Practical Wireless and PRACTICAL TELEVISION

11th YEAR OF ISSUE

EVERY MONTH
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Editor F. J. CAMM

COMMENTS OF THE MONTH BY THE EDITOR

The "Dangers" of Radio

WITHIN the past two months two people have been killed while making adjustments to wireless receivers. It followed as a natural corollary that the daily press gave prominence to these two incidents. We do not think it was their intention to frighten people, and the general public can take consolation from the thought that several million wireless sets are in use in this country for several hours every day and therefore the risk of accident is extremely small. However, two people have been killed, and these tragedies draw attention to the old adage that a little knowledge is a dangerous thing, especially when that little knowledge is applied to what can be a dangerous thing.

Now, a wireless set is in no sense more dangerous than a mangle, a bicycle, a motor-car, a motor-bicycle, a mincing machine, an electric clock or even a vacuum cleaner. Certain precautions must be taken with every piece of apparatus we use. Millions of men shave every day with a razor, but we have not yet heard of anyone accidentally cutting his throat. So the daily newspapers applying the principle that man bites dog is news, seizes upon these two isolated cases, makes scare headlines of them, and succeeds in creating a mild panic among a certain section of the public.

If you are uncertain of the subject it is unwise to tamper with a mains receiver, especially receivers of the A.C./D.C. type, where the chassis is often considerably above mains potential and can provide a shock at a pressure of 600 volts or so. Even when the set is switched off quite a nasty shock can be obtained from the higher capacity fixed condensers unless these are carefully discharged by shorting the terminals with a screwdriver.

In certain circumstances it is necessary to have the set switched on in order to locate a fault, and in such cases insulated pliers, long screwdrivers with insulated handles, and a pair of rubber gloves remove all possibility of shock to the person making the adjustment.

The newspaper reports may possibly have the effect of deterring a number of people from tampering with that which they do not understand, and this may benefit service engineers. During the war the number of skilled service engineers remaining in business is extremely small, and members of the public who have no wish to service their own receivers, provided that they can place the receiver in the hands of a reliable man, have been compelled to undertake their own repairs because of the unsatisfactory position of professional servicing. Some, indeed, of those posing as radio engineers (save the mark!) have been found to be thoroughly dishonest. In one case recently brought before the Plymouth City Magistrate, a radio repairer was charged with having in the course of 18 months stolen and sold over 12 radio sets belonging to customers. The police gave evidence that he had sold 81 of his customers' sets valued at £1,208 10s., component parts valued at £197 19s., and other property entrusted to him for repair to the value of £178 17s. 6d. When enquiries were made by customers or the police, the man concerned rebought some of the sets so that he could satisfy customers that he still had them in his possession. His excuse was that he could not obtain spare parts, and that the set had not been repaired. Only 12 of the 81 sets were in working order when recovered, as they had been stripped, and certain expensive components were lacking. For his pains he is now serving a sentence of 12 months—one month on each of the 12 charges.

Those who do not understand radio and in these circumstances are compelled to service their own receivers, should at least study an elementary textbook on radio and fault finding, such as those published from the offices of this journal, and thus ensure not only a satisfactory repair but that such repair is carried out without risk to themselves.

Electrical Industries Red Cross Appeal

THE donations to date have passed the £6,000 mark. The following letter has recently been issued:

"The Electrical Industries Red Cross Executive Committee, after careful consideration, do not propose to seek a successor to the late Lord Hirst as chairman of the combined appeal of the British Electrical Industries, believing that the chairman would have desired the campaign to continue without interruption.

"In his appeal, dated January 14th, 1943, Lord Hirst said: 'The object for which these funds are needed must commend itself to all of us.' 'All of us.'

"We must be frank: the appeal was addressed to 5,500 electrical firms and undertakings; 236 responded. 130 have presented donations totalling £5,886. 106 have signed the covenant for amounts aggregating £8,801 per annum.

"So far so good—but only so far.

"The committee is convinced that this great industry will do vastly better. They ask most earnestly—for immediate reconsideration in those cases where response to the first appeal was deferred—for immediate consideration.

"Both the Electrical Industries Committee and the Red Cross Organisation will be grateful for any contributions, large or small, but—much more important—the sick, the wounded and the lonely prisoners of war will be grateful.

"In our first appeal it was said: 'It is nothing less than our duty to support this great effort'—it might well have been 'our privilege.'"

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

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

The 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

Photo-facsimile Service

WITH the opening of the new photo-facsimile service between London and Cape Town, cable and wireless now has direct connections with seven cities for this radio-picture service. They are: Moscow, Melbourne, San Francisco, New York, Buenos-Aires, Cairo and Cape Town. New equipment is also to be installed at Bombay and Montreal.

Television in the U.S.A.

ALTHOUGH television in this country has been at a standstill since 1939, a bulletin recently received from the American G.E.C. shows that television transmission services for the American public are being continued. The Americans, while still able to maintain their television services, are experimenting with a view to discovering the ideal material for television.

Spare Parts Shortage

THAT bad distribution was the cause of the shortage of service spares, such as some types of valves and electrolytic condensers, was the opinion expressed at a recent council meeting of the Radio and Television Retailers Association. It was stated that complaints were being received daily from members, and the number of receivers held up for repair, on account of the shortage, was increasing. During the discussion it was also stated that persons who had no previous radio business appeared to be able to obtain supplies, while the established trade had smaller quantities, or sometimes none. The matter was considered of extreme importance, and various suggestions were made to enable the secretary to do everything possible to assist bona fide traders.

Behind the Lines in Burma

IN the early months of 1943, when the first "long range penetration group" drove far into the heart of Japanese-occupied Burma, behind the enemy's lines, radio was the only means of communication. The illustration on this page shows a signal section at work.

Radio Barrage

WE understand that German forces on the Continent are now being subjected to a nine-hour daily radio barrage by the Allies.

One of the most powerful Allied wireless stations, the "Voice of the United Nations," which is broadcasting from recently liberated French North Africa, has started a new service in German, particularly intended for German occupation troops in France.

New Static Eliminator

A COMPACT static eliminator, designed so that it can be adapted to any radio set, has been perfected in the Goodyear research laboratory at Akron. The new device, it is claimed, subdues static to a point where it no longer interferes with reception, and is expected to find immediate application on aircraft, warships and Army vehicles of all kinds.

Radio in a Wadi

THE B.B.C. has for some weeks broadcast a series of "Salute" programmes to the Fighting Forces in the Middle East. Each programme is dedicated to a well-known regiment and in many instances the band of the regiment plays the musical tributes. One such programme was devoted to the Grenadier Guards. In response to it, the following letter was sent to the conductor by an officer of one battalion:

". . . I must take this opportunity of thanking you, on behalf of us all for the excellent programme you put over to the Grenadiers in Africa in your recent broadcast.

The sole communication between the columns which penetrated into Burma behind the enemy's lines, and with the base, was by radio. Here is the signal section of the R.A.F. attached to a column, at work.

"The environment amid which I am writing this (a rather deep hole in Tunisia), does not make for comfort or happiness, but I shall never forget the expression on the faces of "B" Echelon as they sat around a receiver we managed to achieve and listened to the band of the regiment. The setting was good, no battles were in progress and one felt fairly safe in gathering a group in a little olive grove behind a slope of a wadi and letting them listen to you broadcasting from home. . . . I made up my mind then I would write and let you know personally how much it was enjoyed and what a kick it gave to everyone.

"Life is full of interests and excitements out here now, but as we steadily push on we feel we are getting nearer to the day when once again we shall have the honour of marching behind the band which it is your privilege to conduct and direct. . . ."

Proms. Break Records

THE first fortnight of the forty-ninth season of Promenade concerts broke all attendance records. An average of 5,000 people flocked to the Albert Hall nightly, and the sight of the vast audience was one of the most impressive in London. The splash of colour of the women's summer dresses; the floor packed with enthusiasts; eager music-lovers in the high gallery and top balcony; ambassadors and distinguished visitors in the boxes.

On June 23rd the Queen and Princess Elizabeth went to the Bach-Handel concert. At the Russian concert on July 1st the Russian Ambassador and Madame Maisky were present.

International Touch

EVERY night large numbers of men and women from the Forces, ours and those of our Allies, were drawn to the Albert Hall by the spell of great music, and the variegated uniforms added an internationa ltouch to the scene.

Familiar faces are seen night after night; many old habitués of the Queen's Hall are still faithful, but there was a growing number of newcomers, for in the main—and certainly in the popular-priced seats and on the "Promenade" proper—the audience was predominantly youthful. This is the source and secret of the vitality of this phenomenal institution. Year after year, retaining the friends of the past, it is renewed by the younger generation, who discover the beauties of the great masters' works and pass on their faith and love to those who follow them.

B.B.C. Calling the Forces

MEN and women on active service—whether in China, Burma, Iraq, North and West Africa, Canada, or anywhere else, are now able to hear broadcasts from London during 12¾ hours of the day.

The wavelengths of some of the new services are as follow:

North Africa and Gibraltar: 25.15 m., 25.29 m., 42.46 m.

West Africa: 16.84 m., 25.29 m., 31.25 m.

Near East and Eastern Mediterranean: 16.79 m., 19.82 m., 31.55 m.

Burma: 19.42 m., 25.53 m., 31.55 m.

India, Persia, Iraq: 16.84 m., 19.82 m., 25.68 m., 24.92 m., 19.60 m.

Radio "Repeats"

IN future, the pick of the B.B.C. programmes will be broadcast twice. Plays, features, variety, or musical productions may each be selected for "Repeat Performance," which are now heard on each Tuesday in the Home Service. Items will be chosen for second hearing on the basis of listeners' reactions, coupled with the programme directors' views.

Change of Address

AS from July 7th 1943, the address of the Incorporated Radio Society of Great Britain is changed to New Ruskin House, Little Russell Street, London, W.C.1.

Locating the Bombed by Radio

IT is reported that South Coast town rescue parties are using a novel device for locating bomb victims. The equipment consists of a compact frame, with two batteries, earphones, and a loudspeaker. Two victims were buried 6ft. under a pile of debris in a bombed street, and with this apparatus they were detected. The first victim tapped lightly with a pencil and was traced immediately; the other, breathing heavily, was found in five minutes.

Automatic S O S Signals

PATROLLING aircraft of Coastal Command are now dropping portable S O S transmitters in buoyant bags to shipwrecked seamen. The apparatus is about the size of a small coffee mill, and transmits a continuous S O S signal when the handle is turned. The apparatus was recently instrumental in locating, after five days, a lifeboat containing 19 survivors, which, due to bad weather, had been lost by the patrolling aircraft.

New Pacific Station

WE understand that a new international short-wave broadcasting station is being erected near San Francisco. The power will be 50 kW., and the station will operate on the following frequencies, which will be shared with stations WBOS and WKID: 6.06, 7.23, 9.57, 11.87, 15.29, 17.76 and 21.61 mc/s.

Japanese Transmitters

AN article in a German journal of recent date reviewing the expansion of broadcasting in the Far East, stated that Japan now operates more than 50 stations, with a total power of over 400 kW. Many of these stations are in occupied countries.

U.S. Radio Black-out

IT is reported that during air-raid alerts on the west coast of America a radio silence is now observed.

Interior of the wireless car which keeps in touch with the Tactical Air Force.

A Unique Battery-three

A Medium and Shortwave Receiver for Those Who Wish to Make Their Own Coils and Reduce Upkeep Costs.

By JOHN JAY

THIS battery-operated straight-three receiver is unusual as it has A.V.C., and gives reasonable loudspeaker strength with 60 volts for H.T., the total H.T. consumption being only 4 mAs (approximately) under signal conditions. The measured range of the receiver is 200-515 metres on the M.W. band and 19-50 metres on the S.W. section. The circuit diagram is shown in Fig. 1.

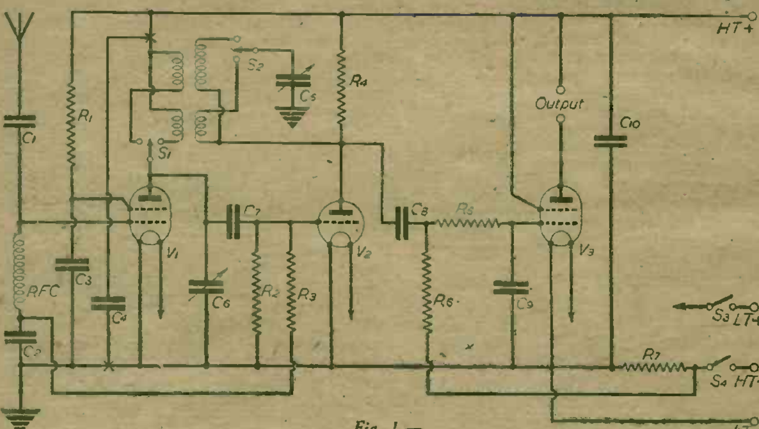


Fig. 1.—

C1	100 mmfd.	C6	.0003 mfd. variable	R1	25,000 Ω	R6	2 MΩ
C2	.1 mfd.	C7	50 mmfd.	R2	2 MΩ	R7	1,000Ω
C3	.01 mfd.	C8	.01 mfd.	R3	2 MΩ	V1	SG.210
C4	2 mfd.	C9	150 mmfd.	R4	150,000 Ω	V2	HL2
C5	.0002 mfd. variable	C10	2 mfd.	R5	250,000 Ω	V3	PT2

The use of only one set of coils and one tuning condenser is made possible by an aperiodic aerial circuit directly coupled to the R.F. amplifier input. The reaction control has proved to be quite smooth over the entire range of the receiver.

The R.F. amplifier is coupled to the detector's input via a 50 mmfd. condenser, which gives a considerable degree of selectivity.

Leaky or cumulative grid detection is employed, the biasing voltage from the detector being fed via a 2MΩ resistor to the grid/filament circuit of the R.F. amplifier to give a measure of A.V.C. The anode circuit of the detector is resistance-capacity coupled to the output-beam tetrode, which is tone-compensated by the use of a 150 mmfd. condenser across its input. Automatic bias is provided for the output valve. Decoupling of the biasing resistor and the H.T. supply is achieved by the use of a condenser of 2 mfd. minimum capacity; an 8 mfd. 150 volt working electrolytic condenser would be quite satisfactory here.

A 0.25 MΩ resistor for a grid stopper ensures that little R.F. feed to the output valve occurs.

Constructional Details

Figs. 2, 3, 4, 5 and 6 show the general constructional details, position of components, wiring, etc. It will be understood that a certain degree of flexibility exists to enable the constructor to suit his own requirements, i.e., whether he requires a "midget" receiver; the type of components available; whether the speaker, power supplies and chassis are to be fitted into a cabinet, etc. For the reasons given, changes in design may be made, but constructors are advised to adhere to the following points: Place the wavechange switch and coils as close together as possible to reduce the length of connections, and keep all connections to the R.F. amplifier anode and grid circuits, reaction and detector circuits as short as possible.

Note that C4 must be connected across the points shown in Fig. 1, to prevent the use of a high resistance path for the anode tuned circuit and thus to increase the receiver's stability.

The size of C1, the series aerial condenser, depends upon several variable factors, such as the proximity of the receiver to broadcasting stations, aerial length, and the degree of selectivity or sensitivity desired.

