Rose," Jessie Matthews has selected "Whip-poor-will" and "Look For the Silver Lining" for her two numbers on *Columbia DB2094*, and she is as delightful as ever. Debroy Somers conducts the orchestra which accompanies her.

Another vocal is *FB2858*. On this Turner Layton renders that Irving Berlin number "Be Careful, It's My Heart," which is featured in the film "Holiday Inn." On the other side of the disc, Turner offers us "Three Minutes of Heaven." Two good numbers in true Turner Layton style. *Columbia FB2858*.

Now for a couple of dance records. The first is a quickstep "I've Seen You Before," and "Where in the World"—slow foxtrot—both played by Victor Silvester and his Ballroom Orchestra, on *Columbia FB2856*. Personally, I can always listen to Victor's music; maybe this is because super rhythm does not appeal to me as much as the strict dance tempo. However, it would not do for all of us to have the same tastes, but I am pretty sure that Victor has a very large following.

Carroll Gibbons is another who always finds a place near the front of my dance record library. I once referred to his touch as "lazy fingers"—well, most of his presentations are remote from the more hectic renderings which are so often classified as dance music. The two pieces he has selected for recording with the Savoy Hotel Orpheans are "It Isn't a Dream Any More" and "Conchita Marquita Lopez" a fine fox-trot. The last number, by the way, is featured in the film "Priorities of 1943." *Columbia FB2853*.

Parlophone

AT the top of my Parlophone list is Richard Tauber on *Parlophone RO20515*, singing two very well known songs in English, namely, "Good-bye" (White-Melville and Tosti) and "My Dreams" (Weatherly—Tosti). Orchestra—under the baton of Henry Geehl—accompaniment.

For the dance fans, there are three records, two of them being by Geraldo and his Orchestra. On *F1943* he offers a fox-trot "Jingle Jangle Jingle," which is featured in the film "Forest Rangers," and "Hey Mabel" also a fox-trot. On his other record, *Parlophone F1944*, we hear him playing "Ganzonette" and "Sweet Bloise," two more fine fox-trot numbers. Nat Temple, by the way, gives a very fine clarinet solo performance in "Ganzonette."

The super rhythm enthusiasts will be pleased to hear that Harry Parry and his Radio Rhythm Club Sextet, have two numbers on *Parlophone R2851*; they are "Rock It Out" and "I Can't Dance," the latter having vocal refrain.

Decca

DVORAK'S Humoreske, Op. 101 No. 7, arranged Kreisler, is a delightful piece, and Ida Haendel—with Adela Kotowska at the piano—renders it with such skill and feeling that the recording is superb. It will be found on *Decca M521*, together with "Caprice Viennois" by Kreisler, also played by the same artist. This is a record of note and I recommend it to all who enjoy violin solos of the first order.

Joan Taylor—soprano—gives a delightful rendering—on *Decca M523*—of two ever popular songs. They are "My Hero" from "The Chocolate Soldier" and "Vilia" from "The Merry Widow."

On *Decca FB203*, we have another "Humoreske," but this time by Tchaikovsky (Op. 10 No. 2) and played by

(Continued on page 40.)

Musical Frequencies

The Relationship Between Mathematics and Music. By CHARLES WILLIAMS

SINCE the mathematical study of frequencies plays such a large part in wireless theory, it is of considerable interest that there is a mathematical basis for musical frequencies also. Musical intervals, were not, of course, invented by the aid of mathematics, but once a scale of musical intervals has been developed it is legitimate to inquire whether there may not be a mathematical reason why these particular intervals have been found pleasing to the ear, and a suitable basis for the construction of harmonies.

The ancient Greeks had three systems of intervals, based on groups of four notes called tetrachords. In one of these systems, the diatonic, the intervals downward from the upper note of the four, were in succession, a tone; a tone, and a semitone; or counting upward, as we are accustomed to do, semitone, tone, tone. It is from this system that our present diatonic scale has developed.

It is said that Pythagoras, as early as the sixth century B.C., discovered that there was a peculiarly simple mathematical relationship connecting this group of notes.

Frequency Ratios

The fundamental mathematical basis of harmony is this. In order that two notes may be in harmony there must be a simple ratio between their frequencies. The simpler the ratio, the more perfect the concord. On this basis it is possible to give a mathematical account of the major diatonic scale.

The simplest possible ratio between two frequencies is 2 : 1. This is the ratio of the octave. The concord is here so perfect that the two notes are recognised as in a sense identical and are given the same name. Thus on the piano we have a succession of notes named C, each having twice the frequency of the one below.

The next simplest ratios in order are:

$$3 : 2 \quad 4 : 4 \quad 5 : 3 \quad 5 : 4$$

which, C being the keynote, gives the notes G, F, A, E. Taking, in order to avoid fractions, 24 as the frequency of our keynote, and calling this C, we get the series:

$$\begin{array}{ccccccccc} C & - & E & F & G & A & - & C \\ 24 & - & 30 & 32 & 36 & 40 & - & 48 \end{array}$$

The successive frequency ratios of the four notes E, F, G, A, are: 32 : 30, 36 : 32, 40 : 36, or more simply 16 : 15, 9 : 8, 10 : 9. Here the ratios 9 : 8 and 10 : 9 are nearly equal, being equal to 1.12 . . . and 1.11 . . . respectively, while 16 : 15 is equal to 1.06. . . . We note that (1.06)² is equal to 1.12 . . . and therefore regard the intervals F to G and G to A as being approximately equal, and each equal to twice the interval from F to G.

Diatonic Scale of Tones

If we call the interval from F to G a semitone, we have in this group of four notes E, F, G, A, the diatonic tetrachord with intervals, semitone, tone, tone. Its advantage harmonically is that each of the four notes has one of the four simplest possible frequency ratios with the keynote.

We have now to consider the intervals C to E, and A to C. The ratio of the frequencies of E and C is 30 : 24, which is the same as 5 : 4. We note that

$$\frac{5}{4} = \frac{10}{9} \times \frac{9}{8}$$

which suggests that we can put a note D between C and E such that its interval from either will be a tone, i.e., 9 : 8 or 10 : 9. This gives:

$$\begin{array}{ccccccccc} C & D & E & F & G & A & - & C \\ 24 & 27 & 30 & 32 & 36 & 40 & - & 48 \end{array}$$

So far there has been no alternative to the suggested

development if the simplest ratios were to be preserved, but the interval A to C, which is equal to three semitones, might be treated in more than one way. In fact, in the major diatonic scale it has been divided into a tone and a semitone. Thus:—

$$\frac{48}{40} = \frac{6}{5} = \frac{9}{8} \times \frac{16}{15}$$

which gives 45 for B.

The complete octave is therefore:—

Note	..	C	D	E	F	G	A	B	C
Relative frequency		24	27	30	32	36	40	45	48
Ratio			$\frac{9}{8}$	$\frac{10}{9}$	$\frac{16}{15}$	$\frac{9}{8}$	$\frac{10}{9}$	$\frac{9}{8}$	$\frac{16}{15}$
Interval	..		T	S	T	T	T	S	

where T stands for a tone and S for a semitone.

What has been established so far is that the diatonic scale of tones and semitones in the above order appears to be, on mathematical grounds, the most satisfactory scale on which to build harmonies. If music in one key only were required, all that would be necessary, in the construction of a keyboard instrument such as a piano, would be to repeat this series of intervals as often as desired to cover the compass of the instrument. This would give a keyboard with the white notes only, and all the intervals could be made to have exactly the frequency ratios given above.

Intermediate Notes

If, however, another note than C is to be taken as a keynote, and the series—tone, tone, semitone, etc., is to start from that note, additional intermediate notes will be required. The only way to make a practical keyboard fulfilling this requirement is to treat all tones as exactly equal intervals, and each of them as equal to two semitone steps.

A keyboard can then be constructed on which every semitone is represented. Five additional notes will be required in each octave, to divide the five tone intervals into semitones. The intervals E to F and B to C are already semitones and do not need division.

The octave will then consist of twelve semitone intervals, not all the notes being required, however, in any one scale. The five additional notes are, of course, the black notes of the piano. This procedure is fortunately possible because the ear does not detect slight departures from a simple frequency ratio. Two notes whose frequency ratio is very nearly 3 : 2 form practically as satisfactory a concord as if the ratio were exact.

If all the semitones are to be equal, what frequency ratio must correspond to a semitone? An interval of an octave, which is twelve semitones, doubles the frequency. Therefore, each of the twelve steps of the geometrical frequency progression must be equal to the twelfth root of two which is, calculated to five figures, 1.0595. Note how near this is to 1.06, which we previously found for the semitone interval.

Geometrical Progression

The frequencies of the notes on the piano, when both black and white are included, therefore form a geometrical progression whose common ratio is the twelfth root of two. A tone consists of two steps in this progression, and a semi-tone of one step.

It remains only to consider how far this tempered scale differs from the theoretical and true diatonic scale. The degree of difference is best exhibited by a table in which the keynote is represented by frequency one.

Note	Tempered Frequency	Diatonic Frequency
C	1.	1.
D	1.1225	1.1250

E	1.2599	1.2500
F	1.3348	1.3333
G	1.4983	1.5000
A	1.6818	1.6666
B	1.8877	1.8750
C	2.	2.

approximate so closely to the simple ratios of the diatonic scale. If they did not the construction of a piano keyboard would be impossible. In the case of the interval C to G for example, the error is hardly greater than one in ten thousand, which is quite appreciable to the ear.

All the frequencies here given are purely relative. The pitch of middle C is chosen arbitrarily, and whether 256 or 261 or any other number is taken the frequencies of the other notes can be worked out from the ratios already given.

Even the best piano tuned is therefore slightly out of tune in relation to the natural diatonic scale. It is a remarkable fact, and a fortunate one for musical instrument makers, that the powers of the twelfth root of two



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).

Tenth Anniversary of "P.W.": Crystal Reception

SIR,—I hope you will get me right when I say I see nothing very wonderful in the survival of PRACTICAL WIRELESS and its Tenth Anniversary. Its merits have been so outstanding, as compared with its competitors, that I don't see how it could fail to survive and flourish. It is packed from cover to cover with the most valuable technical information and assistance, and your own "Refresher Course in Mathematics" alone makes it worth far more than its published price.

This is a subject which, I must admit, has been a bit beyond me, but I know enough to realise what is being put into these articles, and I have little doubt that some of the Great Intellectuals of the Brains Trust may be carried out of their depth in this direction.

"Sutor ne supra crepidam judicaret." Let them stick to what they are more familiar with, such as "Flies on Ceilings," etc.

By the way, I was interested to note F. G. Rayer's comments on "Loud-speaker and Crystal Set" in Open to Discussion Page, but I think he has missed the point. We knew many years ago that phones placed in a dish would slightly increase volume from a crystal set and, as he says, a sensitive loud-speaker of ordinary type would also give "bedside" reception, but not sufficient to fill a small sitting-room at comfortable strength.

A speaker constructed on the lines I suggested would, I think, overcome this defect, but only actual experiment could settle this question, and I had not the facilities. Some day the idea may be tried out.—K. T. HARDMAN (Birkenhead).

Simple Morse Oscillator

SIR,—Having a little time to spare recently I decided to experiment with a morse oscillator I had built some time ago from a simple circuit, shown in the accompanying diagram. The chief components used were a Varley "Nicklet" 3.5/1 L.F. Trans. (T1) and a Midget R.1 "Parafreed" L.F. Trans. (T2). The latter was included with intention of increasing volume, also to obtain a higher frequency. C.1 is a .00075 mfd. "Polar" solid dielectric condenser (any other value could be used) for the frequency control. Keying is obtained by short circuiting the primary of the transformer T1 with a back contact morse key.

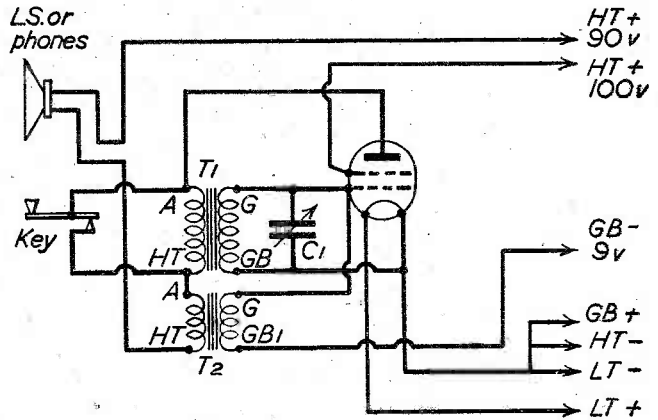
The valve can be a S.G. or an L.F. output pentode. The anode voltage is lower than the screen voltage,

depending on the valve in use, and is best decided by experiment.—P. KING (Swindon).

Station HCJB

SIR,—I have just received a communication from Station HCJB, "The Voice of the Andes," in Quito, Ecuador, and, in view of the fairly widespread popularity of this station among DX enthusiasts, the following details may be of interest.

A complete history of the station since its inception in 1931 is given and relates how in that year, with a staff of three, the first "Radiodifusoras" HCJB was installed and inaugurated. The description traces its rise from a modest 200 watt local transmitter to that day in 1940 when, after two years of planing and construction, the new 10 kW station was opened by the President of Ecuador and the signals from "La Voz de Los Andes" were at last destined to reach every corner of the globe.



Circuit diagram of a simple morse oscillator, described by P. King, of Swindon.

The new verification card of the station is included in the communication. It portrays the Ecuadorian colours—red, blue and yellow—and displays a photograph of the station and its beam antenna, behind which lie many of the Andean peaks. There are actually six stations using the same call. These are:

1. The international on 12.4 mc/s—10 kW with a four-element rotary beam.
2. A provincial on 4,107 kc/s—1 kW.
3. A local on 970 kc/s—1 kW with a three-element beam.

4. An amateur (HC1JB) on 28,370 kc/s.
5. An experiment on 27,985 kc/s.
6. A mobile on 20 metres with a half-wave vertical antenna.

The 12.4 m/c station is on the air every day except Mondays and broadcasts programmes in five languages. Its exact locality is to the north of Quito. It holds a unique position in being the first station constructed chiefly for the purpose of religious devotion, and on account of this bears the title of the "Pioneer Missionary Broadcaster."—JOHN W. MACVEY (Kelso).