Coil Construction

The coils are wound on cardboard tubes 1in. in

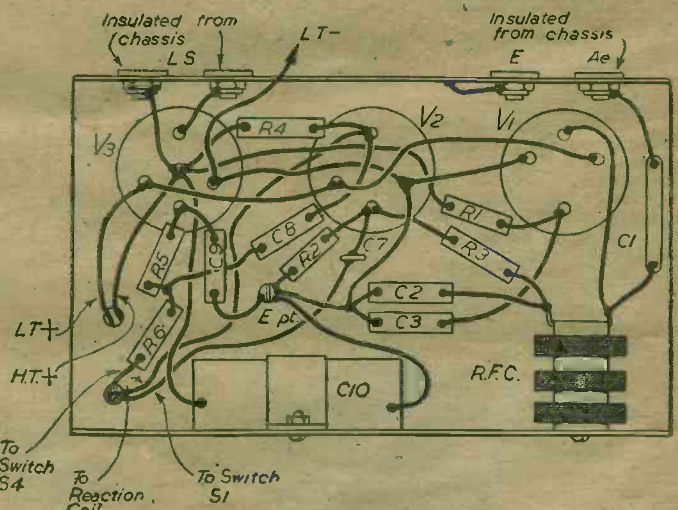
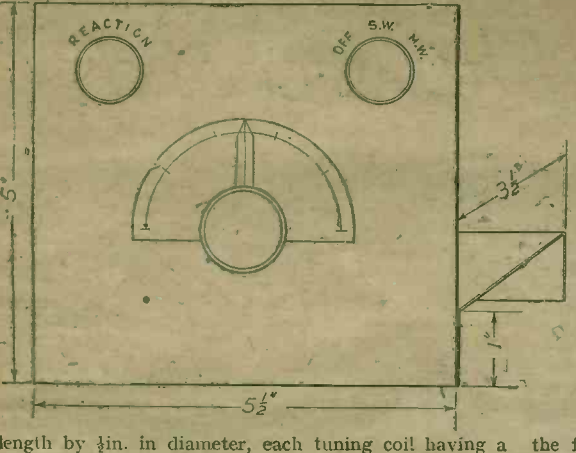


Fig. 2.—Underside of chassis showing wiring, etc.



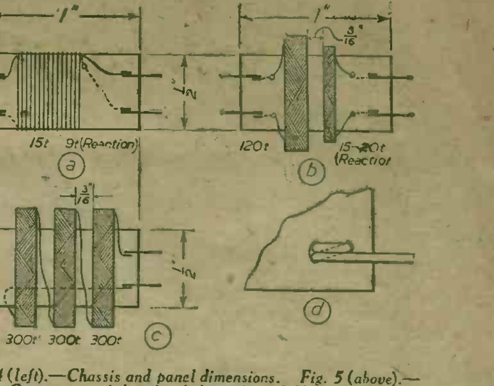


Fig. 4 (left).—Chassis and panel dimensions. Fig. 5 (above).—Constructional details of the coils and H.F. choke.

length by ½in. in diameter, each tuning coil having a tuning and reaction winding.

The shortwave coil, Fig. 5 (a), consists of 15 close turns of 24 S.W.G. enamelled wire for the tuning winding, with 9 turns of 38 S.W.G. double-silk-covered (D.S.C.) wire wound close to it for the reaction winding.

the frequency range of the receiver, and is designed with this point in view.

If it is possible to obtain suitable commercial coils of the dimensions required, the constructor is advised to do so, in as much that the efficiency of the coils is of extreme importance.

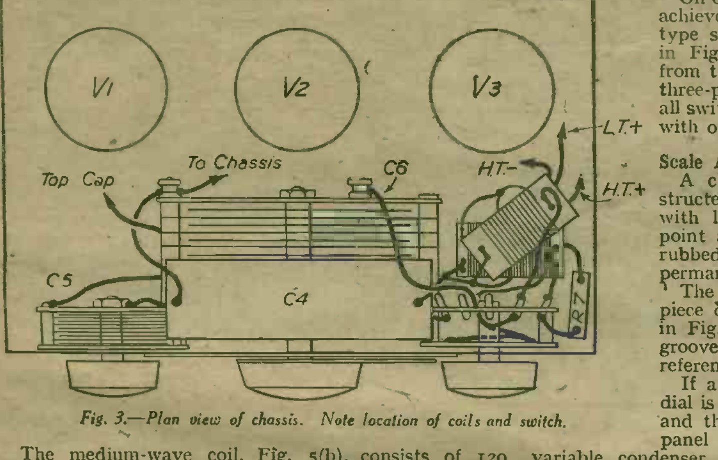


Fig. 3.—Plan view of chassis. Note location of coils and switch.

Switching

On-off and wavechange switching are achieved by the use of an Oak or Yaxley type switch, details of which are shown in Figs. 6(a) and (b). It can be seen from the illustration that four single-pole, three-position switches are required, if all switching operations are to be achieved with one control.

Scale Arrangements

A clear, accurate scale may be constructed from a piece of ivorine, ruled with lines by means of a sharp metal point and a steel ruler; if indian ink is rubbed into the grooves formed, clear, permanent markings are produced.

The pointer may be made from a piece of thick celluloid shaped as shown in Fig. 4, and having an indian ink-filled groove down its centre to act as a reference line.

If a suitable slow-motion drive or S/M dial is to hand, it can, of course, be fitted, and thus improve the appearance of the panel and simplify tuning. Provided a variable condenser is not substituted for C.1, it will not be a difficult matter to calibrate the tuning dial in wavelengths, or, at least, with the names of the stations most likely to be received.

The medium-wave coil, Fig. 5(b), consists of 120 turns of 38 S.W.G. D.S.C. wire for tuning with 15-20 turns of 38 S.W.G. D.S.C. wire for reaction.

The number of turns for the reaction windings may have to be increased or decreased to allow for slightly different capacities that the reaction circuit may have. The ends of the windings are soldered to pieces of stiff wire fixed to the coil former as shown in Fig. 5(d).

The high-frequency choke (H.F.C.) consists of approximately 900 turns of 38 S.W.G. D.C.C. wound in three banks upon a wooden former 1in. by ½in. diameter, as shown in Fig. 5(c).

The H.F.C. together with the aerial capacity must not resonate within

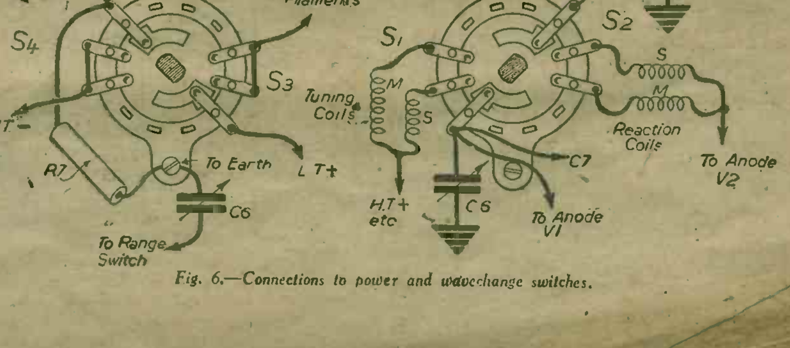


Fig. 6.—Connections to power and wavechange switches.

A Portable Record Amplifier

A front view of the portable record amplifier. Turntable has been removed to show position of valves.

Details of a Portable Gramophone and Amplifier for A.C. Operation

MANY designs have been published for amplifiers for use with a pick-up, but these usually entail the use of two or, more often, three units—(1) pick-up and turntable, (2) amplifier and (3) loudspeaker. This, however, is not always convenient, as it is somewhat cumbersome; therefore, with a view to combining the three component parts in one unit, the following design was produced.

The amplifier is not pretentious, but it gives enough output to fill quite a large room. The main problems involved were hum and obtaining correct tracking for the pick-up in a small space.

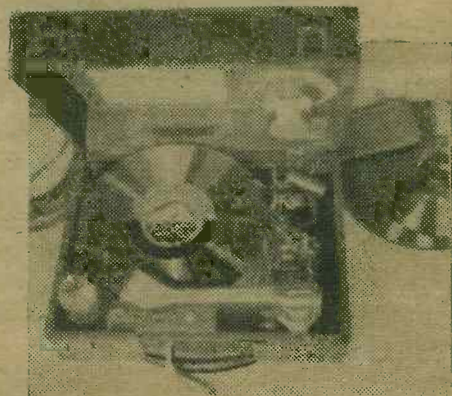
Considering the amplifier design, it will be seen to be quite orthodox (Fig. 1). The first valve is a general-purpose triode, a Mazda AC2/4L, and its input is taken from the moving arm of a half megohm potentiometer. The anode current of this valve is 2.5 mA. and it requires a bias of 1.2v.—but satisfactory results were obtained with a bias resistor of 1,000Ω, with which a 25μF electrolytic condenser was used for by-passing. The makers specify an anode load of 50,000Ω, the anode circuit being decoupled by a 0.2 μF condenser and a 20,000Ω resistor. This may seem inadequate at first, but these values have proved satisfactory. If, however, instability is experienced, increase the value of the condenser.

In order to save space, resistance-capacity coupling is used to link the two valves. It has been said that the values of coupling condensers and resistors should be calculated from the following time constant:

$$C \times R = .005,$$

where the values are expressed in micro-farads and megohms, but, by experiment, using a .5M.Ω resistor, it was found that a .05 μF was a most suitable value for C. This means the CR is .025, which is high, so that if you experience "top-cut" the value of C should be decreased to, say, .01 μF.

The next valve is a Mazda Pen 4H5. This is an output tetrode with pentode characteristics; it has a rating of 4.85 watts output. The anode current is 40 mA.



Another view of the amplifier, showing a record in playing position.

and the bias is 8.5v., and so using Ohm's Law to find the value of bias resistor:

$$Rg = {}^{Vg}/Ia \times 1{,}000 = \frac{8.5}{40} \times 1{,}000 = 212.5\Omega,$$

250Ω being a practical value. Another 25μF electrolytic condenser is used for by-passing the cathode resistor.

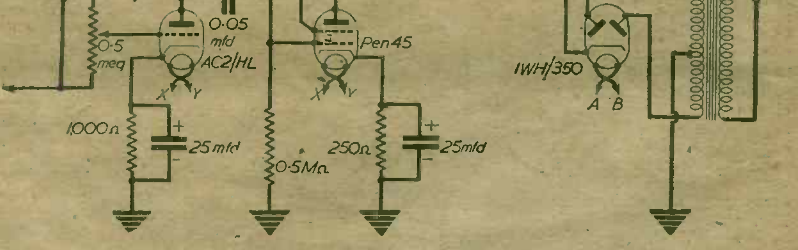


Fig. 1.—Theoretical circuit diagram.

The primary of the output transformer gives an inductive load for the output valve. The choice of transformer depends upon two things: (1) the optimum anode load of the output valve; (2) the impedance of the loudspeaker.

The optimum anode load for a Pen 45 is 5,200Ω, and the 5in. Rola speaker used has a 3 ohm. speech coil, so the output transformer ratio is:—

$$T=\sqrt{\frac{5200}{3}} = \sqrt{1733.3} = 41.62.$$

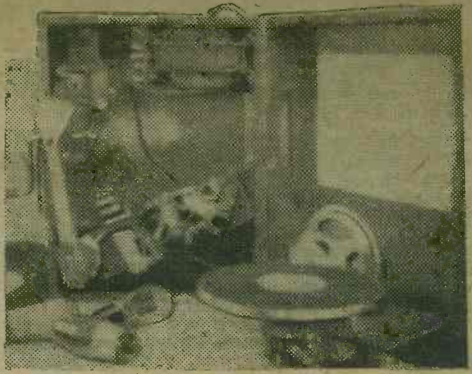
A ratio of 40 : 1 is therefore required, but this would have to be changed if a different valve or speaker is used.

Full wave valve rectification with a transformer is used in the power pack. The transformer has a 230v. input, with an output of 350-0-350 volts at 120 mA's; 4V, 1A and 4V, 2A. With this a Mullard IW4/350 was used. This is an indirectly heated full wave rectifier, giving 120 mA. maximum output.

Smoothing

Smoothing is carried out by the two electrolytic condensers of 8 μF and 16 μF, in conjunction with the energising field of an old speaker which serves the purpose of an L.F. choke. This gives a financial gain, if you have such a component to hand, and, as the D.C. resistance of a speaker field is round about 3,000Ω, it will drop the H.T. supply to a value suitable for the valve anodes.

Owing to the closeness of the components, bad 50 cycle hum was at first encountered. The usual dodges of earthing one side of the heaters, earthing the mains and output transformer chassis, and the motor and turntable were tried, but all without a major success. Eventually the trouble was overcome by mounting an H.F. choke over the output transformer, with a resistor of 2,000Ω in series, so as not to reduce the volume too much. This feeds back the 50 cycle hum out of phase with that present at the grid of the first valve, so that one cancels out the other. These two components are wired in parallel with the pick-up coil, but keep those grid leads short and don't forget to screen them.



A view of the amplifier with turntable and valves removed.

Mounting Components

The mounting of the components is clearly seen in Fig. 2 and photographs, but variations may be tried to suit your pick-up or cabinet. If the pick-up is mounted in the orthodox way, it will sweep over the amplifier chassis, which is the only area shallow enough to leave housing for the loudspeaker above when the lid of the cabinet is closed. In order to leave this space free, the pick-up is mounted in the front of the cabinet without interfering with the correct tracking of the particular type in use.

Although a 5in. Rola speaker is used, a larger model would be an improvement if space permits. There is enough spare room for several accessories, such as a small wire hook mounted next to the rectifier (see photograph (3)) so that the pick-up can be held in position by a rubber band or spring when the cabinet is being carried, and a clip for a needle-case, velvet polisher, etc.

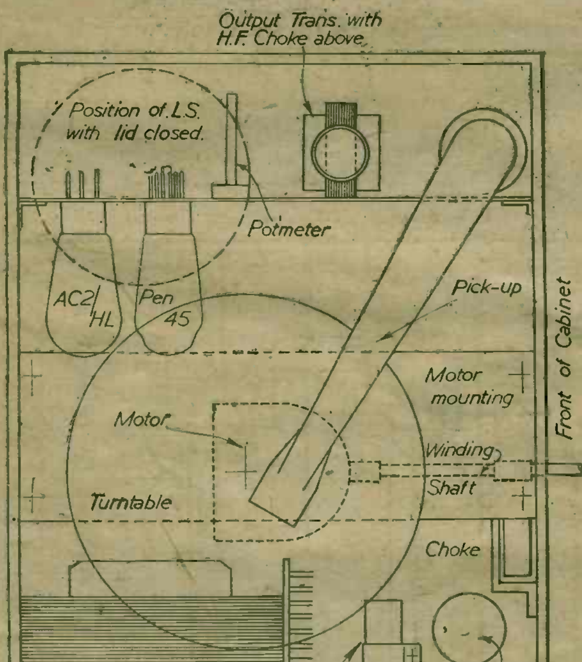


Fig. 2.—Plan view of the record amplifier, showing layout of components.

LIST OF COMPONENTS

- One gramophone cabinet, motor and turntable.
- One gramophone pick-up.
- One Mazda AC2/4L.
- One Mazda Pen 45.
- One Mullard IW4/350.
- One potentiometer .5 megohm.
- One fixed resistor 1,000Ω.
- One fixed resistor 20,000Ω
- One fixed resistor 50,000Ω.
- One fixed resistor 0.5 MΩ.
- One fixed resistor 250Ω
- One fixed resistor 5,000Ω
- One fixed resistor 2,000Ω.
- Two fixed condensers 25μF electrolytic.
- One fixed condenser 16μF+8μF electrolytic.
- One fixed condenser 0.2 μF.
- One fixed condenser 0.5 μF.
- One fixed condenser 0.05μF.
- One speaker field (D.C. resistance 3,000 Ω approx).
- One H.F. choke (200-2,000 metres).
- One mains transformer.
- One five-pin valveholder.
- One four-pin valveholder.
- One Mazda octal valveholder.
- One 5in. PM MC Rola speaker.
- One Output transformer, 40 : 1.
- One Chassis cut to fit cabinet.
- One reel of tinned copper wire.
- Three coils of systoflex.
- One length of braided screening cable.
- Nuts, bolts, wood screws, brackets, etc.

Frequency Modulation—3

FM Receiver: The Limiter and the Discriminator are Discussed in this Article

By F. E. SCALES, Assoc.Brit.I.R.E.

(Continued from page 359, August issue.)

IN the previous article we have discussed the operation of the "Reactance Modulator," and the method by which it enables FM transmissions to be produced.

The circuit given would need a little modification in actual practice for satisfactory results. In the first place, although it is highly desirable that the frequency should vary, it obviously should only vary when modulating voltages are applied. There are, unfortunately, other possible causes of frequency variation, and these must be eliminated as far as possible.

The usual precautions must be taken in the design of the components used in the oscillator, so that temperature variations etc., do not cause any appreciable change in the frequency of the oscillations. Also, it is much easier to design a stable oscillator to work on a fairly low frequency, and this is another reason why the oscillator will normally be working on a lower frequency than the final output frequency, and will be followed by frequency multiplier stages.

The H.T. supply on any oscillator has a marked effect on the frequency of the oscillations, and any fluctuations in the anode voltage will produce corresponding variations in frequency. Therefore, it is customary to stabilise the H.T. supply as far as possible, and in the simplest transmitters this is accomplished by connecting a neon stabilising valve between H.T. positive and H.T. negative where they are connected to the oscillator. (This is shown in Fig. 1.) In more elaborate transmitters, a separate crystal oscillator is employed in addition to the normal oscillator, and both are mixed together in such a way that if the main oscillator frequency drifts away from the crystal oscillator frequency, a bias is produced which is applied to the reactance modulator valve, and brings the oscillator back on frequency rather in the manner of an automatic tuning control.

The remainder of the transmitter will, more or less, follow normal lines, the only provision being that the response of the amplifier tuned circuits should be flat enough to give equal amplification over the range of frequencies through which the carrier deviates.

In some cases a device is included to prevent any changes in carrier amplitude resulting when modulation is applied, since it is difficult to design a modulator that does not introduce some amplitude variation when the frequency of the oscillator is varied.

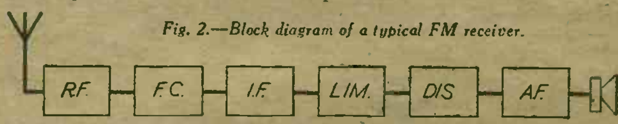


Fig. 2.—Block diagram of a typical FM receiver.

The Transmitter

The complete circuit of a simple transmitter is shown in Fig. 1. V2 is a normal Hartley oscillator operating on a frequency of 13 mc/s. The modulated output of this stage is applied to a frequency trebler valve V3, leak and condenser bias being provided. If the values of these components are chosen correctly, the valve will be biased beyond cut-off when in operation, and the desired harmonics produced. A fixed class C bias could be used as an alternative. The anode circuit of this valve (V3) will be tuned to 39 mc/s, which in this case is the final frequency. A higher frequency could be obtained by the use of additional frequency multiplying stages. The last valve (V4) is the power output stage and will be coupled to a suitable aerial system.

Modulation is effected by means of a reactance modulator valve (V1) and the circuit is similar to that already described. In order to obtain sufficient audio frequency voltage, a carbon microphone will be used in this particular case. Additional A.F. amplification would be required if a crystal or other low-sensitivity microphone were used.

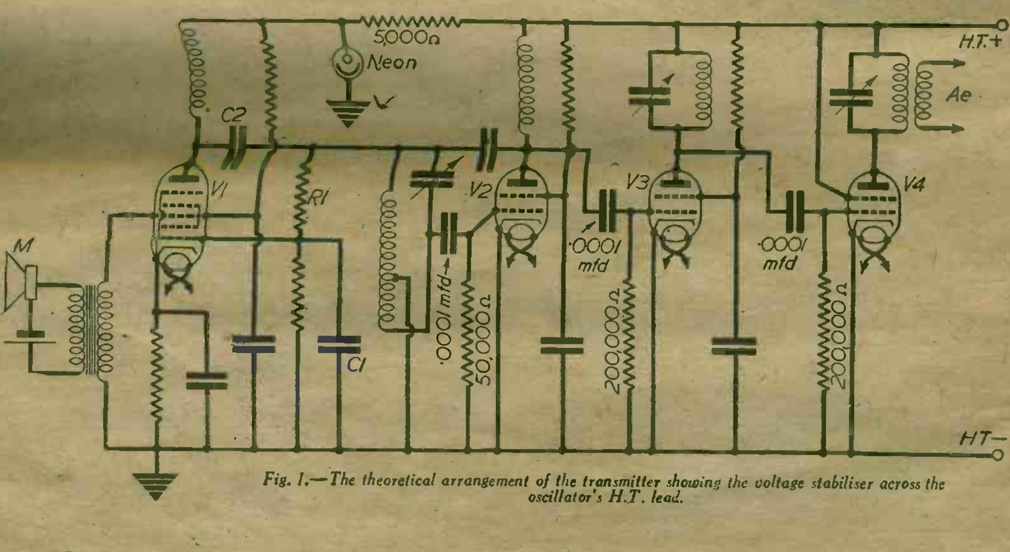


Fig. 1.—The theoretical arrangement of the transmitter showing the voltage stabiliser across the oscillator's H.T. lead.

The Frequency Modulation Receiver

Having discussed the production of FM signals, it now remains to be seen what type of apparatus is necessary in order to receive these signals. It will be fairly clear that the essential difference between a FM receiver and an AM receiver will be in the detecting system. The remainder of the receiver will more or less follow the same lines as in the AM receiver.

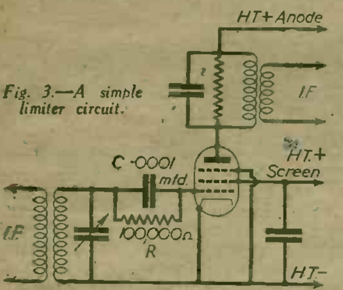


Fig. 3.—A simple limiter circuit.

The first stage of the receiver, which will be of the superhet type, will be the RF amplifier, frequency changer, and intermediate frequency amplifier stages. Provided that these stages will give equal amplification for all frequencies through which the carrier deviates, they can follow normal practice. To ensure sufficient band-pass in the IF stages, the tuned circuits will be damped by means of resistances connected in parallel with them, or by using tightly coupled IF transformers.

It should be noted that when the carrier frequency is reduced to an intermediate frequency by means of the frequency changer, the frequency deviation remains the same.

Following the last IF stage, there is an additional stage not found in AM receivers. It is known as the limiter, and its purpose is to suppress any amplitude variations that may be present on the carrier. These amplitude variations may be caused by heterodynes or external noise or any other type of interference, and it is essential that the signal applied to the "detector" (or "discriminator" as it is called), should be of constant amplitude.

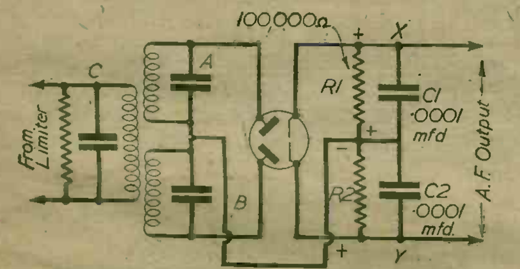


Fig. 5.—Circuit of amplitude discriminator.

Following the limiter is the discriminator stage, and then the AF and output stages, as usual. Fig. 2 illustrates a block diagram of a typical receiver.

The Limiter

A pentode valve is normally employed in the limiter stage, and the valve is operated with much lower anode and screen voltages than normally. This will so affect the mutual characteristic of the valve that only a small amount of negative bias is sufficient to reach cut-off point and prevent the valve conducting. There is no bias applied to the control grid of the limiter valve, a condenser and leak being used instead, so that the circuit very much resembles a leaky grid detector—in fact, the operation of the limiter is very similar to that of a leaky grid detector. Whatever the amplitude of the input voltage, if the values of the leak and condenser are chosen correctly, the grid voltage will only swing sufficiently positive to allow grid current to flow and charge the condenser. The actual variation in input signal amplitude will vary only the amount by which the grid voltage goes negative, as in the leaky grid detector.

However, since only a small negative grid voltage is required to cut the valve off, these variations in amplitude will be past cut-off and will therefore have no effect on the amplitude of the anode current variations, which will remain constant.

This limiting will tend to reduce interference due to internal noise, and will also prevent any amplitude variations caused by external noise reaching the discriminator. These noises will, however, introduce phase changes, as previously explained, but these will not produce so great an output as they would in an AM receiver.

Fig. 3 illustrates a simple limiter circuit, R and C being the leak and condenser respectively. In both anode and grid circuits there is a tuned circuit tuned to the intermediate frequency.

The Discriminator

The only remaining stage in the receiver to be

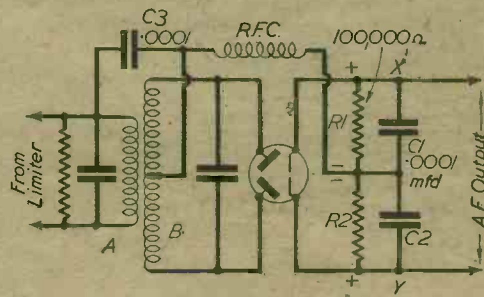


Fig. 6.—The arrangement of a phase discriminator circuit.

discussed is the discriminator stage. This is, of course, the most important stage in the receiver, since it has to convert frequency variations into audio frequency (amplitude) variations.

Now it should be clear that if an FM signal were applied to an ordinary detector, no AF output would result, since the detector only responds to amplitude variations, and if a constant amplitude were applied there would be no output even though the carrier frequency might vary considerably.

What is required is a device that responds to changes of frequency, and, furthermore, responds faithfully to these changes of frequency, i.e., no distortion is introduced. We can plot the characteristic that we desire to obtain, showing AF volts output against frequency deviation, and in the ideal case it would appear as in Fig. 4.

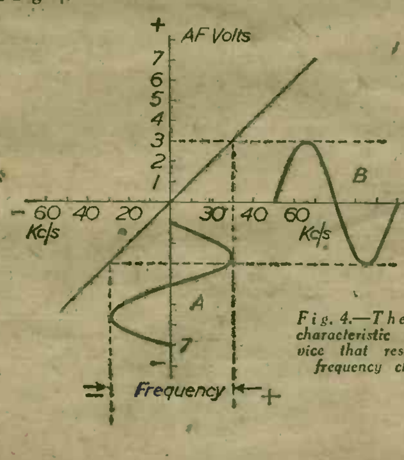


Fig. 4.—The ideal characteristic of a device that responds to frequency changes.

A carrier-wave whose frequency varied as shown at A would produce an AF output as shown at B, which, in this case, is a perfect reproduction.

We now have to find a device that has a characteristic similar to the one shown. It will be remembered that a tuned circuit has a response curve, a portion of which is similar to the characteristic shown. As the frequency of a voltage applied to a tuned circuit is decreased below the resonant frequency of the tuned circuit, the response or circuit magnification of the circuit will fall off, until, if the frequency is sufficiently far removed from the resonant frequency, no magnification takes place at all. Thus variation of frequency produces a variation of output.

Amplitude Discriminator

One practical type of discriminator, known as the amplitude discriminator, uses this principle, employing two tuned circuits. The arrangement is shown in Fig. 5. C is the primary circuit of an IF transformer, and it will be connected in the anode circuit of the limiter valve, already described, and will be tuned to the IF (i.e., the mean frequency about which the IF deviates). This circuit will have to be flatly tuned, so that when the IF deviates the voltage induced in the secondary circuits remains constant.

There are two secondary circuits (A and B), one tuned to a higher frequency than the IF, and the other tuned to a lower frequency than the IF. They must both be mistuned by the same amount.

When the carrier is unmodulated, the IF will remain constant at a frequency midway between the resonant frequency of the two tuned circuits. Equal voltages will be developed across both tuned circuits. These voltages, when rectified, will produce DC voltages across R_1 and R_2 which will be equal, and since the output is taken from the extreme ends of these resistances (X and Y), no output voltage will result because the two voltages are in opposition.

If, however, the carrier is modulated, a different effect is observed. Supposing the IF increases, so that it becomes nearer the resonant frequency of the tuned circuit A—at the same time it will move farther away from the resonant frequency of tuned circuit B. Hence, more voltage will be developed across A and less across B. Therefore, the rectified voltage across R_1 will be greater than that across R_2, and some output voltage will result. This output voltage is the difference between the voltages across R_1 and R_2, and in this case it will be positive at X and negative at Y.

The IF will gradually decrease, with consequent fall in output, until it deviates below its normal value with the result that more voltage is developed across tuned circuit B than across tuned circuit A, and therefore a greater voltage across R_2 than across R_1. The output, which will be the difference between the two voltages, will now be reversed, i.e., negative at X and positive at Y. Thus, if the IF deviates at audio-frequency, AF output will be developed across XY and can be amplified in the normal manner.

It is essential that the IF should not deviate to such an extent that the frequency reaches the resonant frequency of A or B, or it would introduce distortion. The tuned circuits would normally be designed to handle the largest frequency deviation likely to be received.

Another type of discriminator, known as the phase discriminator, is shown in Fig. 6. A and B are the primary and secondary windings of an IF transformer, both of them being tuned to the normal IF. The inductance B is centre-tapped and connected via an RF choke to the centre-point of R_1 and R_2. In addition to inductive coupling between the two circuits there is also capacitive coupling via C_3.

The action is too complicated for explanation here, but it may be stated that due to the phase changes produced by inductively coupled circuits, a voltage is produced across the RF choke, due partly to the voltage across half the secondary and partly to the condenser C_3, giving a response curve very similar to that of the amplitude discriminator. AF voltages will be developed across XY and amplified as usual.

(*To be continued.*)

An Unusual Fault

ONE of those least expected faults was experienced the other day, when a commercial A.C. operated receiver was under test. While admitting that the actual trouble was, in itself, quite simple, its nature was such that many valuable minutes were wasted before it was finally located.

When the receiver was switched on, it soon became apparent that the mains transformer was overheating, and as no appreciable H.T. was present at the normal points in the circuit, it was naturally assumed that a short-circuit was present in the high-tension supply. Tests revealed that the rectifier and its circuit was O.K. so far as the mains transformer was concerned.

Condensers Were Suspected

The smoothing condensers, therefore, came under suspicion, but, much to the surprise of the tester, after disconnecting all condensers across H.T. supplies and breaking the supply to the actual receiver circuit, the short was still there.

An examination of the theoretical circuit, as shown in the service manual for the set concerned, did not show any other possible paths for short-circuit; therefore, it only remained for a further inspection of the set.

The speaker was of the energised type; the speech coil was connected in series with a hum-bucking coil which, as readers are aware, is wound on or adjacent to the energising coil.

Hum-bucking Coil

Further investigation showed that one side of the hum-bucking coil was connected to the common negative earth line by means of a fifth lead to the speaker, but this was not shown in the theoretical diagram.

As the energising coil was being used as the smoothing choke, and as it was in series with the positive H.T. supply, it and the hum-bucking coil were subjected to careful tests. The results revealed the fact that the insulation had broken down between these two windings, thus allowing the H.T. to be shorted to earth via the h.b. coil and its earthing wire. As mentioned at the start, the actual trouble was not serious so far as it would take to locate normally, but what led the tester off the track was the fact that no sign of such earthing arrangements was shown in the service manual.

EXIDE INDUSTRIAL EXHIBITION

Many workers engaged on work of vital importance often feel that they are not taking an active part in the war effort because the items they are producing do not take the form of shells, bombs, guns and tanks, etc. The makers of the famous Exide products decided to "educate" their workers by staging an Exhibition which would prove that 95 per cent. of the items manufactured in their works are used in the war effort.

(Above) A striking direct appeal. Production figures prove that the workers have answered it 100 %.

(Above) A general view of one section which stresses the importance of the workers' products.

(Left) Communications play a vital part in any modern campaign. Radio transmitters and receivers, telephone sets, and signalling all depend on efficient batteries.

(Above) The workers showed considerable interest in the R.A.F. section, and a few are here seen examining one of the rubber dinghies carried by our 'planes.

(Left) Batteries are of vital importance to all our Ack Ack batteries. A fine display depicting action, and driving home the need for both types of batteries.

Radio Examination Papers—22

A Further Selection of "Test Yourself" Questions, with Suitable Answers by THE EXPERIMENTERS

QUESTIONS

1. *Show a simple method of obtaining bass-boost in the circuit arrangement illustrated in Fig. 1.*
2. *Explain the meaning and effect of radiation resistance as applied to a transmitting aerial.*
3. *If modulation hum was noticeable in a newly-built superhet, how would it be recognised, and what steps would you take to eliminate the noise?*
4. *Is any advantage to be gained by using* amplified *A.V.C. by comparison with ordinary A.V.C.?*
5. *Explain the underlying principles of automatic frequency correction.*
6. *Give a formula for finding the approximate inductance of an iron-cored choke with an air gap. Find the inductance of a choke wound on a Stalloy core of* 1 *sq.in. cross-section, with a* .05*in. air gap, and wound with* 10,000 *turns of wire.*

1. Improving Bass Response

ONE easy method of "bringing out the bass" is by shunting the output circuit with a fixed condenser of fairly low capacity. A similar result can be obtained by connecting a condenser between the detector anode and earth.