S.W. Listening

SIR,—The comments and opinions expressed in the November issue of *P.W.* by F. G. Rayer are most interesting. I assume he questions my statement in the general sense. The facts, however, are as stated. With this and several other instances in mind, including correspondence devoted to the same subject in a pre-war contemporary in which the solutions were a special coil, or alternatively removing one complete turn from grid winding, a friend of mine who uses the same value of tuning capacity as F. G. R. experienced the same trouble, and had to wind a special coil on a standard former. In all instances, including mine, the receivers have been beyond question in every way, including the maximum capacity of tuning condenser. Band spread is used generally, but this condenser was cut out during tests. I do not question your correspondent's results, and the conclusion reached was that whilst the rated approximate minimum was 9 metres in practical use, the actual minimum was around 12 metres. The question of dead spots does not arise, as my receivers are entirely free from these effects, and smooth oscillation is obtainable over the full tuning range—below 10 metres to 180 metres. Entire freedom from body capacity effects is also usual. In view of his remarks relative to aperiodic windings, has your correspondent removed interwound aperiodic windings, and rewound them to suit himself? Also, does he use a standard low loss commercial coil base? Whilst I agree in some measure with his comments I think that taking into account the efficiency of modern six-pin coils used, and inductively coupling to H.F. circuits, and as a form of doublet coupling it seems that they are designed as a compromise. The aperiodic coupling being much too tight to allow oscillation of O-V-1 type detector circuits. I am fully aware as to how simple it is to obtain satisfactory and true aperiodic coupling with home-made six-pin coils. These coils are designed for the job, and not as a compromise. I do not alter commercial coils, or favour this practice. I prefer to follow the makers' instructions, and judge them on the results obtained. With a home-made coil I find it possible to cover the 10 metres band on a standard S.W. receiver, and the same applies to 5 metres. A suitable H.F. choke, of course, is incorporated. The opinions of other readers are invited. A study of the correspondence so far rather indicates that opinions will be divided. The question is can you cover the 10 metres band using a 0.001 mfd. tuning condenser, and a commercial coil rated at approximately 9 metres minimum range, including and excluding band-spreading condenser? The examples quoted by me are not confined to one make of coil, but three different makes, and with losses reduced to the minimum in detector circuits the obtainable minimum in all cases is above 10 metres. Valves used are standard HK210 triodes. As modern sponsored designs always include a series aerial condenser of semi-variable type, it seems that designers generally come up against this snag.—A. W. MANN (Middlesbrough).

IMPRESSIONS ON THE WAX

(Continued from page 37)

that very fine orchestra—conducted by Montague Birch—the Bournemouth Municipal Orchestra. On the other side of the record, they give Schubert's "Marche Militaire" and, needless to say, their performance is outstanding in all respects.

The Royal Air Force Dance Orchestra have selected for their recording this month "Conchita Marquita Lopez" and "Be Careful It's My Heart," two numbers which are well to the fore and in this instance, well played. *Decca F8194*.

Charlie Kunz and his Ballroom Orchestra, with, of course, himself at the piano, offers—in strict tempo and without vocal chorus—two fox-trots "Look For The Silver Lining" and "I've Seen You Before," on *Decca F8199*. Two good tunes nicely presented.

A record which is fine for our own entertainment (when we require something light and tuneful), and ideal for the many thousands of war workers, is *Decca F8209*. It is entitled, "Music While You Work" Series No. 1 and 2. The first side of the record, that is No. 1, records a good selection from "The Merry Widow" and introduces "Vilia," "The Merry Widow Waltz" and "The Merry Widow March." On the other side of the disc (No. 2), another popular selection is provided, this time under the title of "The Maid of the Mountains." This introduces "Paradise for Two," "A Bachelor Gay Am I" and "Love Will Find a Way." The Victory Band make the recordings a thoroughly enjoyable performance.

To close my *Decca* list, I have selected Ambrose and his Orchestra playing "Jingle Jangle Jingle" and "Rollole Rolling Along," a fox-trot and waltz respectively. I recommend this to all dance enthusiasts; it is *Decca F8212*.

Rex

"**S**ANDY Joins the Home Guard" is a merry little comedy sketch—in two parts—from that popular comedian Sandy Powell. In it, he introduces the song "The Home Guard," and puts over the comedy stuff in his own inimitable manner. *Rex 10154*.

On *Rex 10150*, Issy Bonn—with orchestral accompaniment—records "Where in the World" and "This is Worth Fighting For."

Finishing once again on dance tunes, Jay Wilbur and his Band, on *Rex 10151*, plays "You Walk By" a fox-trot, and "Farewell to Dreams"—waltz.

PRIZE PROBLEMS

Problem No. 438

THE two-valve battery receiver which James was using had suddenly developed a peculiar scratching sound at one point on the tuning scale. He thought that this was, perhaps, due to condenser traces short-circuits, and accordingly proceeded to test the receiver to that end. He connected a voltmeter in series with a 1.5-volt cell and joined this across the two terminals of his variable condenser. He found that a reading was obtained on the meter, no matter where the condenser was adjusted, and he therefore assumed that the condenser was shorting. What was wrong with his test?

Three books will be awarded for the first three correct solutions opened. Mark your envelopes Problem No. 438 and address them to The Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Entries must be received by the first post Monday, November 16th, 1942.

Solution to Problem No. 437

Jones overlooked the fact that the anode resistor of the R.C. stage acted to some extent as an H.F. choke, and also restricted the applied voltage on the anode of the detector. When the L.F. transformer was substituted, no H.F. choke effect was obtained, and a much higher voltage reached the anode, these two items combining to produce instability.

The three following readers successfully solved Problem No. 436 and books have accordingly been forwarded to them. (Mr. F. H. Watts; R. Barlow, Ulverston; Hugh Walker, Montreal.

Radio Engineer's Vest Pocket Book

3/6 or 3/9 by post, from

GEORGE NEWNES LTD., Tower House,
Southampton Street, Strand, London, W.C.2.

Replies to Queries

RULES

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

- | | |
|--|---|
| (1) Supply circuit diagrams of complete multi-valve receivers. | (3) Suggest alterations or modifications to commercial receivers. |
| (2) Suggest alterations or modifications of receivers described in our contemporaries. | (4) Answer queries over the telephone. |
| | (5) Grant interviews to questists. |

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

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

Send your queries to the Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

The Coupon on page iii of cover must be enclosed with every query.

Heater Leads

"I am making up an A.C. receiver and am rather anxious regarding the wire to be used for wiring up the heaters. In some receivers which I have looked at I find that solid wire is used, while in others flex has been employed. Does it matter what type of wire is used, provided that the current-carrying capacity is ample for the total heater circuit?"—T. R. (Kenton.)

THE usual reason for using flex is that it is more easily bent to follow the run of wiring. If solid wire is employed for a given current rating, it will be heavier than the stranded or flexible wire, and therefore more awkward to twist and bend. Furthermore, the flex must be bared at the points where it makes contact with the various valveholders in the wiring and this means that there are two junctions at each valve heater pin. This may lead to difficulties as there will be an undue thickness of wire at that point. By using solid wire of suitable diameter it may be soldered to a valve pin, insulated sleeving slipped over ready cut to a suitable length, and thus only one joint has to be made and this is generally simpler for the amateur.

Auto-transformer

"Can you tell me what an auto-transformer is? I thought these things were only used in A.C. mains-motor-generators, but an old circuit which I have turned up for radio specifies an auto-transformer for L.F. coupling, and I cannot see how this would work."—F. N. (Lewisham.)

THE auto-transformer consists merely of a tapped choke, used for L.F. coupling and fed in the usual way from the anode of the preceding valve through a condenser to the tapping. One end of the choke is joined to the grid and the other to G.B. (or earth). By changing round the connections to the ends two different ratios are obtainable. The portion of the winding between the coupling condenser and earth acts as the primary, and the total winding as secondary, and thus the ratio is dependent upon the amount of wire between coupling condenser and earth.

Potentiometer Connections

"I am including a potentiometer in a test circuit, but only require to use the unit as a variable resistance. One side of the element is joined to earth, but I am uncertain whether I should join the arm of the control also to the other end of the element or whether this latter point should be left unconnected."—B. U. (Teddington.)

IN most circuits it is unnecessary to connect one side of the element to the arm when using a potentiometer as a variable resistance. The "dead end" will be of no consequence, and the only effect of connecting both together is to short-circuit the unused portion of the element. In some special circuits it might be desirable to do this, especially if a wire-wound component is employed, but for all general purposes the two connections alone will suffice.

H.F. or L.F. ?

"At present I am using a single-valve (detector) receiver, but naturally I get a limited field of reception. I am prepared to go to the expense of adding one further stage of amplification, but I have been told that if I add L.F. I shall not get any more stations, whereas if I add H.F. I shall get more but not any louder. I should be glad to know exactly what will happen with either form of amplification and which is best for my purpose."—W. H. (Oxford.)

IN theory the addition of an L.F. stage will merely increase the volume of signals received by the detector, while the addition of H.F. will increase the signals present on the aerial and thus give you a greater field of reception. In practice, however, there are differences in this. With your detector you will probably find that signals are present which are extremely weak

and probably can only be discerned when you concentrate seriously—and in some cases they may be just inaudible. The addition of an efficient L.F. stage will bring these up to audibility and thus you will probably hear stations at present not received if you add L.F., in addition to the obvious strengthening of those signals which are now heard. The fitting of H.F. will, besides bringing in stations not now received, often so increase the strength of those stations you do hear that they may be put on the speaker without L.F. amplification. Overloading must, however, be considered when strong signals of this type are available.

A Decimal Point

"Could you please let me know whether a .0005 tuning condenser is the same as a 0.0005 condenser. The set I am building has a number of condensers marked 0.0005, 0.0003, and 0.003, etc."—G. P. (Birmingham.)

THE cipher preceding the decimal point is often employed in order to enable the decimal point to be more clearly identified. If this first figure is not employed there is sometimes a risk of the decimal point being mistaken for a mark on the paper, etc., but the 0 preceding it makes it quite clear. Therefore 0.0005 is exactly the same as .0005.

Microphone Transformer

"I have a microphone which I was told required a transformer. Not having seen any data concerning this type of transformer, I tried an ordinary 3 to 1 L.F. transformer. Results were very disappointing. Are there any special details to remember with transformers for this purpose?"—V. W. (Bath.)

THE L.F. transformer is of no use, although you do not state what type of microphone you were using. Generally, the transformer used in conjunction with a carbon type of microphone has a very high ratio, somewhere in the neighbourhood of 75 to 1. You should endeavour to ascertain some details concerning the particular microphone, in order to obtain a satisfactory type of transformer for use with it. See the December, 1941, issue.

Replacing Condenser

"I have a mains set which has developed a fault that I have now identified as being due to a fractured electrolytic smoothing condenser on the H.T. side. This is a small waxed cardboard box with three leads coming from it, two red and one black, and the wax has run and I have tested the H.T. and find none there. I am going to replace the condenser but I am not certain which lead is which, and as I want to use a wet electrolytic condenser in place of these cardboard items I should like to know how to identify the leads."—H. Y. (Slough.)

THE condenser block obviously consists of two condensers, and these are joined together inside the casing with a single lead from the two negative poles. This lead is the black one. The positive side of each condenser is provided with a red lead. Therefore, when replacing this unit by two ordinary electrolytics they should be mounted so that the case of each is in contact with the chassis (or the H.T.—line) and the centre terminal points on the condensers should be joined to the points to which the red leads are now connected.

EVERYMAN'S WIRELESS BOOK

By F. J. GAMM

NEW EDITION.

6/- or 6/6 by post from Geo. Newnes, Ltd. (Book Dept.), Tower House, Southampton Street, Strand, London, W.C.2.



COMPONENTS FROM STOCK

Below we give a selection of the wide range of components at present in stock. Webb's war-time service is still unique in the facilities it offers to the radio-man.

- CONDENSERS**
 .00035 mfd. Tuning Condensers with Slow Motion and Dial ... 7/6
 3-gang .0005 " Tuning Condensers (Ceramic insulation) ... 7/6
 Eddystone (Special) 15 mmfd. Band Spread or U.S.W. Microdenser ... 3/6
 Cyldon 20 mmfd. Air Trimmer Ceramic Cyldon 350 mmfd. Tuning Condenser incorporating slow motion dial ... 7/6
 Ceramic Compression Trimmers, 250, 450, 750 mmfd. and double 100 mmfd. U.L.C. Trimmers and Fixed Condensers. All values available.
 Aerovox 40 mfd. 200 volt Condensers for Midset Receivers ... 6/6
 Dubilier 1 6,000 volt working ... 6/-
 First Grade NSF Tubular Condenser, .1 and .01 mfd. (350 volt) ... 6d.

- MORSE PRACTICE**
 Battery-operated audio oscillator type BL works on 2 volts only ... 27/6
 Streamline Metal Key, U.S.A. pattern 8/6
 G.P.O. Bar Type Practice Key ... 3/6
 G.P.O. Bar Type Keys, first grade finish (2 contacts) ... 17/6
 G.P.O. Bar Type Keys, first grade finish (3 contacts) ... 22/6
 G.P.O. Bar Type Heavy Duty Operating Key (3 contacts) ... 28/6

- MICROPHONES**
 Rothermel—Brush D.104 Crystal 25/5/-
 Rothermel—Brush D.104 Crystal with control switch handle ... 26/6/-
 Rothermel—Brush D.104 lapel Crystal 22/10/-
 Rothermel—Brush Crystal on heavy desk stand (best quality) ... 25/0/-
 Moving Coil, highest quality with transformer ... 25/5/-
 Microphone Stands for M.C. Mike 22/2/-

- MISCELLANEOUS ITEMS**
 Push Back Insulated Flex (single) doz. yds. 1/-
 Screened Braided Wire (finest quality) per yard 9d.
 Resistance Cord for A.C./D.C. Receivers (100 ohms per ft.) ... per ft. 2/-
 Potentiometers and volume controls—all usual values from stock at ... 4/6
 Midret type Centralb at ... 5/-
 Collapsible Microphone Stands ... 42/-
 4-in. Permanent Magnet "Rola" Loud Speakers ... 18/9
 Goodman 8-in. Permanent Magnet Output Transformers for above, tapped triode and pentode ... 5/6
 A.C. Battery Chargers, output 2, 6 and 12 volts 1 amp. ... 45/-

- AMPLIFIERS**
 One of our specialities—High Fidelity Amplifier Equipment and Components. Linear response input and output transformers.
 Complete amplifiers:
 Webb's 30-watt A.C. operated ... 230
 Webb's 30-watt battery-operated ... 230
 (Both include microphone)

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

WEBB'S RADIO, 14 Soho St., Oxford St., London, W.1 Telephone GERRARD 2089
 Open 9 a.m. to 4 p.m. Sats. 9 a.m. to 12 noon

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

- FUSES.** 1 amp. tubular type, 3d. each.
VALVE HOLDERS. U.S. type, 4 and 7 pin, 6d. each. 5 and 7 pin English, 8d. each. Mazda octal, 8d. each. All chassis mounting. 4 pin baseboard type, 3/- doz.
REACTION CONDENSERS. .0003 mfd. 6d.
MICA CONDENSERS. All values. 12 assorted. 5/- Our selection.
VOLUME CONTROLS. Ideal for servicemen. 6/- doz.
ELECTROLYTICS. 8 mfd., 12 mfd., 16 mfd., 8 x 4, etc. Tubular type. Not wet. Our price to clear, £1 per doz. Our selection.
3 WAVE BAND DIALS. Glass, in very nice colours. Complete with backplate. 2/-
ERIE RESISTORS: 2 watt. 330 and 600,000 ohms. 1/- each. 10/- doz.
TUBULAR CONDENSERS. .02, .001, .0002, .0005, .005, .0001, .0003. All 6d. each. Metal-cased, 0.25 mfd. 1,000 v. working. 1/6. T.C.C., 50 x 12, 1/6 each.
RESISTORS. 1 watt. 500 ohms., 7,000 ohms., 12,000 ohms. 3/- doz.
METER RESISTORS. Correct to 1 ohm. 400 ohms. 7d. each.
SPECIAL OFFER. H.T. Eliminator Transformers, 220 v. input, 150 v. output. 15/- each.
MORSE KEYS. Ideal for practice. 3/6
SPEAKER TRANSFORMERS. Pentode output only. 5/- each.
 Regret No. C.O.D. Please Add Sufficient Cash to Cover Postage.
RELIANCE RADIO SERVICE, 8, Kennington Park Road, S.E.11.