Unfortunately, this simple method has the objection that it operates by reducing high-note response rather than by increasing bass response. Thus, the mean volume level for any given setting of the volume control is reduced by applying this method.

A better result may be achieved by including in series with the grid leak, or in series with the anode resistor, an oscillatory circuit which resonates at a low frequency. For example, if the circuit comprised by L and C in Fig. 2 were to resonate at (or tune to, in other words) 500 cycles, the output would tend to rise in the region of that frequency. The effect can be obtained in a worth-while degree only when the overall resistance of R.1 and V.1 in parallel is high in relation to the resistance of the grid leak, R.2.

In practice R.1 would be of sufficiently high value only when a pentode or tetrode valve were used as V.1. When using a pentode, however, R.1 would require to have a high value in order to provide suitable matching, and the parallel resistance of the valve would be high enough to have a very marked effect on the overall resistance.

The effect of the resonant circuit is to increase the total effective resistance between the grid of V.2 and earth at frequencies near the resonant frequency of LC; at other frequencies LC has little effect, and therefore the resistance between grid and earth is comparatively low.

2. Radiation Resistance

When a high-frequency oscillation is applied to an aerial, electro-magnetic radiation takes place. The efficiency of an aerial as a radiator depends upon its correct matching to the output circuit of the transmitter, and also upon its natural frequency in relation to the frequency of the oscillations applied to it.

An aerial, whether of the "Hertz" or "Marconi" type, has inductance and capacity, and therefore resonates at a certain frequency. In this respect it is in every way comparable to a tuned circuit comprising an inductance and capacity in parallel. Now, at resonance, a parallel-tuned circuit has an overall resistance equal only to its D.C. resistance. But it may be shown that the effective resistance of an aerial at resonance is greatly in excess of the D.C. resistance. This is because, in radiating, energy is being dissipated. It is the difference between the effective resistance and the D.C. resistance which is known as radiation resistance.

Another way of looking at the matter is to state that the radiation resistance is equal to the quotient obtained by dividing the radiated power in watts by the square of the H.F. current fed into it, and subtracting from this the D.C. resistance. In an efficient aerial system the radiation resistance is high in relation to the D.C. resistance.

Incidentally, the above explains why indicated aerial current is not necessarily a true guide as to the H.F. power radiated: aerial current may be high due to the radiation resistance being low.

3. Modulation Hum

Modulation hum differs from ordinary mains hum in that it occurs only when the receiver is tuned to a carrier wave. The hum becomes superimposed upon the carrier, and so modulates it. In general, modulation hum more frequently occurs with a superhet than with a "straight" receiver. It may be due to coupling between the A.C. mains supply and the wiring of the set—possibly through the mains transformer. Inefficient decoupling in the oscillator-anode circuit of a superhet may often prove to be the cause of the hum, whilst general lack of adequate filter and smoothing arrangements may be responsible. A poor earth connection to the receiver may also accentuate, or even cause, modulation hum, especially if the primary and secondary

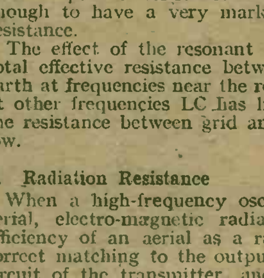


Fig. 1.—A simple R.C.C. amplifier stage, in which it is required to increase bass response.

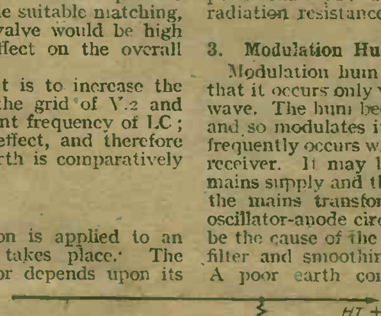


Fig. 3.—Simplified circuit of a second detector providing delayed and amplified A.V.C.

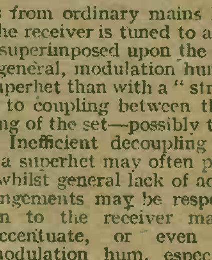


Fig. 2.—Bass-boost is obtained by connecting an oscillatory circuit in series with the grid leak.

winding of the mains transformer are not suitably screened from one another.

In the case of a midget universal mains receiver, normally operated from a short "throw-out" aerial and without an earth connection, modulation hum is sometimes in evidence at the higher settings of the volume control if the "throw-out" aerial is attached to a longer aerial.

4. Amplified A.V.C.

The chief advantage of amplified A.V.C. is that it provides more effective control of output than can be obtained when using ordinary A.V.C., particularly when the signal voltage applied to the second detector is low; say not more than one volt. This means that output from the speaker remains more nearly uniform irrespective of the strength of the received signal.

A.V.C. amplification is generally combined with a delay system which, in itself, prevents the backing-off of signal strength until the received signal voltage reaches a certain pre-determined figure.

The principle of amplified automatic volume control, as the name indicates, is that the rectified signal voltage is amplified before being passed back to the grids of the controlled valves. How the system works can be followed by reference to Fig. 3, where a double-diode-triode is shown as second detector and first L.F. amplifier. The diode anode marked D.1 is for detection, and that marked D.2 is for providing A.V.C. Instead of returning the cathode directly to the earth line, through its bias resistor, it is taken to a point which provides as negative potential relative to the earth line. The values the anode resistor, R, and the cathode resistor, R.1, are such that the grid of the triode portion of the valve is at zero potential.

When a signal is applied to D1 and rectification takes place the grid becomes negative. As a result, anode current falls and so reduces the voltage drop across R1. At the same time the cathode potential will fall from a positive value to zero, according to the signal voltage and the amplification factor of the valve. Any increase in signal voltage will tend to drive the cathode negative in respect of earth. Should that happen, D2 will be positive in respect of the cathode and current will flow from the cathode to this anode. Thus, there will be, virtually, a conducting path between cathode and D2. As a result, any further rise in signal voltage will make the cathode still more negative. In turn, this will drive D2 more negative, and so increase still further the negative A.V.C. bias.

5. Automatic Frequency Correction

The object of automatic frequency correction is to provide that if the signal reaching the second detector is above or below the correct intermediate frequency, an alteration to the oscillator frequency will be brought about automatically. The system is of value principally in a receiver with push-button tuning, especially when remote control is provided and the tuning condenser is rotated by means of an electric motor mounted inside the set.

An automatic frequency correction system consists of two essential parts: a discriminator and a corrector. The former is fed from the output of the I.F. amplifier, and generally consists of a double diode wired as shown in Fig. 4. The two tuned circuits are accurately and sharply tuned to frequencies, one slightly above and the other slightly below, the intermediate frequency. When a signal of exactly the intermediate frequency is applied to the circuit the two halves are balanced and therefore the potential at the point marked "control" is zero. Should the frequency be slightly higher or lower than the I.F. the voltage developed across one of the tuned circuits will be greater than that across the other. In consequence, the control voltage will become positive or negative.

This controlling voltage can be used in one of several different ways. Perhaps the simplest is as shown in Fig. 4, where it is fed back to the grid of a valve whose grid and cathode are connected to the two ends of the oscillator tuned circuit. Due to the Miller Effect (recently briefly explained in this series) the grid-cathode capacity is varied by variation in grid voltage. Thus there is, in effect, a fine-tuning device across the oscillator circuit, the resonant frequency of which being thereby varied.

6. Inductance Calculation

The inductance of a choke with gapped iron core of Stalloy or similar material can be found approximately by using the formula:

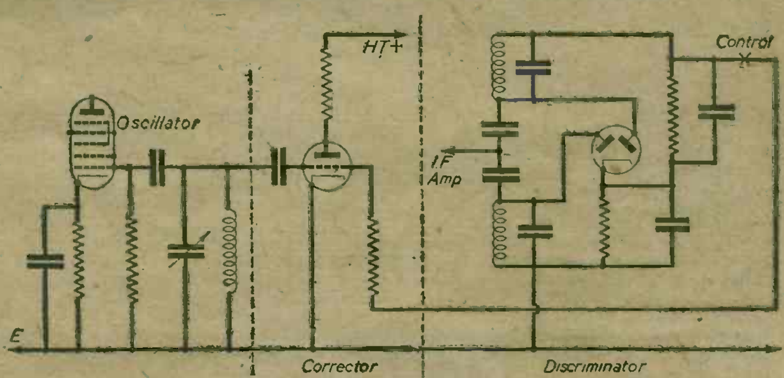


Fig. 4.—Skeleton diagram showing the general arrangement of a simple system of automatic frequency correction.

$$L = \frac{3.2 \times A \times N^2}{a \times 10^8}$$

where L is the inductance in Henries, A is the area of cross section of the core in sq. in., N is the number of turns on the choke and a is the length of the air gap in in. It should be pointed out that this formula is only approximately accurate, and should normally be applied only when the air gap is fairly wide. Incidentally, the wider the gap the more uniform is the inductance for varying current loads.

Substituting the figures given in the question in the above formula we have:

$$L = \frac{3.2 \times 1 \times 100,000,000}{.05 \times 10^8}$$

It will be seen that one-hundred million in the numerator is the same as ten-to-the-eighth in the denominator. Therefore, these two will cancel out, leaving as the answer 3.2 divided by .05, or 320 divided by 5, which is seen to be 64. The inductance is, therefore, 64 henries.

The formula does not take into account the gauge of wire used, but that would be chosen according to the D.C. current which it has to carry. The current rating should be based on a figure not exceeding 1,500 amps. per sq. in. In turn, the winding area provided by the core stampings must be so chosen that the requisite number of turns for the intended inductance can be accommodated.

Short-wave Dials

A Novel Arrangement to Simplify Tuning and Calibration.

By WM. NIMMONS

ONE of the failings of the average short-wave condenser is that the dial provides no indication of the waveband or station that is being received. It is so often graduated in degrees—either 100 deg. or 180 deg.—and this does not make tuning too easy, especially with the simple regenerative detector stage.

For those who have experienced the trouble the writer has in mind, and who would like to eliminate the finicky searching for stations, the simple dial system described below will be helpful. It is particularly suitable for the simple s.w. set, though it may be applied in modified form to a superhet receiver in which there are several s.w. bands.

The first thing to do is to calibrate the main tank

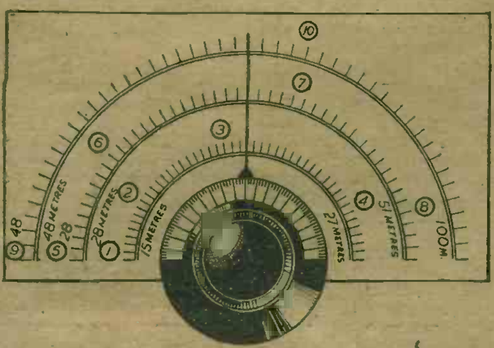


Fig. 1.—The concentric circles are calibrated in metres. The numbers 1-10 are where the pointer is placed when the band-spreader is brought into use

condenser—the band setter. It can be calibrated either in metres or kilocycles; as the former is generally more familiar to the amateur it should be used, though there is nothing to prevent the dial being calibrated in kilocycles if the operator so desires. To do this, a piece of white cardboard or drawing paper is fastened to the panel in such a way that it projects about two or three inches above the old tuning dial. A pointer is then attached to the dial so that it sweeps over the paper as the dial is turned from its minimum to its maximum setting. There are one or two preliminary remarks to be made before beginning the calibrating.

The first concerns the aerial series condenser, if any. If this is adjusted *after* the dial has been calibrated, the scale will be thrown out of the true, so it is necessary to see that the aerial series condenser is adjusted for satisfactory oscillation on all bands and then left alone. If a loose-coupled aperiodic aerial winding is used without an aerial series condenser, then the above remarks do not, of course, apply. The second remark concerns the reaction condenser. If this is of the "straight" pattern, a certain amount of tuning drift may be experienced when it is manipulated, and while this does not matter when the tuning condenser is used with a dial simply marked in degrees and not calibrated, it cannot be tolerated when accurate calibration is desired. The remedy is to use a differential reaction condenser with the moving plates going to the anode of the detector valve, one set of fixed plates to the reaction coil, and the other set of fixed plates to the earth line of the receiver.

Now to begin calibrating, one coil at a time, the different coils being calibrated on concentric circles as shown in Fig. 1. A wavemeter will be of assistance, but much can be done by assiduous listening to stations of known frequency. If you are uncertain as to the exact minimum and maximum wavelengths, leave them unmarked but fill in the intermediate wavelengths. By drawing a graph, using, say, half a dozen known stations as a guide, you can calibrate the three wavebands perfectly.

The Band-spreader

Here, too, is needed a pointer to indicate the travel of the condenser. Instead of the scale being fixed, however, it is best to have a separate scale for each band. That is, not merely a scale for each coil, but for each group of stations, of which there are about 10 altogether. Each of these scales is brought into position when we are receiving that particular band, the others being folded back into their case when not in use. The entire series can be numbered 1 to 10, the same numbers being placed on the band-setter in such a position that when the band-setter pointer is placed to the appropriate number the band-spreader is automatically set for reception on that band. The card scales themselves are provided with a thumb index so that the appropriate one can be selected at a glance. (Fig. 2.)

When the band-spreader scales have been filled in with the stations received, you are no longer working in the dark. Simply set the band-setter to any number, place the corresponding band-spreader scale in position and tune in, making sure that the right coil is inserted.

To do this it is a simple matter to label the three concentric circles on the band-setter condenser A, B and C, corresponding to the three short-wave coils in use. Thus A would correspond to the 13-27 metre coil, B to the 24-51 metre coil, and C to the 48-100 metre coil—or whatever the three ranges are. The procedure is to select one of these three ranges, see that the correct coil is in position, set the tank condenser pointer very carefully to a pre-arranged position below each band of stations and then note which number this is in the series 1 to 10. The corresponding card is then placed in position on the band-spreader and tuning carried out in the ordinary way. It is necessary always to set the tank condenser pointer to the same position, or the calibration will not hold on the band-spreader.

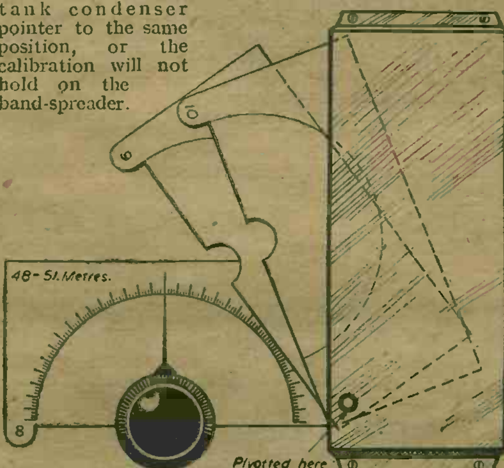


Fig. 2.—The 49 m. card in position ready for calibrating. Remaining cards swing back into pocket as shown.

ON YOUR WAVELENGTH

By THERMION

Raif !

SO the B.B.C. has decided that Ralph is to be pronounced as *Raif*! There seems to be no end to the stupidity of the B.B.C. No one except a B.B.C. announcer will adopt this effeminate pronunciation of a praenomon associated with all that is tough and caveman: "Sir Ralph the rover tore his hair"! Imagine the twitters in the classroom when our blonde male teachers of the future, with right toe delicately poised and right knee delicately bent, in sylph-like tones and velvet voice instruct the pupils to say "Sir *Raif* the rover tore his hair," coupled with a suitable roll of their cerulean optics. My advice to the B.B.C. is to drop this nonsense at once. No one in this country is going to call Ralph, *Raif*, and the announcers merely make themselves sound stupid by adopting this invented pronunciation. Of course, the Scots have always loved to invent a pronunciation. In Scotland Dalziel must be pronounced De-ell! Why is there all this vanity about Christian names? Why is a man named Smith anxious to let you know that he is of an exceptional brand of Smith, such as Cholmondelay-Smith? Like authors of pot-boiling novels, they must have their photographs in the *Radio Times* smoking a pipe, the bowl of which is firmly grasped in the right hand, with the right elbow resting on the desk, whilst they gaze wistfully and dreamily into the future with the evident desire to give an owl-like, and professorial veneer to an otherwise vapid and vacuous countenance. Surely the B.B.C. can find something better to do than to sit in conference on the pronunciation of Ralph. *Raif* is almost as bad as *goff* for golf. You know the type of man who says that he is going to play a game of *goff*, with a lazy and bored drop of the lower jaw—the type of man who goes huntin', shootin', fishin', etc. The B.B.C. has a tendency to drawing-room its pronunciations. I hope that none of my readers, blessed with the Christian name of Ralph, will be hailed by his friends as *Raif*. I can almost imagine all the Ralphs vomiting at the thought. I must admit, however, that *Raif* is very ladylike.

Glossary of Electrical Terms

THE British Standards Institution has issued Part 7 of the revised edition of B.S. 205—"Glossary of Terms Used in Electrical Engineering," and it concludes the series of definitions and only the alphabetical index remains to be issued. Part 7 contains an entirely new section on surge and lightning phenomena, as well as with impulse voltage testing. Another section contains definitions relating to electric lifts and electric welding. The concluding section deals with X-rays and electro-medical practice. Copies of Part 1 and of all the earlier parts may be obtained from the British Standards Institution, 28, Victoria Street, London, S.W.1, price 2s. each. Terms relating to radio, telegraphy and telephony, which were formerly dealt with in B.S. 205, will be included in a revised and much enlarged new edition of B.S. 204, which will be published under the title of "Glossary of Terms Used in Telecommunication."

B.I.R.E. Lecture

"MODERN Magnetic Materials" was the subject of an informal discussion at a recent meeting of the British Institution of Radio Engineers, held at The Institution of Structural Engineers' Building, 11, Upper Belgrave Street, London, S.W.1.

G. A. V. Sowter, B.Sc., M.I.E.E., M.Brit.I.R.E., and A. J. Tyrrell, A.M.I.E.E., A.M.Brit.I.R.E. opened the discussion, Mr. Sowter representing the "Soft" magnetic, or high permeability materials, and Mr. Tyrrell the "Hard," or permanent magnet types.

Present-day achievements, said Mr. Sowter, when compared with the position 20 years ago, were astounding, modern materials in everyday use now being 10 times more efficient than was thought possible then. He surprised most of the audience when he described a new alloy, which, while it possessed excellent magnetic properties, was composed entirely of non-magnetic materials.

Mr. Tyrrell, in presenting the case for permanent magnets, showed that similarly remarkable developments had occurred in that field over the same period. He described the composition and treatment of the alloys then and now, and explained the methods used to magnetise them and to determine their optimum operating points. He, too, presented a surprise in the form of permanent magnets, suitable for domestic loud-speakers, so small that the complete "pot" was little more than an inch in diameter, yet the speaker would handle an output of two watts.

Radio in Robotland

[Press item.—Mr. Dalton, President of the Board of Trade, says that 90,000 domestic "Utility" radio sets are in process of manufacture, and that all new domestic sets made here shall be of simple standard designs.]

He's cut down socks and shortened shirts,
And now with radio Dalton flirts—
Let's hope with some futility!
For radio fans the prospect's bleak
And rightly will they howl and shriek
When all sets are "Utility."

But there it is; the People's Voice
Is vain when asking for a choice—
"The Minister knows best!"
Ours to submit, and cease all strife,
Theirs to control our daily life
Within this land so blest.

Will thus our fight for freedom end—
Dalton prohibits "anode bend,"
Or orders back to crystals!
Enforcement officers employed
To see no valve sets are enjoyed,
By threatening us with pistols!

Ah! Sad the fate of this poor land,
When subject to the State's dead hand,
And endless despots rule us.
Each crying "Liberty" aloud,
They seek to hypnotise the crowd—
Their tactics don't befool us.

To win the war we've stood a lot,
And seen our freedom go to pot.
When won, we will disown
Fanatics' fingers on the probe—
Which into fury freeman goad;
They shall leave well alone.

"TORCH."

Our Roll of Merit

Readers on Active Service—Thirty-third List

F. Gameson (L.A.C., R.A.F.).
E. Hanson (L/Cpl., R.E.).
M. A. Thompson (Cfn., R.E.M.E.).
J. S. Farmer (Sgt., R.A.F.).
A. West (L.A.C., R.A.F.).
N. Bouchier (A.C./1, R.A.F.).
— Richardson (Sigmn., Royal Corps of Signals).
R. Taylor (A.C./1, R.A.F.).
J. A. Gould (Cadet, R.N.R.).

Elementary Electricity and Radio—8

Neutralising : A Complete Broadcasting System

By J. J. WILLIAMSON

(*Continued from page 392, August issue*)

Neutralising

REFERENCE to Fig. 26 (a) shows the principle of neutralising. The waveform in Fig. 25 (b) represents the waveform of the oscillatory voltage conveyed by the *Cag* from the anode tuned-circuit to the grid tuned-circuit. Voltages are induced (by the magnetic field around L_1) in L_3, hence, in the circuit L_3 C_3 L_4 oscillatory current is flowing, which, producing a magnetic field in L_4 causes voltages to be induced in L_2. Obviously we are deliberately feeding back energy from anode to grid tuned-circuits, and if we ensure that these feed-back voltages act against the voltages fed via the *Cag*, then the two will cancel as shown in Fig. 26 (b), thus preventing the maintenance of oscillation.

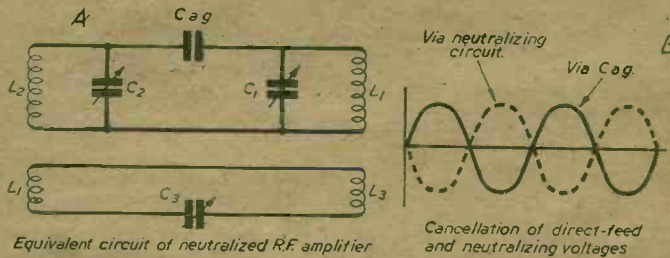


Fig. 26.—Neutralising principle, equivalent circuit and graphical form.

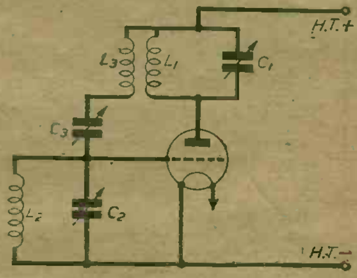


Fig. 27.—A typical neutralising circuit.

It can be seen that the best results occur when the neutralising voltages are 180 deg. out-of-phase with and the same amplitude as the "direct-feed" voltages: adjustment is achieved by means of C_3.

A typical neutralising circuit is shown in Fig. 27. The neutralising voltages are picked up by L_3 and fed back to the grid of the triode via C_3, which, being variable, permits adjustment to be obtained.

Because of the superiority of the screen-grid valve in overcoming instability, neutralising is rarely used in receivers, but it is employed in radio-frequency power-amplifiers in transmitters, when the use of a triode is advantageous.

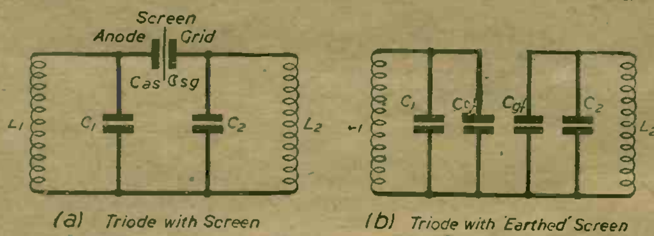


Fig. 28.—Equivalent circuits of R.F. amplifier with "screened" Cag.

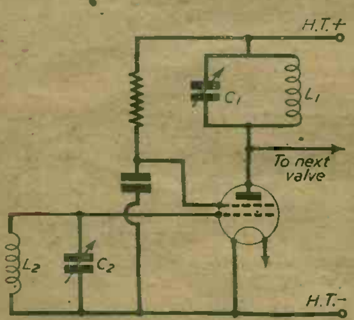


Fig. 29.—A complete S.-G. R.F. amplifier.

The Screen-grid Valve

Fig. 23 (b) gives the equivalent circuit of an R.F. amplifier using a triode; the insertion of a screen between anode and grid modifies this circuit to that shown in Fig. 28 (a). We now have two capacities in series, i.e., *Cas* and *Csg*. Now let this screen be connected to the earth (filament or cathode end of the tuned circuits). Note that—Fig. 28 (b)—the *Cag* has now become *Cgf* and *Caf*, and our object has been achieved.

Certain difficulties arise, however, when we attempt to use a screen between anode and grid in a triode. We cannot place a solid screen in the electron stream, thus a wire mesh is inserted; the screen grid must be given a positive potential, usually about two-thirds that of the anode-voltage; the screen-grid cannot be connected directly to "earth" from a D.C. point of view, thus a condenser of suitable value has to be inserted.

A complete R.F. amplifier employing a screen-grid valve is shown in Fig. 29.

The effect of coupling between anode and grid circuits has been shown to cause instability, therefore it is important to ensure good

(*Continued on page 415.*)

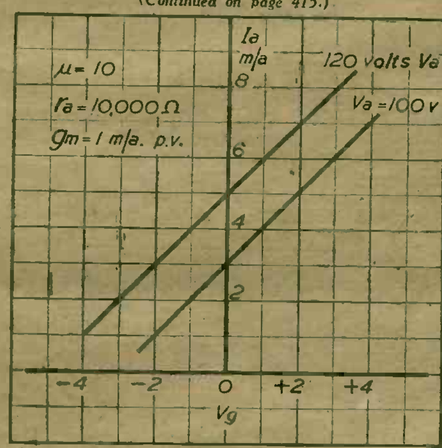


Fig. 30.—Ia/Vg. curve for Answer 1, page 415.

design in order that grid and anode leads are kept as far apart and as short as possible.

General Examples

(1) What is the reactance of a 0.001 μF condenser at a frequency of 1,000 cycles per second ?

(2) What value of inductance would have the same value of reactance as the condenser in (1) at 1,000 cycles per second ?

Answers for Article Six

1. See Fig. 30.
2. (a) $\mu = 16.6'$; $ra = 10{,}000\ \Omega$; $gm = 1.6$ m/a.p.v.
   (b) 10,000 Ω

A Complete Broadcasting System

By a "complete broadcast system" we are referring to the system whereby the mechanical energy of sound waves is converted to electrical energy, passed through a transmitter, broadcast, received, passed through a receiver and finally used to reproduce sound waves. Fig. 31 is a "block" diagram of the processes involved.

When sound occurs, compressions and rarefactions of the air are caused, these disturbances spreading out, impinge on the diaphragm of the microphone (A).

The L.F. voltages are then magnified by being fed to an L.F. amplifier, which, if amplification is distortionless, produces a magnified or amplified copy version of the original signal (C).

We wish to broadcast intelligence, represented by L.F. voltages, but direct use of these voltages would require great power. Radio or high frequency (R.F. or H.F.) voltages will give us the communication distance we require, for low power, but does not represent the intelligence to be conveyed !

To overcome this apparent dilemma, we cause some factor of the R.F. to vary between 25 and 30,000 times per second (at L.F. rates), thus, the R.F. "carries" the intelligence, giving rise to the term "carrier wave."

Obviously, two processes are now required : (1) the production of radio frequency voltages and (2) the "alteration" of the steady R.F. to place the intelligence upon it, i.e., the "modulation" of the wave ; (D) and (E) respectively.

Fig. 32 (a) shows the effect of making the *amplitude* of an R.F. wave vary at L.F. rates—amplitude modulation. Fig. 32 (b) represents a wave whose *frequency* has been made to vary about a fixed value at L.F. rates

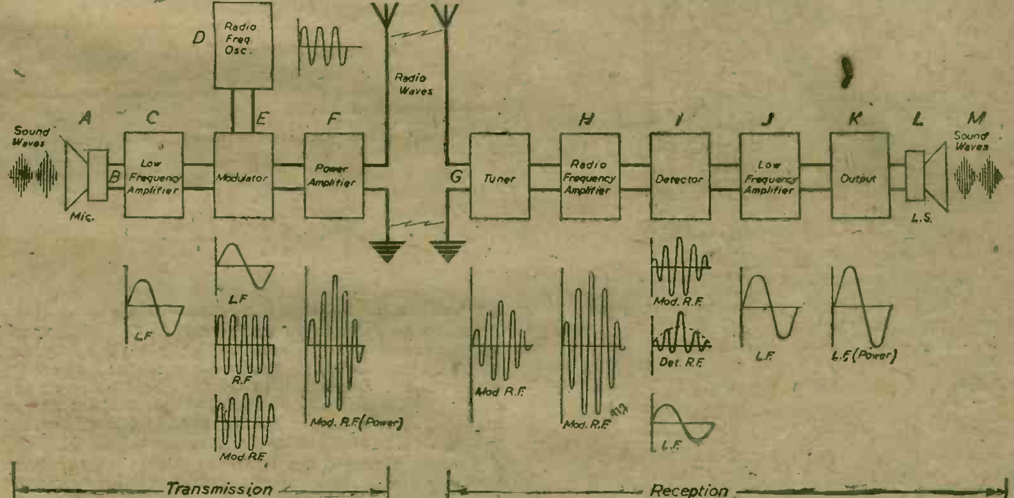


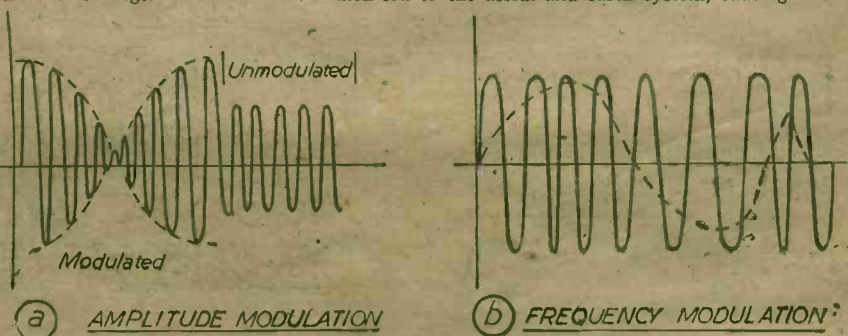
Fig. 31.—The schematic layout of a transmitting and receiving station.

—frequency modulation. Although frequency modulation is becoming increasing attractive to the radio world, amplitude modulation is still in general use.

The rapid vibration of the microphone's diaphragm causes a voltage, the variation of which is exactly similar to the variation of air pressure, to appear across the microphone circuit (B). The varying voltages produced can be called L.F. (low frequency) or A.F. voltages (audio or audible frequency), their frequency being between 25 and 30,000 cycles per second—L.F. will be used in future when speaking of frequencies in this range.

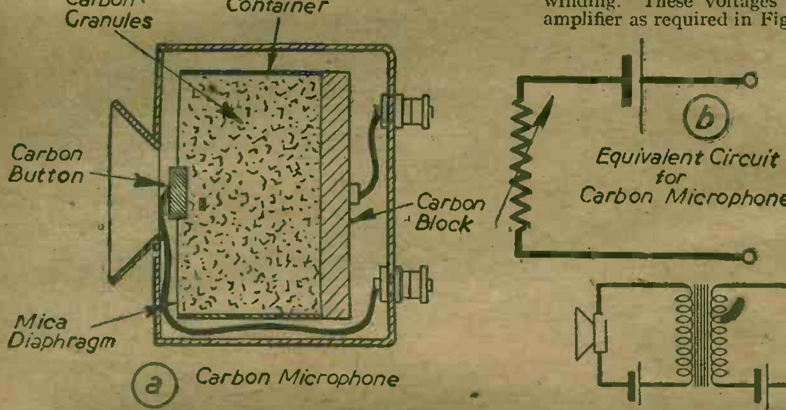
The amplitude modulated radio frequency voltages from the modulating process are passed to an R.F. power amplifier (P.A.), where they are given energy (F), and then fed to the aerial and earth system, causing alter-

Fig. 32. — Showing the difference between amplitude and frequency modulation.



nating currents therein, thereby producing electromagnetic radiation.