GALPIN'S ELECTRICAL STORES.
SHEET EBONITE, size 12in. by 11in. by 1/32in., best quality. Price 4/- per doz., post free.

ELECTRIC LIGHT CHECK METERS, well-known makers, first-class condition, electrically guaranteed, for A.C. mains 200/250 volts 50 cy. 1 phase 5 amp. load, 10/- each; 10 amp. load, 12/6, carriage 1/-.
AUTO TRANSFORMER, 1,500 watts, tappings 0-110-200-220 and 240 volts for step-up or step-down. Price 25, carr. pd.
ROTARY CONVERTOR, D.C. to D.C.; input 220 volts D.C.; output 12 volts at 50 amps. D.C., ball bearing, condition as new. Price £10, carriage forward, or 17/6 passenger train.

ALTERNATOR, output 220 volts, 1ph., 50 cycles at 180 watts, will give 1 amp. easily, speed 3,000 r.p.m.; self-exciting, condition as new. Price £8, carriage forward, or 15/- passenger train.

TRANSFORMER, input 230 volts, 50 cycles, 1 ph.; output 1,100-0-1,100 volts at 220 milliamps, and 6 volts C.T. three times, earth screen, wound to B.S.R., weight 32 lbs. Price £6, carriage passenger train 7/6.

MOVING COIL METERS, high grade, 2in. dia., flush mounting, reading 0-50 milliamps. 50/- post free.

110 V. D.C. KLAXON MOTORS, precision made, ball bearing, variable speed, approx. 1/10th h.p., laminated fields, as new. Price 30/- each, post free.

MOTOR BLOWER, 110 volts, D.C., 6in. dia. inlet and outlet, 1-h.p. motor, condition as new, portable lightweight, 1,800 r.p.m. Price £7, carriage paid.

SEARCH OR FLOODLIGHT, 20in. dia., on swivel stand, Mangin mirror reflector, fitted G.E.S. lamp holder. Price £7/10/-, carriage forward.

ROTARY CONVERTOR, D.C. TO A.C., no name plate or particulars, estimated rating 220 volts, D.C. input, 150 volts A.C. output at 1,000 watts, condition as new. Price £10, carriage forward.

LOUD RINGING BELLS, working on 20 volts D.C., 3in. dia. gong (bell metal), plated, waterproof, absolutely as new. Price 30/-, carriage 2/-.

(Continued top of next page.)



3-v. RECEIVER
 Complete Kit of Parts for building 3-valve receiver. S.G. DET.-OUT-PUT. Includes valves, chassis (size overall with components mounted, 12in. x 8in. x 7in.), P.M. speaker, all components wiring, etc., with circuit.
 BATTERY £4 12 6
 BATTERY ALLWAVE 25 12 6
 A.C. £6 10 0
 Less batteries and cabinet. (Regret no cabinets available.) Carr. Paid.

MAINS TRANSFORMERS. 350-0-350 v. 80-100 m.a. 4 v. 4a., 4 v. 2a., input 200-250 v. A.C. 25/- each.

VARIABLE CONDENSERS. 2-gang, standard type, ceramic insulation. Brand new, 7/6 each.

CHASSIS. Brand new metal chassis, undrilled, finished in battleship grey, size 10 1/2" x 8 1/2" x 2 1/2", 4/6 each.

SCREENED COILS. Phillips dual range aerial coils (no reaction), with air-space trimmers, circuit 1/6.

SHORT-WAVE DOUBLE-WOUND FILAMENT CHOKE, 1/-
TAPPED MAINS DROPPING RESISTANCES, approx. 800 ohms, standard for Pye, Lissen, etc., 2 amp., 3/6.

RESISTORS, different values, 3-watt, 4d., 1-watt, 6d., 1-watt, 1/-.
SCREENED VALVE CAPS, 6d. each.

2-v. RECEIVER
 Economy Local Station Quality: Receiver very efficient and reliable. Complete kit of parts, including: P.M. Speaker, B.V.A. valves, circuit. wiring and all components.
 BATTERY £3 15 0
 A.C. £3 10 0
 Less batteries and cabinet. (Regret no cabinets available.)
 CARRIAGE PAID.

TUBULAR CONDENSERS, T.C.C. or B.1. X.L. 0.0001, 0.0002, 0.0003, 0.0005, 0.005, 0.0015, 8d.; 0.01, 0.02, 0.1, 8d.; 0.25, 1/3; 0.5, 2/-.
 Tubular Electrolytics, 25 mfd. 25 v., 2/-; 75 mfd. 12 v., 2/-; 50 mfd. 12 v., 1/6.

MICA CONDENSERS, 30 mmfd. and 0.0005 and 0.0001, wire ended, 8d.

VALVE HOLDERS, English chassis type, 4-pin 6d.; 5-pin and 7-pin, 6d.; English Octal, 6d.; American U.N. type, 4-, 5-, 6-, and 7-pin, and International Octal, 6d.

OCTAL CABLE PLUGS AND SOCKETS, 1/6 complete.
GROUP BOARDS & TERMINAL STRIPS, ASSTD., 3d., 1/- each.

Speakers and Mains Transformers will shortly be available in small quantities. Please send us your enquiries.

Kit Sets made up to your own specification or to conform with "Practical Wireless" blueprints. (Alternative components will be sent where original specifications are not available.)

HOURS: 9-6 p.m. Saturdays, 1 p.m. C.O.D. orders accepted, prices subject to alteration without notice; special terms to members of H.M. Forces and Civil Defence workers; licence to export to Northern Ireland and Irish Free State; please add postage for enquiries and mail orders.

We supply kits to your specification.
51-52 CHANCERY LANE
 LONDON, W.C.2. Telephone HOLBORN 4551

ROTARY CONVERTER, D.C. to A.C., input 35 v. at 16 amps. D.C., output 24 volts, 100 cycles, speed 3,000 r.p.m., 4 pole, ball bearings, condition as new. Price **£5**, carriage paid.

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

X-RAY TRANSFORMER, output 45,000 volts at 5 k.v.a. constant rating, 50 cycle, single phase, input tapped for 70, 105, 150, 200, 220 and 240 volts, oil-filled tank. Price **£30**, carriage paid.

D.C. MOTORS, 110v. and 220v., approx. 1/10 h.p., series wound, in perfect working order. Price 12/8 each, carriage 1/-. Please state voltage required.

HEAVY DUTY CABLE, V.I.R., and braided, in first-class condition, size 37/13, lengths 30 to 40 yards. Price by the length 6/- per yard, carriage forward, or 8/- per yard for short lengths, carriage paid.

200 AMP. SWITCH FUSE, three-way. Ironclad, unused, 400 volt, size overall 30in. x 12in. x 12in., maker E. N. Bray, Ltd. Price **£6**, carriage forward.