Electro-magnetic waves consist of electric and magnetic fields at right angles to each other, both being propagated outwards at the speed of light (approx. 186,000 miles or 300,000,000 metres per second). It is to be remembered that if an electric field acts along or if a magnetic line-of-force cuts a conductor, then an E.M.F. is produced across the ends of that conductor; thus, when an electro-magnetic wave strikes the receiving aerial and earth system, minute E.M.F.s are produced (G), which vary in exactly the same way as the currents in the transmitter's aerial and earth system. These E.M.F.s are *amplified in an* R.F. amplifier—their amplitude only being effected (H)—and passed to a "detector," which utilises the changing strength of the R.F. voltages (intelligence) to produce L.F. voltages (I).



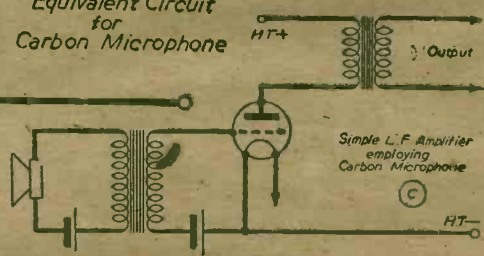


Fig. 33.—Simple microphone, its equivalent circuit and amplifying stage.

of the carbon button upon the carbon granules, thereby reducing and increasing the contact area of the instrument.

Now $R=\frac{\rho l}{A}$ where ρ (*rho*) is the specific resistance of the carbon, l is the length of the current's path through the microphone, and A is the cross-sectional area of the path provided for the current through the carbon granules;

Thus, if A varies, R varies also.

Now, the current through the microphone depends upon the voltage applied and the resistance encountered. $I=V/R$. Thus, if R varies, so does the current. Therefore, the current "ripples" according to the vibration of the diaphragm.

In Fig. 33 (c) the rippling current passes through the primary winding of a transformer, thereby causing alternating voltages to appear across the secondary winding. These voltages can now be fed to an L.F. amplifier as required in Fig. 31 (B).

There are several types of microphones, but they all cause the production of voltages which follow the variation of pressure at their diaphragms.

The L.F. voltages are now fed to an L.F. amplifier (J), and thence to an output stage, where they gain further energy (K). The output stage feeds a loudspeaker or a pair of telephones (L), causing their diaphragms to vibrate and thus reproducing sound waves (M).

Note the following points: (1) the "effects" of the alternating voltages are "*passed on*" through the various processes, i.e., it is not a single, alternating voltage that is acting; (2) the "blocks" represent *processes*, and not necessarily separate pieces of apparatus for each purpose; (3) modulation is defined as the "alteration" of some factor of a steady R.F. wave to place intelligence upon it; (4) detection is defined as the process whereby the changing amplitude or strength of the amplitude modulated R.F. carrier wave is utilised to give L.F. voltages.

The Carbon Microphone

A microphone is a device capable of reproducing the variations of air pressure (sound waves) as electrical variations.

Fig. 33 (a) shows a simple carbon microphone. Fig. 33 (b) giving the equivalent circuit. As shown, the microphone acts like a variable resistance controlled by sound waves.

The compression and rarefaction of the air causes the mica diaphragm to vary the pressure

An Outline of Amplitude Modulation

In Fig. 34 we have a tuned circuit L_1 C_1 and the aerial and earth system adjustment to C_1 enables the frequency to which the circuit responds—its resonant frequency—to be varied. Connected to the tuned-circuit is an R.F. oscillator, the output of which is controlled by an L.F. amplifier. The L.F. amplifier enables the microphone voltages to be amplified.

Tracing through the effects, notice that the sound waves govern the power supplied to the oscillator, therefore the amplitude of the pulses supplied to the tuned-circuit will vary in accordance with air-pressure upon the microphone's diaphragm.

Notice that for maximum results to be obtained the tuned circuit should respond to the oscillator's frequency, i.e., the tuned circuit's resonant frequency should be the same as the frequency produced by the oscillator.

The simple process described above represents the general method of amplitude modulating a carrier wave, variations of the method occurring according to the requirements of the transmitter.

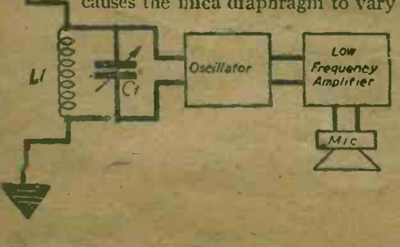
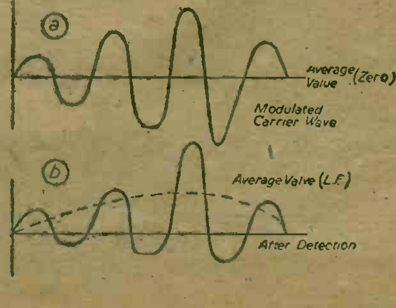


Fig. 34. (Left).—Basic arrangement for modulation.

Fig. 35 (Right).—Detection or demodulation.



The Progress of Detection Discussed

Fig. 35 (a) shows a portion of an amplitude modulated carrier wave. A moment's thought will make it clear that the effect of a voltage of this type applied to a pair of telephones or a loudspeaker will be equal to the average value of the wave, which is zero at all times, i.e., the "pushes" on the diaphragm are equal to the pulls, and because of the speed and the inertia of the diaphragm, act, to all intents and purposes, at the same time.

It can be seen that the average value of the wave must be made to vary. This is done by amplifying the positive half-cycles more than the negative or vice-versa. See waveforms below (I) Fig. 31 and Fig. 35 (b).

When detection has been achieved the R.F. "ripple" is filtered out, leaving L.F. voltages only.

The Heterodyne Principle

Heterodyning is the placing together of two frequencies to form others.

In Fig. 36 (a) and (b) we have two frequencies, f_1 and f_2. Fig. 36 (c) shows the effect of placing f_1 and f_2

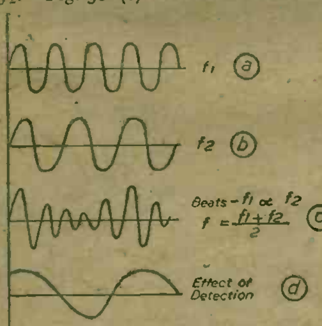


Fig. 36.—Showing the resultant effect of heterodyning two frequencies.

together. We no longer have a steady waveform, the amplitude varying according to the difference in frequency and amplitude of f_1 and f_2.

The frequency at which the shape of the resultant waveform varies (the beat frequency) equals $f_1 \propto f_2$.

Thus : f_1 = 100 kc/s p.s.

and f_2 = 110 kc/s p.s.

then the beat frequency is $f_1 - f_2 = 10$ kc/s p.s., therefore two radio frequencies can produce a low frequency beat which is the result of the two waves falling in and out of step with one another over a period of time. If we "detect" this resultant wave then we obtain a 10 kc/s p.s. voltage, as in Fig. 36 (d).

The frequency of (c) Fig. 36 is the average frequency $\frac{f_1+f_2}{2}$, whilst a further frequency, f_1+f_2, is also produced; we are not concerned with that.

The Superheterodyne Receiver

It will be remembered that an amplifier is more efficient at low frequencies than high, therefore if we can change the frequency of the incoming amplitude-modulated R.F. carrier-wave to a lower frequency for amplification purposes, then greater efficiency can be obtained, and the "sensitivity" of the receiver increased. Further, if we can arrange the circuits so that *any* frequency of carrier-wave is converted to *one* fixed beat frequency then we can design the amplifiers of this beat frequency for maximum response at one position, no tuning controls being required. Greater "selectivity" is thereby attained, shutting out interference from nearby stations.

Fig. 37 is a block diagram with waveforms for a superheterodyne receiver. The aerial voltages (A), are fed via an R.F. amplifier (B), to a "frequency-changer" (C) (also known as a "mixer" or first detector).

The carrier frequency f_1 together with the R.F. (f_2) provided by the "local oscillator" (D), produces a "beat" in the frequency-changer which also "detects" it, producing the lower carrier frequency (intermediate frequency—I.F.) which appears at (E). Notice (1) that the I.F. still contains the intelligence that was upon the original carrier-wave; and (2) that the local oscillator's frequency is adjusted at the same time as the incoming signal's frequency, in order to maintain a constant difference between them and hence a constant I.F. The I.F. is fed through a series of amplifiers (F), and thence to a "second detector" (G), which gives us the intelligence in the form of L.F. voltages. An L.F. amplifier (H), output stage (I), and a loudspeaker or pair of telephones complete the chain (J).

Continuous Wave (C.W.) Reception

Continuous or unmodulated carrier-waves are generally used for morse communication, because of the greater range possible with this type of transmission. By reference to Figs. 36 and 37 it is obvious, because of the constant amplitude of the wave, that detection will produce no audible note, merely a "click" if the wave suddenly stops or starts. To convert the R.F. into an audible frequency in a superheterodyne receiver, a second heterodyne action is required and is provided by the heterodyne oscillator (K). The R.F. is thereby stepped down to an audible frequency when heterodyned and detected. L.F. appears across the output of (G) and a steady whistle is heard in the telephones.

To enable extreme selectivity to be obtained the pitch of the audible note can be adjusted to that frequency which gives the greatest response in the telephones, usually 1,000 cycles per second, and a filter circuit also connected, thereby preventing the passage of all frequencies, with the exception of 1,000 c.p.s. (L).

The superheterodyne receiver possesses the advantages of high selectivity and sensitivity and easy tuning, but because any noise voltages in the aerial and R.F. amplifier circuits are also heterodyned, there is a tendency towards a "noisy" background. Also, because amplification is mainly at a lower frequency, the stability of the receiver is increased.

General Examples

1. A signal of 256 kc/s is received by a superheterodyne receiver with I.F. amplifiers tuned to 40 kc/s. What must be the frequency generated by the local oscillator?

2. What must be the frequency provided by a hetrodyne oscillator, if the I.F. is 112 kc/s and a note of 1,000 c.p.s. is required in the telephones?

Answers for article seven.

1. 159,200 ohms.
2. 25.35 H.

(*To be continued*)

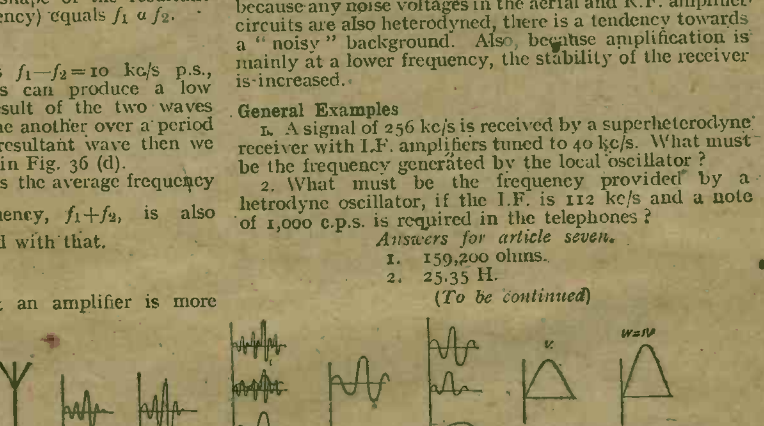


Fig. 37.—The super-heterodyne circuit stage by stage.

The valve tester as made by the author.

YOUR SERVICE WORKSHOP—6

A Valve-testi

(Continued from page 377, Augu

Constructional Details of the Complete Valve T

THE circuit diagram of the valve tester is shown in Fig. 1, where it will be noted that H.T. power is derived from A.C. mains via a transformer and half-wave valve rectifier. L.T. is delivered to the valves by the multi-tapped filament transformer, details of which were given in the August issue. High-tension and screen are each fed to their respective moving contact on the electrode selector switch, as are grid—actually grid bias—and cathode—actually high-tension negative. Since each set of fixed contacts are connected in parallel, and to the valve pins in accordance with the B.V.A. standard numbering, it follows that any source, such as H.T. or grid, may be connected to any pin of any valve holder.

A switch, S1, may be put to "normal" or "rectifier" and in this latter position rectifying valves may be tested; also, with the switch in this position, an average load is thrown across the valve under test.

S2 is for the purpose of selecting "mutual conductance" test or "full emission" test and the former is used in conjunction with S3 and an external meter plugged into sockets so marked, while full emission is indicated on the panel meter shown in the illustrations. S4 is the "soft" test switch, which, when open-circuited, connects a resistor in series with the grid circuit.

Of the power controls, VR1 varies H.T. positive or anode, VR2 controls the screen voltage, VR3 the grid bias voltage, and VR4 is the "set zero" control for use in the mutual conductance test.

From sockets marked "Neon test" the Neon lamp is brought into use for the purpose of checking insulation between electrodes. S5 is the on/off switch.

General Construction

Construction is on rather unique lines, as it allows of a compact assembly and also gives ease of control and viewing. Reference to the illustrations and drawings will show that the tester is built in three sections—the valve panel, the switch panel, which also carries a milliammeter, Neon lamp, etc., and the power unit. The valve panel consists of 1/4in. ebonite and carries 10 valve-holders (see Fig. 3) made up of three English type, four American type, two side-contact and one octal. Also in the centre of this panel are three sockets for a top cap or side terminal connection to anode, screen, or grid, while at the end a socket connects to high-tension negative.

The power unit, which slides into the cabinet from the back, is constructed on a plywood baseboard, a small ebonite control panel measuring 12in. x 2 1/2in. being screwed to the front edge and upon which are mounted all the variable resistors and the on/off switch S5. The latter has to make and break four separate circuits, thus it is convenient to make use of two 2-pole on/off toggle switches ganged together. This is quite simple; the switches are mounted close together, one dolly (the little control knob) is drilled 6 B.A. clearance, the other drilled and tapped 6 B.A., and, after fitting a short length of tubing between the two dollies, a piece of 6 B.A. rod is slipped through and tightened up. The idea will be seen from the illustration. The variable resistors VR1 to VR4 are all of the wire-wound type. VR1 and VR4 must also be capable of carrying a fairly large current, say, 40 milliamps for valves of the P.X.4 type. It would be desirable to increase the value of VR1, but bearing in mind the above remarks it is hardly possible, especially during these times.

The baseboard is covered with metallised paper—more for convenience of earthing than anything else—for in an instrument of this nature one is at least relieved of the necessity of avoiding troubles due to interaction, unwanted coupling, etc.

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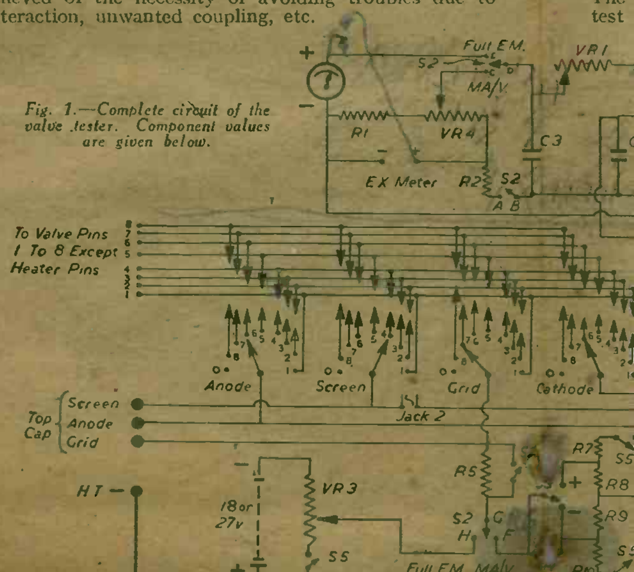

Fig. 1.—Complete circuit of the valve tester. Component values are given below.

C1	8 mfd.	C5	2 mfd.	VR1	50,000 Ω	R1
C2	4 "	C6	0.1 mfd.	VR2	100,000 Ω	R2
C3	2 "		——	VR3	100,000 Ω	R3
C4	2 "		——	VR4	10,000 Ω	R4

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YOUR SERVICE WORKSHOP—6

A Valve-testing Unit

(Continued from page 377, August, 1943)

Constructional Details of the Complete Valve Tester. By STANLEY BRASIER

American type, two side-contact and one octal. Also in the centre of this panel are three sockets for a top cap or side terminal connection to anode, screen, or grid, while at the end a socket connects to high-tension negative.

The power unit, which slides into the cabinet from the back, is constructed on a plywood baseboard, a small ebonite control panel measuring 12in. x 2½in. being screwed to the front edge and upon which are mounted all the variable resistors and the on/off switch S5. The latter has to make and break four separate circuits, thus it is convenient to make use of two 2-pole on/off toggle switches ganged together. This is quite simple; the switches are mounted close together, one dolly (the little control knob) is drilled 6 B.A. clearance, the other drilled and tapped 6 B.A., and, after fitting a short length of tubing between the two dollies, a piece of 6 B.A. rod is slipped through and tightened up. The idea will be seen from the illustration. The variable resistors VR1 to VR4 are all of the wire-wound type. VR1 and VR4 must also be capable of carrying a fairly large current, say, 40 milliamps for valves of the P.X.4 type. It would be desirable to increase the value of VR1, but bearing in mind the above remarks it is hardly possible, especially during these times.

The baseboard is covered with metallised paper—more for convenience of earthing than anything else—for in an instrument of this nature one is at least relieved of the necessity of avoiding troubles due to interaction, unwanted coupling, etc.

Mains Section

The universal filament transformer has already been referred to, and it will suffice to say that from the secondary tappings, leads are taken to 15 sockets equidistantly spaced round a circle of roughly 3in. diameter on a small ebonite panel. The panel is mounted so that it is accessible from the side of the cabinet, to the inside of which it is screwed after the power unit is in position. The high-tension transformer is designed to deliver approximately 250 volts at 60 milliamps from its secondary, together with a 4v. 2 amp. winding for the rectifying valve. No *very* high degree of smoothing is required in the instrument, therefore, a half-wave system has been used, but a normal full-wave rectifier with transformer to suit could obviously be used if it happens to be more convenient. Smoothing condensers C1 and C2 are in the form of an 8+4 mfd. block 300 v.w., while C3 and C4 each consist of a 2 mfd. T.C.C. Mansbridge type 300 v.w. If the baseboard is metal covered, it will be necessary to fit a piece of insulating material—celluloid or paxolin—under the rectifier valve holder which is of the baseboard mounting type. The grid battery for the mutual conductance test consists of two 1.5 volt cells mounted

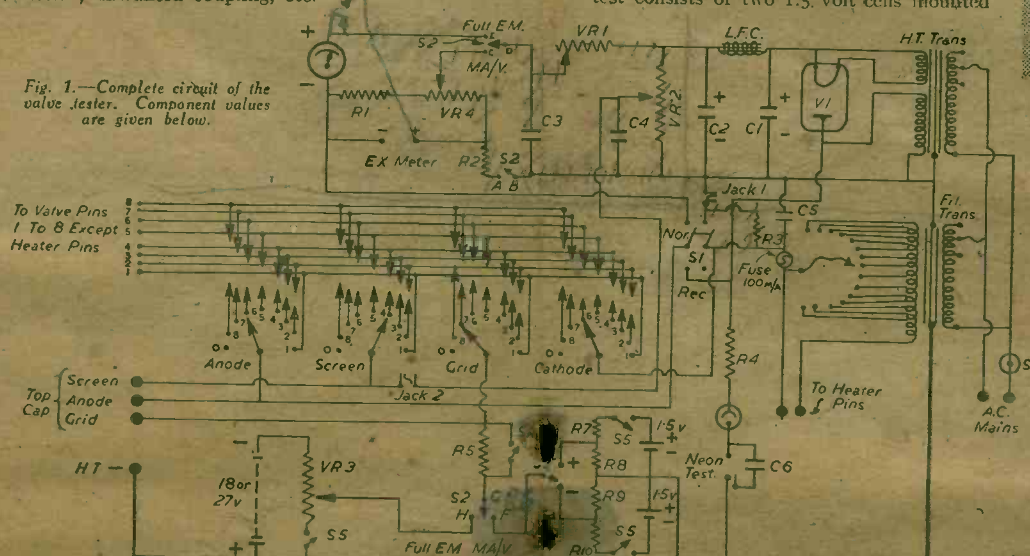


Fig. 1.—Complete circuit of the valve tester. Component values are given below.

C1	8 mfd.	C5	2 mfd.	VR1	50,000 Ω	R1	7,000 Ω	R5	.1 meg. Ω	R9	500 Ω
C2	4 "	C6	0.1 mfd.	VR2	100,000 Ω	R2	7,000 Ω	R6	1 meg. Ω	R10	1,000 Ω
C3	2 "		—	VR3	100,000 Ω	R3	10,000 Ω	R7	1,000 Ω		
C4	2 "		—	VR4	10,000 Ω	R4	50,000 Ω	R8	500 Ω		

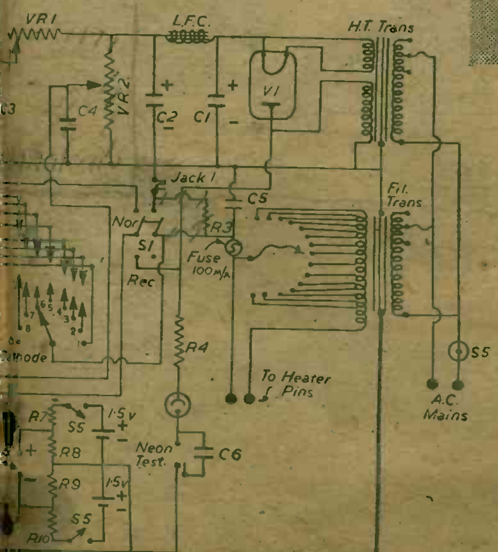
sting Unit

(377, August, 1943)

Valve Tester. By STANLEY BRASIER

Mains Section

The universal filament transformer has already been referred to, and it will suffice to say that from the secondary tappings, leads are taken to 15 sockets equidistantly spaced round a circle of roughly 3in. diameter on a small ebonite panel. The panel is mounted so that it is accessible from the side of the cabinet, to the inside of which it is screwed after the power unit is in position. The high-tension transformer is designed to deliver approximately 250 volts at 60 milliamps from its secondary, together with a 4v. 2 amp. winding for the rectifying valve. No *very* high degree of smoothing is required in the instrument, therefore, a half-wave system has been used, but a normal full-wave rectifier with transformer to suit could obviously be used if it happens to be more convenient. Smoothing condensers C1 and C2 are in the form of an 8+4 mfd. block 300 v.w., while C3 and C4 each consist of a 2 mfd. T.C.C. Mansbridge type 300 v.w. If the baseboard is metal covered, it will be necessary to fit a piece of insulating material—celluloid or paxolin—under the rectifier valve holder which is of the baseboard mounting type. The grid battery for the mutual conductance test consists of two 1.5 volt cells mounted on the baseboard. They are wired in series, with the centre point to earth, and in the original model a mounting was devised whereby a thick wire was soldered across the bottom—positive of one and negative of the other—the ends of which were turned into a loop and screwed to the metal-covered baseboard.



R1	7,000 Ω	R5	.1 meg. Ω	R9	500 Ω
R2	7,000 Ω	R6	1 meg. Ω	R10	1,000 Ω
R3	10,000 Ω	R7	1,000 Ω		
R4	50,000 Ω	R8	500 Ω		

Switch Panel

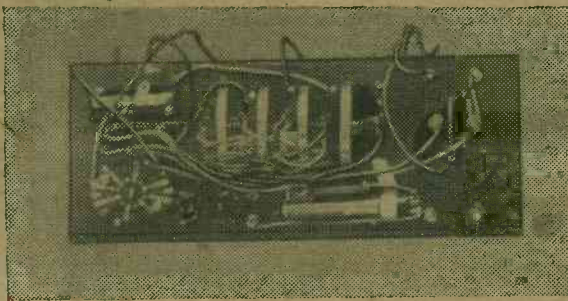
The switch panel is fixed at an angle so that the electrode selector switch (which was the subject of last month's article) may be viewed and operated with ease

The tester with front panel removed and the valve holder panel lifted to show wiring.

This panel is of ebonite and carries switches S1, S2, S3 and S4. S1 is a D.P.D.T. Q.M.B. toggle switch. S2 has to perform various functions and therefore requires two S.P.D.T. and one ordinary make and break switches operated by one control. For want of a more suitable type, the writer has used a switch of the Yaxley pattern, but since one S.P.D.T. section has to stand up to the H.T. supply from VR1, it remains to be seen how it will function with time; so the reader is advised to procure something more suited to the job if at all possible.

For instance, two Q.M.B. toggle switches—one D.P.D.T. and one ordinary on/off—could be ganged together in a way similar to S5. Whatever switch is used it is important to note that it must be wired in such a way that when the slider of VR1 connects to the positive side of the milliammeter, R2 must be disconnected from the earth line and R5 and S4 must, at the same time, be connected to the slider of VR3 in order to ensure the correct operation of the tester.

S3 and S4, although separate electrically, are constructed as one component—a push switch on these lines has previously been suggested in PRACTICAL WIRELESS. The drawing is self-explanatory, but it is necessary to explain that in the S.P.D.T. section, S3, the lower brass contact must be insulated from the next one: it is easily achieved by drilling a hole of sufficient



Rear view of front panel, showing selector switches and neon tube, etc.

clearance so that when clamped between the ebonite collars or spaces it does not make contact with the screw which passes through it.

The Jacks and Meter

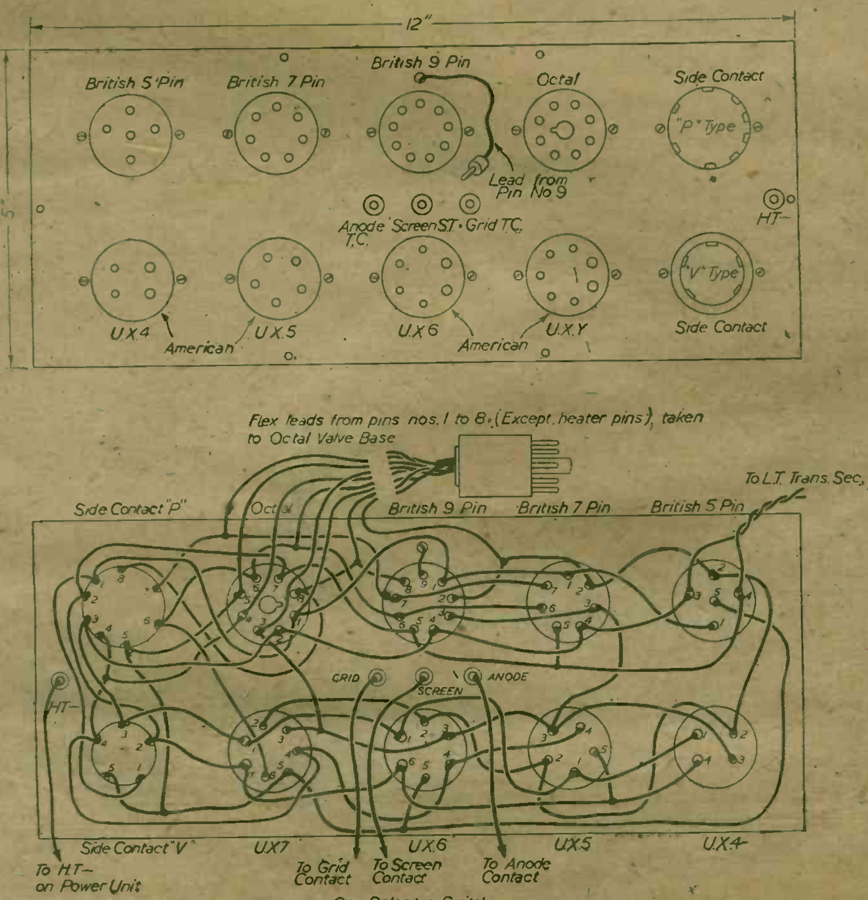
Jacks 1 and 2 are of the closed circuit variety for measuring rectifier and screen current respectively. Another little home-made gadget is utilised on the "Neon test" sockets. One of these is adapted so that when a plug is pushed home into it the fixed condenser—which is normally joined across the sockets—becomes disconnected. The tip of the brass arm which the plug pushes out when it is inserted must, of course, be insulated. The milliammeter shown reads 0-10 and the writer intends to add shunts to increase the range to 25 and 50 milliamps., consequently details of these are not given because it is improbable that the constructor will use a meter of the same type. Anyway, the inclusion of a meter in the actual tester is not absolutely essential—it was used in the original because it was serving no other useful purpose—and if one is not available, sockets marked "external meter full emission" could be used in conjunction with a universal test meter in the same way as in the mu/con. test.

The neon tube is of the type normally used as a tuning indicator with a striking voltage of about 150. It is mounted behind a suitable shaped aperture cut in the panel, the face edges being rounded off to give a neat finish. Other types of lamp—almost any sort may be used—may naturally require a different method of mounting and the value of the resistor R4 may have to be different.

The three ebonite panels, by the way, are finished in grey enamel, which, together with the black controls, gives the tester a smart and professional appearance. The indicator plates are typewritten on thin card, covered by clear celluloid and secured to the panel by small brass pins.

Wiring

Assuming that all components are mounted, the wiring may be commenced. Any remarks in previous articles regarding careful wiring up of test instruments apply more than ever in this case, for it is, of necessity, rather complicated in the whole, but if each section is worked on separately it is just a matter of going methodically through it, making sound soldered joints. Connections which require to be made between the various sections are done with good rubber flex and after soldering one end to the appropriate point the other is clearly marked by affixing a paper tab. This will ensure that, when the final assembly is carried out no confusion exists with all the stray leads. It is necessary that the



Figs. 2 and 3.—Plan and underside views of the valve panel.

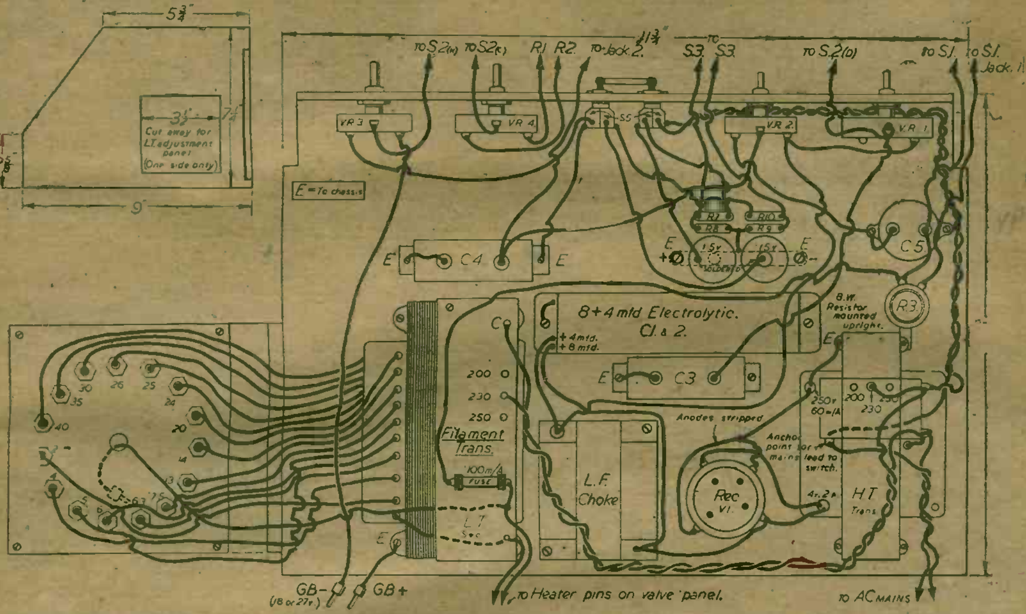


Fig. 4.—Layout and wiring of power unit. The L.T. voltage adjustment panel is accessible from side of panel as shown by the inset.

constructor should understand exactly how the valve panel is wired to the electrode switch. First, all the heater or filament pins of the valve holders are wired in parallel and joined subsequently to the filament transformer secondary. There is no switching here except of course, the adjustment for the various heater voltages. All the remaining pins of the same number, from 1 to 8, are joined together *except where that number is a heater or filament pin.* For instance, take No. 3 pin; a wire will connect to all pins of that number except on the five-pin (British) and both side-contact holders, which are heater pins. Having made this point clear it will be assumed that the electrode selector switch itself is already wired up according to details given in the last article, so that the remaining connections consist of eight flexible leads from pins 1-8 on the vale panel to the eight fixed contacts at the end of the selector switch. They must, of course, be joined so that No. 1 on the valve holders connects with No. 1 contact on the selector switch, No. 2 to No. 2, 3 to 3, etc. For convenience the leads from the selector switch are taken to an octal valve holder, while those from the valve panel go to an octal valve base. When assembling, the valve holder is screwed to the inside of the cabinet (on short ebonite pillars) immediately below the left-hand end of the valve panel, that is, just above the H.T. mains transformer. In this position the plug from the valve panel may be conveniently inserted into it and does save unsoldering at least eight connections if the panels required to be removed at any time.