THREE-PHASE TRANSFORMER, core size 2 1/2 in. by 1 7/8 in., each pole area 7 1/2 sq. in., each pole double wound D.C.C. copper ribbon, rating not marked, condition first class, weight approx. 2 1/2 cwt. Price **£10**, carriage forward.

110V. D.C. MOTOR, compound wound, 1/2 h.p., 2,200 r.p.m., ball bearing, condition as new. Price **£3/15/-**, carr. paid.

GALPIN'S ELECTRICAL STORES, 21, WILLIAM STREET, SLOUGH, BUCKS.

Phone: Slough 20855.

Terms: Cash with order.

FRED'S RADIO CABIN.

FUSES, glass, 1 1/2 inches long, 2 amp. and 1 1/2 amp., 3/- doz.

MAINS DROPPERS, 0.2 amp., Pye, 3/6.

MICROPHONES. Complete with transformer. Solid ebonite job, full instructions included. New line, 6/- each.

TRIMMERS. 100 m.mfd. small type on paxolin base, 4d. each, 3/9 dozen. New.

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

TRIMMERS, straight line type, capacity 2.35 m.mfd., 6d. each.

SPEAKER GRILLES, 7in. x 3 1/2 in. Chromium plated, cheap to clear, 1/6 each.

GRID LEAKS, 1 1/2 meg. wire ends. 4d.

SUPERHET CONDENSERS. Three-gang, .0005 mfd., 1/3 each.

EKCO mains twin filter chokes. 1/6 each.

CRYSTAL and Catwhisker in metal box. New stock at low price of 6d. each.

SLEEVING. 3 1/2d. per yard length. 1 doz. lengths, 3/-. Braided sleeving 8d. per yard length, 7/- doz. lengths.

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

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

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

MICROPHONE Inserts, ex G.P.O., 2/3.

MORSE KEYS on polished solid oak base, exactly as supplied to the Air Training Corps, etc., 4/6 each.

CRYSTAL Detectors, permanent type, 1/6.

STANLGO Electric Soldering Irons. Made by Standard Telephones, with special bit for radio service work. 21/- each. Also "Solon" irons, new, 13/- each. Resin-cored solder, 4/- lb. reel.

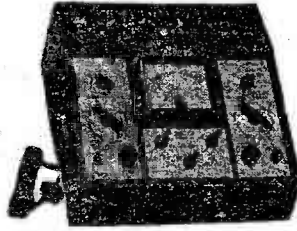
METAL Spade Tags, 3d. dozen.

T.C.C. Electrolytics, 50 mfd., 12 volt working, 1/3 each.

CONDENSERS. "Plessey" 4-gang, screened, 6 1/2" x 3 1/2", 4/6, 3-gang 6 1/2" x 3 1/2" unscreened, 2/6. "Utility" 3-gang

(Continued top of column 3.)

TAYLOR MUTUAL CONDUCTANCE VALVE TESTERS



Robust, compact and accurate test instruments.

This instrument provides a quick and accurate measurement of Mutual Conductance of practically every type of British and American valve. Tests are also provided for Cathode Leakage, Electrode Shorts, Filament Continuity and Diode and Rectifier Emission.

MODEL 45
£15:15:0

Taylor Valve Testers are supplied with a book of instructions, including wiring diagram, a valve chart covering over 1,000 types of valves, and a grid connecting lead.

Taylor Electrical Instruments Ltd.
419/422, Montrose Avenue, Slough, Bucks.
Telephone: Slough 21381.

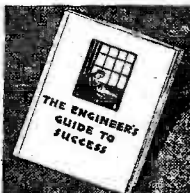
AUTHORITATIVE ENGINEERING TRAINING

**32 FIRST PLACES
and Hundreds of Passes
were gained by T.I.G.B.
students at recent examinations
for A.M.Inst.C.E.,
A.M.I.Mech.E., A.M.I.E.E.,
A.F.R.Ae.S., C. & G., etc.**

Write to-day for "The Engineer's Guide to Success," containing world's widest choice of home-study engineering courses—Wireless, Television, Electrical, Mechanical, Aeronautical, Automobile, Building, Civil, Chemical, Gas, etc., and which alone gives the Regulations governing admission to the Recognised Engineering Institutions. Mention branch, post or qualification that interests you. The T.I.G.B. guarantees training until Successful for the one fee.

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

(Founded 1917.
20,000 Successes.)



World's best choice of
Courses in Engineering

.0005 mfd. straight, screened, 5 1/2" x 3 1/2", 4/-.. All brand new and include trimmers. Fine geared drive, about 50-1.0005 mfd. straight, 3-gang for flexible or direct drive, 4/6.

TRIMMERS. 4 on bank 1-4,000 m.mfd., 9d. each.

TRANSFORMERS for laminations only, 3" x 2 1/2", 1/6.

WANDER-PLUGS. Red and black, 1/3 doz.

CHASSIS. Drilled for 3 v. 7" x 7" x 2 1/2", 1/3.

KNOBBS. 2 1/2" Brown Bakelite 1" spindle, 2 grub screws, 1/-.

Postage must be included. No C.O.D.

FRED'S RADIO CABIN FOR BARGAINS, 75, Newington Butts, S.E.11. Rodney 2180-
New branch at 17, Hamilton Parade,
London Road, North Chesham, Surrey.

GEE GEE GEE GEE GEE GEE
15, LITTLE NEWPORT STREET, W.C.2.

AMERICAN & B.V.A. VALVES. Many types available. Send requirements for quotation.

MAINS TRANSFORMERS. Brand new, 300-0-300, 120 m.a. 4 v. and 4 v., also similar giving 6.3 v. and 5 v. output. 21 each. Also, superior quality 4 v. 6 amp. and 4 v. 2 1/2 amp. 150 m.a., 25/-.. Include 9d. extra for carriage.

MAINS DROPPERS. .2 amp., suitable for Milsen, Pye, etc., brand new, 3/9 each, also 3 amp. for Decca, Ferranti, Maestro, brand new, 5/6 each.

TUBULAR CONDENSERS. 50 mfd. 12 v. working, brand new, 1/- each.

PENTODE Output speaker transformers, brand new, reduced price, 5/- each.

T.C.C. TUBULAR CONDENSERS. .1 mfd., 9d. each, 8/- dozen.

I.F. TRANSFORMERS, brand new, 465 kc. iron core, absolutely first class, 9/- pair. Also suitable 5 wave band coil packs. Complete assembly, including switch, condensers, trimmers, etc., but less switch rod. Brand new, ready for connection, 20/-.

STAMPED Envelope must accompany all enquiries.

GEE ELECTRIC, 15, LITTLE NEWPORT STREET, W.C.2. GERRARD 6794.

TUITION

LEARN MORSE CODE the Candler way. See advertisement on page 28.

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

PRACTICAL Postal Radio Courses, coaching for I.P.R.B. exams and post-war appointments: booklet free.—Secretary, I.P.R.B., Bush House, Watfon Avenue, Henley-on-Thames.

WANTED

WANTED. 18 S.W.G. Enamelled Copper Wire. Sample, price, quantity available, to Bain, 15, Dragon Road, London, S.E.15.

WANTED, American Valve, HYTRON BANTAM 50. L. G. G.T. New, if possible. —Westoby, 24, Laurel Ave., Langley, Bucks.

WANTED, Buy or loan Blueprint and Instructions Book for Mains S.T. 600.—Phuces, 9, Whitehill Rd., Brinsworth, Rotherham.

WANTED. "Electrical Measurements," by "Golding," 1940 ed. Generous price.—Eales, 145, Wicklow Drive, Leicester.

PRACTICAL WIRELESS, dated Oct. 31st, 1937, and blue print of S.T.900.—Cope, 51, St. Johns Road, Chelmsford.

Practical Wireless BLUEPRINT SERVICE

PRACTICAL WIRELESS Vol. 11
No. of June, 1940

CRYSTAL SETS
Blueprints, 6d. each
1937 Crystal Receiver PW71
The "Junior" Crystal Set PW74

STRAIGHT SETS
One-valve : Blueprint, 1s. each
All-Wave Universal Receiver PW31A
Bestial's One-valver PW36

Two-valve Blueprints, 1s. each
The "Aurora" PW72
The "Aurora" PW76
The "Aurora" PW76

Three-valve Blueprints, 1s. each
The "Aurora" PW76
The "Aurora" PW76
The "Aurora" PW76

Four-valve Blueprints, 1s. each
The "Aurora" PW76
The "Aurora" PW76
The "Aurora" PW76

Five-valve Blueprints, 1s. each
The "Aurora" PW76
The "Aurora" PW76
The "Aurora" PW76

SIX-VALVE BLUEPRINTS, 1s. each
The "Aurora" PW76
The "Aurora" PW76
The "Aurora" PW76

SEVEN-VALVE BLUEPRINTS, 1s. each
The "Aurora" PW76
The "Aurora" PW76
The "Aurora" PW76

EIGHT-VALVE BLUEPRINTS, 1s. each
The "Aurora" PW76
The "Aurora" PW76
The "Aurora" PW76

NINE-VALVE BLUEPRINTS, 1s. each
The "Aurora" PW76
The "Aurora" PW76
The "Aurora" PW76

TEN-VALVE BLUEPRINTS, 1s. each
The "Aurora" PW76
The "Aurora" PW76
The "Aurora" PW76

ELEVEN-VALVE BLUEPRINTS, 1s. each
The "Aurora" PW76
The "Aurora" PW76
The "Aurora" PW76

Twelve-valve Blueprints, 1s. each
The "Aurora" PW76
The "Aurora" PW76
The "Aurora" PW76

Thirteen-valve Blueprints, 1s. each
The "Aurora" PW76
The "Aurora" PW76
The "Aurora" PW76

Fourteen-valve Blueprints, 1s. each
The "Aurora" PW76
The "Aurora" PW76
The "Aurora" PW76

Fifteen-valve Blueprints, 1s. each
The "Aurora" PW76
The "Aurora" PW76
The "Aurora" PW76

F. J. Camm's A.C. Superhet 4 PW50
F. J. Camm's Universal 24 Super-
het 4 PW40
"Qualitone" Universal Four PW73
Four-valve : Double-sided Blueprint, 1s. 6d.
Push Button 4, Battery Model 22.10.38 PW95
Push Button 4, A.C. Mains Model

SHORT-WAVE SETS Battery Operated.
One-valve : Blueprint, 1s.
Simple S.W. One-valver PW88
Two-valve : Blueprints, 1s. each
Midget Short-wave Two, (D, Pen) PW38A
The "Fleet" Short-wave Two
(D (HF Pen), Pen) PW91
Three-valve : Blueprints, 1s. each
Experimenter's Short-wave Three
(SG, D, Pen) PW30A
The Prefect 3 (D, 2 LF (RC and
Trans) PW63
The Band-Spread S.W. Three
(HF Pen, D (Pen), Pen) PW68

PORTABLES
Three-valve : Blueprints, 1s. each
F. J. Camm's E.L.C. Three-valve
Portable (HF Pen, D, Pen) PW65
Parvo Flyweight Midget Portable
(SG, D, Pen) PW77
Four-valve : Blueprint, 1s.
"Tiny D" Portable 4 (D, LF, LF
(Pen)) PW86

MISCELLANEOUS
Blueprint, 1s.
S.W. Converter-Adapter (1 Valve) PW48A

AMATEUR WIRELESS AND WIRELESS
MAGAZINE
CRYSTAL SETS.
Blueprints, 6d. each.
Four-station Crystal Set. AW427
1934 Crystal Set. AW444
150-line Crystal Set. AW450

STRAIGHT SETS. Battery Operated.
One-valve : Blueprint, 1s.
B.B.C. Special One-valver AW387
Two-valve : Blueprints, 1s. each.
Melody Ranger Two (D, Trans) AW388
Full-volume Two (SG det., Pen) AW392
A Modern Two-valver WM409
Three-valve : Blueprints, 1s. each.
25.75 S.G. 3 (SG, D, Trans) AW412
Lucerne Ranger (SG, D, Trans) AW423
25.38. Three : De Luxe Version
(SG, D, Trans) AW435
Transportable Three (SG, D, Pen) WM397
Simple-Tune Three (SG, D, Pen) WM397
Economy Pentode Three (SG, D
Pen) WM397
"W.M." 1934 Standard Three
(SG, D, Pen) WM361
23.38. Three (SG, D, Trans) WM364
1935 25.68. Battery Three (SG,
D, Pen) WM371
PTP Three (Pen, D, Pen) WM389
Ovaloid Three (SG, D, Pen) WM393
Miniature Three (SG, D, Trans)
All-Wave Winning Three (SG, D,
Pen) WM400

Four-valve : Blueprints, 1s. 6d. each.
25.75 S.G. 3 (SG, D, RC, Trans)
Self-contained Four (SG, D, LF,
Cl. B) WM331
Lucerne Straight Four (SG, D,
LF, Trans) WM350
25.38. Battery Four (HF, D, 2LF)
The H.K. Four (SG, SG, D, Pen)
The Auto Straight-Four (HF, Pen,
HF Pen, DDT, Pen) WM404
Five-valve : Blueprints, 1s. 6d. each
Super-quality Five (2 HF, D, RC,
Trans) WM320
Class B Quadradyne (2 SG, D, LF,
Class B) WM344
New Class B Five (2 SG, D, LF,
Class B) WM340

Mains Operated.
Two-valve : Blueprints, 1s. each
G.S. Electric Two (D, Pen) A.C.
Economy A.C. Two (D, Trans) A.C.
Three-valve : Blueprints, 1s. each
Economy New All-Electric
Three (SG, D, Trans) A.C.
Economy A.C. Three (HF, Pen,
HF Pen, Pen) WM37
42.5.1935 A.C. Radiogram
(HF Pen, Pen) WM4
Four-valve : Blueprints, 1s. 6d. each.
A.C. Mains Four (SG, D, Pen)
Mains De Luxe Radiogram (HF,
Pen D, LF, Pen) WM1

SUPERHETS.
Battery Sets : Blueprints, 1s. 6d. each.
"Mars" Four W
The Request All-Waver W

PORTABLES
Four-valve : Blueprints, 1s. 6d. each.
Holiday Portable (SG, D, LF,
Class B) AW393
Family Portable (HF, D, RC,
Trans) AW447
Tyers Portable (SG, D, 2 Trans) WM307

SHORT-WAVE SETS. Battery Operated.
One-valve : Blueprints, 1s. each.
S.W. One-valver for America P.W.15.10.38 AW429
Roma Short-Waver AW452
Two-valve : Blueprints, 1s. each.
Ultra-short Battery Two (SG, det
Pen) WM402
Home-made Coil Two (D, Pen) AW440
Three-valve : Blueprints, 1s. each.
Experimenter's 5-metre Set (D,
Trans, Super-regen) AW438
The Carrier Short-waver (SG, D, P)
..... WM390
Four-valve : Blueprints, 1s. 6d. each.
A.W. Short-wave World-champion
(HF, Pen, D, RC, Trans) AW436
Empire Short-waver (SG, D, RC,
Trans) WM313
Standard Four-valver Short-waver
(SG, D, LF, P) WM383
Superhet : Blueprint, 1s. 6d.
Simplified Short-wave Super WM397

These Blueprints are drawn full size.
Copies of appropriate issues containing descriptions of these sets can in some cases be supplied at the following prices which are additional to the cost of the Blueprint. A dash before the Blueprint Number indicates that the issue is out of print.

Practical Wireless (issues dated prior to June 1st, 1940) 4d. Post Paid
(Issues dated June 1st to July 27th, 1940) 6d. Post Paid
(Issues dated September, 1940, to November, 1941) 7d. Post Paid
(Issues dated December, 1941, and after) 10d. Post Paid

Amateur Wireless 4d. ..
Wireless Magazine 1/4 ..
The index letters which precede the Blueprint Number indicate the periodical in which the description appears: Thus P.W. refers to PRACTICAL WIRELESS, A.W. to Amateur Wireless, W.M. to Wireless Magazine.

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

Mains Sets : Blueprints, 1s. each.
Heptode Super Three A.C. WM359

PORTABLES
Four-valve : Blueprints, 1s. 6d. each.
Holiday Portable (SG, D, LF,
Class B) AW393
Family Portable (HF, D, RC,
Trans) AW447
Tyers Portable (SG, D, 2 Trans) WM307

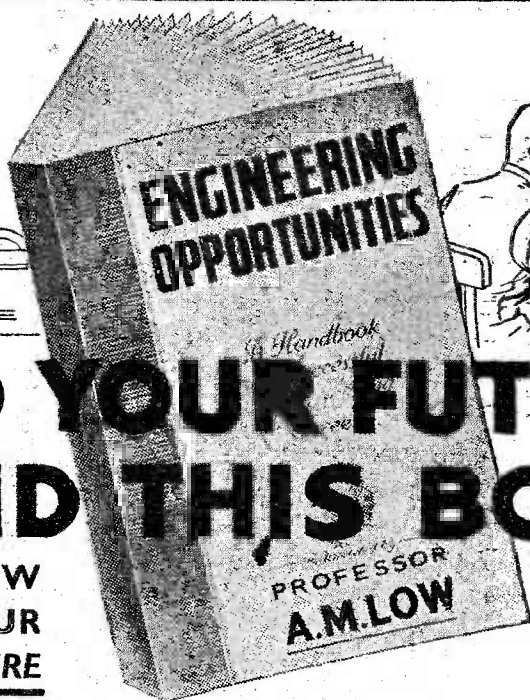
SHORT-WAVE SETS. Battery Operated.
One-valve : Blueprints, 1s. each.
S.W. One-valver for America P.W.15.10.38 AW429
Roma Short-Waver AW452

Two-valve : Blueprints, 1s. each.
Ultra-short Battery Two (SG, det
Pen) WM402
Home-made Coil Two (D, Pen) AW440
Three-valve : Blueprints, 1s. each.
Experimenter's 5-metre Set (D,
Trans, Super-regen) AW438
The Carrier Short-waver (SG, D, P)
..... WM390
Four-valve : Blueprints, 1s. 6d. each.
A.W. Short-wave World-champion
(HF, Pen, D, RC, Trans) AW436
Empire Short-waver (SG, D, RC,
Trans) WM313
Standard Four-valver Short-waver
(SG, D, LF, P) WM383
Superhet : Blueprint, 1s. 6d.
Simplified Short-wave Super WM397

Mains Operated.
Two-valve : Blueprints, 1s. each.
Two-valve Mains Short-waver (1s.
Pen) A.C. AW453
Three-valve : Blueprints, 1s.
Emigrator (SG, D, Pen) A.C. WM352
Four-valve : Blueprint, 1s. 6d.
Standard Four-valve A.C. Short-
waver (SG, D, RC, Trans) WM391

MISCELLANEOUS
S.W. One-valve Converter (Price
6d.) AW529
Enthusiast's Power Amplifier (1/6
Littener's 5-watt A.C. Amplifier
(1/6) WM357
Radio Unit (2r.) for WM 392 (1/6)
Harris Electogram battery am-
plifier (1/6) WM398
De Luxe Concert A.C. Electro-
gram (1/6) WM359
New Style Short-wave Adapter
(1/6) WM388
Trickle Charger (6d.) AW402
Short-wave Adapter (1/6) AW456
Superhet Converter (1/6) AW457
E.L.D.L.C. Short-wave Converter
(1/6) WM405
Wilson Tone Master (1/6) WM406
The W.M. Short-wave Con-

All applications respecting advertisements in this Publication should be add
GEOURGE NEWNES, LTD., Tower House, Southampton Street, Strand, Lo



BUILD YOUR FUTURE ROUND THIS BOOK

IT TELLS HOW
TO MAKE YOUR
FUTURE SECURE

In the more competitive days of peace, technical training will be a vital necessity to the Engineer who wishes to safeguard his position and make advancement. "ENGINEERING OPPORTUNITIES" will show you how to secure this all-important technical training quickly and easily in your spare time. This 112-page book is full of valuable information and explains the simplest way of preparing for recognised Examinations. Among the courses described are:

A.M.I.Mech.E.

Inst. of Production Engineers.
Mechanical Engineering.
Draughtsmanship.
Tracing.
Works Management.
Jig and Tool Design.
Maintenance Engineering.
Diesels.
Inspection.

A.M.I.E.E.

City and Guilds.
Electrical Engineering.
Installations.
Electricity Supply.

A.M.I.C.E.

Civil Engineering.
Structural Design.

L.I.O.B.

Building Construction.
Clerk of Works.

A.F.R.Ae.S.

Air Ministry Licences.
Aeronautical Engineering.

A.M.I.A.E.

Repair Certificates.
Automobile Engineering.
Garage Management.

A.M.Brit.I.R.E.

Wireless.
Radio Servicing.
Television, etc., etc.

Special Courses for London Matriculation and R.A.F. Mathematics.

If you are earning less than £10 a week you cannot afford to miss reading "ENGINEERING OPPORTUNITIES." Write (or forward the coupon) for your copy of this enlightening guide to well paid posts NOW—FREE and post free.



**WE DEFINITELY
GUARANTEE**

Corps, etc.
CRYSTAL Detectors, permanent type, 1/6.
STANELCO Electric Soldering Irons.
Made by Standard Telephones, with special bit for radio service work. 21/- each. Also "Sofon" irons, new, 13/- each. Resin-cored solder, 4/- lb. reel.
METAL Spade Tags, 3d. dozen.
T.C.C. Electrolytics, 50 mfd., 12 volt working, 1/3 each.
CONDENSERS. "Plessey" 4-gang, screened, 61" x 31", 4/6, 3-gang 61" x 51" unscreened, 2/6. "Utility" 3-gang

(Continued top of column 3.)

BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY

409a, SHAKESPEARE HOUSE, STRATFORD PLACE, LONDON, W.1.

Please forward FREE and post free your 112-page handbook; "ENGINEERING OPPORTUNITIES."

Name
Street
City Address

Telephone
Post Office
211, BRITISH INSTITUTE OF ITS KIND IN THE WORLD House.

Printed by THE BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY, Limited, Tower House, Southampton Street, Strand, London, W.C.2, and
PRINTING CO., LTD., Exmoor Street, London, W.10. Sole Agents for Australia
(From 20,000) Africa: CENTRAL NEWS AGENCY, LTD. Subscription rates including postage:
Canada: Registered at the General Post Office for the Canadian Magazine Post.