Although the photographs give a good idea of the component layout, etc., it was not possible to complete all the wiring at this stage.

Cabinet

The cabinet is of extremely simple construction and measurements are given of the side-view, in order to show the correct panel angle, in Fig. 4. It is covered in black rexine and for this reason, if plywood is not obtainable, even a stout margarine or similar box, reasonably smooth, may be adapted for the purpose. The weight of the whole outfit, however, is considerable, so that a strong construction is necessary. It will be seen from the illustration that a type-written sheet of valve data is fixed to the inside of the lid, which latter incidentally keeps dust out of the valveholders when closed. A reproduction of the data sheet will be given later when it will be seen to embrace every valve—except some American ones—that one is likely to test. Against each valve type is a column headed "code number," and the purpose of this will be referred to later.

(To be continued)

LIST OF COMPONENTS

- One universal filament transformer. (As described in "P. W." August, 1943.)
- One mains transformer output 250v. at 60 milliamps 4v. at 2 amps.
- One 4-volt rectifying valve.
- One 4-pin base-board mounting valve holder.
- One L.F. choke, 20 henry 50 milliamps.
- One electrode selector switch. (As described in "P.W." August, 1943.)
- Switches, S1, S2, S3, S4 and S5 (see text).
- Ten sockets.
- Two closed circuit jacks (or plugs and sockets with shorting link).
- One Neon lamp (see text).
- One milliammeter if required.
- Three ebonite panels (see text).
- One ebonite panel mounted with 15 sockets (for low tension voltage).
- One fuse and holder, 100 milliamps.
- Two or three (as required) 9-volt grid bias batteries.
- Two 1.5v. unit cells.
- Ten valve holders as shown on valve panel.
- One octal valve base and holder.
- Cabinet, wire, screws, hinges for lid, etc.
- Resistances: Two potentiometers, 100,000 ohms (wire wound); one potentiometer, 10,000 ohms (wire wound, see text); one variable resistor, 50,000 ohms; two resistors, 7,000 ohms, 3 watt; one resistor, 10,000 ohm, 8 watt; one resistor, 50,000 ohm, 1 watt; two 1 megohm, ½ watt; two 1,000 ohm ½ watt, and two 500 ohm, ½ watt.
- Condensers: One 8+4 mfd. electrolytic, cardboard type, 300v.w.; three 2 mfd. Mansbridge type, 300v.w.; one 0.1 mfd., 350v.w.

Measuring Resistance with a Voltmeter

A Useful Method Which Will Help Many Constructors Who Are Short of Equipment

MANY constructors, these days, find themselves called upon to undertake radio servicing, with little or no equipment; therefore, the following simple method of measuring resistance, with nothing more than a voltmeter, and any available battery, will prove helpful.

If one measures the voltage of a battery, and then puts a resistance in series with the meter, and measures the same voltage again, it will be found that the second reading is less than the first. This is due to the fact that all moving-coil and moving-iron meters draw current, and the resistance placed in series with the meter causes a voltage drop, thus making the actual P.D. across the meter (which is what it measures) less than before.

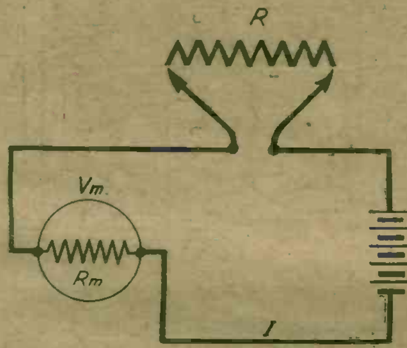


Fig. 1.—The basic circuit illustrating the principle of the ohm/volt meter.

Voltage Drop

It can be seen that the larger the resistance in comparison with that of the meter, the greater will be the drop in voltage across this resistance, and the smaller will be the reading of the meter for any particular battery voltage. A simple application of Ohm's Law will enable us to find the value of this resistance, provided we know the resistance of the meter, and the difference in reading between battery P.D. (V in Fig. 1) and "battery + resistance" P.D.

Assume one uses a battery of voltage V as measured by the meter (resistance Rm Ω). Then if R, the unknown resistance, is placed in series, the indicated voltage will drop to Vm (Fig. 1) where Vm = Rm × current I.

$$\text{Now } I = \frac{V}{R+Rm} \therefore Vm = \frac{Rm \times V}{R+Rm} \quad R = \frac{Rm(V-Vm)}{Vm}$$

or Unknown Resistance =

$$\frac{\text{Meter Resistance} \times \text{Drop in reading of meter}}{\text{Final reading of meter}}$$

Thus all one has to do is to measure the battery voltage before starting, then when any resistance is placed in series one just substitutes the drop in reading into the above formula. As an example: If the meter had a resistance of 10,000Ω and a 15v. G.B. battery was used as V, then if the meter reading with an unknown resistance in series was, say, 3.75v., $R = \frac{10,000 \times (15-3.75)}{3.75}$ = 30,000 ohms.

If, as might easily be the case, the meter's resistance is not known, it can be found with the aid of a fixed resistance R, of a known value as follows. Measure the voltage of a battery, place the resistance in series with the meter, and note the drop in reading of the meter.

$$\text{Then } Rm = \frac{R \times \text{Final reading of meter}}{\text{Drop in reading}}$$

Thus if placing a resistance of 10,000Ω in series with a meter and a 15v. battery caused the meter's reading to drop from 15v. to 5v,

$$Rm = \frac{10,000 \times 5}{10} = 5,000 \text{ ohms.}$$

Estimating Resistance

The writer has been for some time in a part of the world where testing equipment is unobtainable, the only meter on hand being one which I believe is well known to members of the R.A.F. It is a small moving coil meter with two ranges, of 3 and 30 volts, and has a resistance of 600 and 6,000 ohms respectively on these ranges. A series of graphs has been drawn for use with a 1.5 volt cell, 2-volt accumulator, or a 3-volt battery, depending on which is available at the time. By means of these graphs it is possible, as can be seen by Fig. 2, to obtain reasonably accurate estimates of resistance from 50 to 7,000 ohms. If a 30-volt battery is obtainable, and the 30-volt range of the meter used, then the values of resistance shown in Fig. 2 are correspondingly multiplied by 10, extending the range to 70,000 ohms.

It must be pointed out that Fig. 2 is principally an illustration and cannot be used for meters of other than 600Ω resistance. However, readers should find no difficulty in preparing similar graphs for their own use, and they will find that a small amount of time spent in this way will be amply repaid by the time saved when they are again "caught out" with no proper equipment.

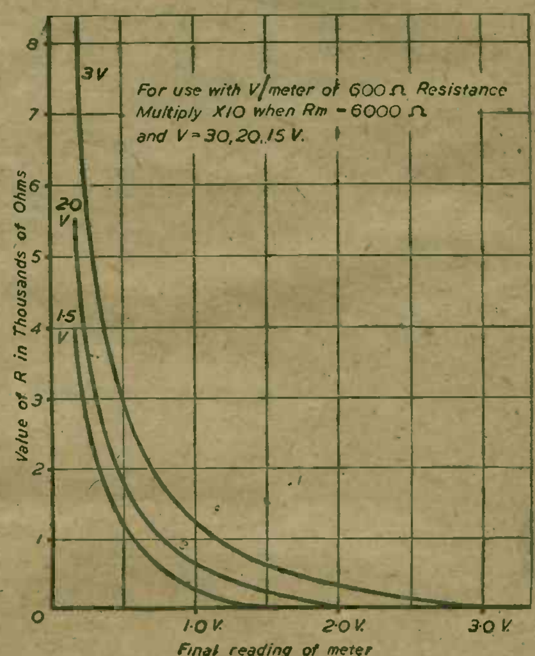


Fig. 2.—The curves compiled for the meter used by the writer of this article.

Practical Hints

Detachable Oscillator Arrangement

I RECENTLY constructed a morse key and oscillator, and wanted to be able to connect and disconnect the key from the oscillator frequently, to extend the key with flex for use over longer distances. Not having enough terminals, I employed the following method: Having an old valve holder I unscrewed the sockets and soldered two of them to one end of the flex and two old valve legs to the other. Next I fastened the remaining sockets on a piece of hard wood and screwed this on the side of the oscillator base, with the leads for the key soldered to them. The wires from the key contacts were then soldered to the other two valve legs. These were then glued into small holes drilled in the base of the key. Everything was now easily detachable, and this idea may be put to a number of uses.—R. K. ADAMS (Swindon).

THAT DODGE OF YOURS!

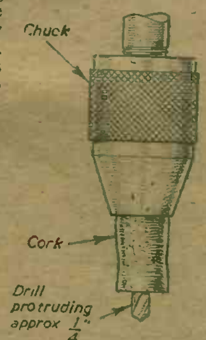
Every Reader of "PRACTICAL WIRELESS" must have originated some little dodge which would interest other readers. Why not pass it on to us? We pay £1-10-0 for the best hint submitted, and for every other item published on this page we will pay half-a-guinea. Turn that idea of yours to account by sending 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 iii of cover.

A Drill Stop

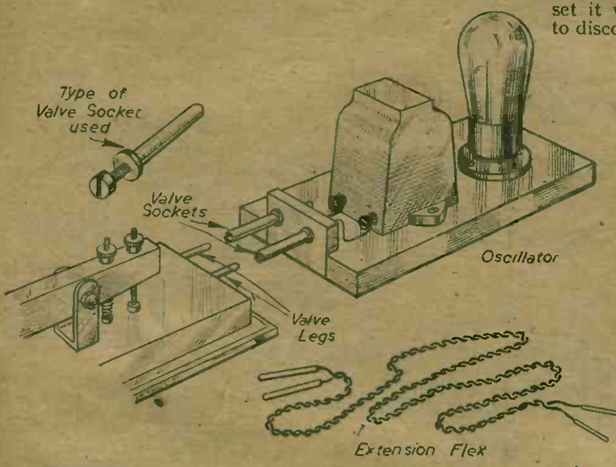
WHEN drilling small holes through a metal chassis the sudden breaking through of the drill may result in a dented chassis or damage to a component previously mounted on the chassis. A small cork placed on the drill as shown will obviate this risk.—C. F. MAY (Birmingham).



A drill stop for use when drilling holes in thin metal.

Testing All-wave Sets

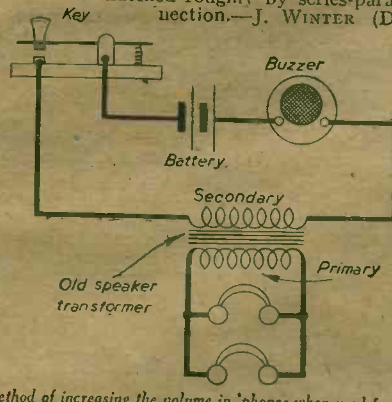
WHEN poor results are obtained with an all-wave set it will often prove of value to disconnect all coils except one, testing the set on that particular range in order to judge of the performance. This suggestion is made as it is often found that the general results given by the set are below standard due to a fault in a component or a valve which is not up to efficiency, and considerable time may be wasted in trying coil connections and the switch assembly. The set should be tried with the medium-wave coil only, as results will more easily be judged on that band. If satisfactory, the short-wave coil should be wired into position and the performance checked in this respect.—R. WARD (Bletchley).



A simple arrangement for a detachable morse key and oscillator.

Multi-phone Morse Circuit

WHEN a buzzer is being used for morse practice many experimenters are dissatisfied with the volume if 'phones are used. By means of the arrangement illustrated up to 10 pairs of 'phones may be used at very good volume. If the impedance of the primary is known the 'phones may be matched roughly by series-parallel connection.—J. WINTER (Dorking).



A method of increasing the volume in 'phones when used for morse practice.

Fixing Control Knobs

MANY constructors build a good receiver, and when installing it in the cabinet spoil the appearance by scratching the front by allowing the screw-driver to slip whilst locking grub-screws in the control knobs. Unfortunately, these screws are not easily accessible and a small watchmaker's screwdriver is generally needed. If the control knob is held rigidly by the fingers of one hand whilst the screw is tightened, no difficulty should arise, but a dodge worth passing on is to cut a large disc from tin or aluminium and cut a small hole in the centre to clear the majority of standard fixing bushes or spindles. A slot is then cut from the edge of the disc to the centre hole. The disc should be pushed over the spindle, the knob then placed on and the screw tightened. Should the driver slip the panel will not be defaced. When the knob is locked up the disc may be removed by opening the slot and lifting it over the knob.—S. WESTON (Cambridge).

Permanent Magnets—VII

Damping Torque : Ballistic Galvanometer : Grassot Fluxmeter

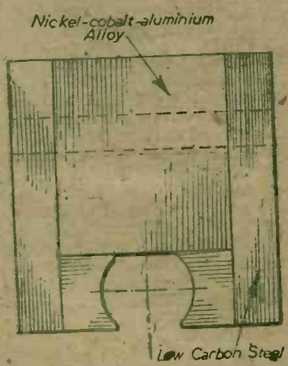
By L. SANDERSON

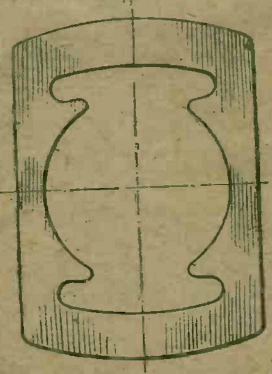
(*Continued from page 382 August issue.*)

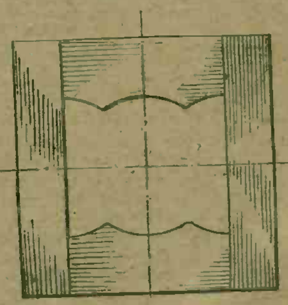
IT must be noted in connection with moving coil permanent magnets that damping becomes necessary in order to eliminate mechanical oscillations of the moving parts of the instrument. Permanent magnets are employed in numerous instruments of this type in order to damp the movement of the moving system, instead of using oil or air dashpot damping.

Generally, the damping is achieved with the aid of eddy currents induced in the metallic former about which the moving coil is wound. A vane of aluminium or other light alloy is attached to the movement, and severs the flux in the magnet air gap, thus producing eddy currents in the metal as soon as it moves. These currents have a reacting effect on the flux, with the result that a torque is produced opposing relative motion of the metal vane and flux in such a way that when properly proportioned the vane may be hindered from swinging about its mean position, and the deflection made "aperiodic" or "dead-beat" as required.

It should be borne in mind that the term "meter damping magnet" is often used when not this type of magnet is meant, but one attached to electric meters in order to furnish the required retarding torque against which the current to be metered does work.







Figs. 1, 2 and 3.—Types of permanent magnet formed in the latest alloy.

Calculating Damping Torque

To calculate the damping torque the formula used is $T=\frac{4B^2r^2l^2wtd10^{-9}}{6(4r+2l)}$. In this equation, T is the damping torque, w is the disc's velocity in radians per second, t is the thickness of the former, d the width of the former, 6 is the specific resistance of the disc material, r is the radius of the disc, and the result is expressed in dyne-cms.

In estimating the leakage flux of moving coil magnets, the air gaps are usually regarded as straight, while the areas over which leakage occurs are similarly regarded as being flat, and of identical area. The area itself is assumed to be the mean of the two unequal areas over which leakage of flux occurs. A point worthy of note is that with these moving coil magnets the flux does not only have to cross an air gap, but must also pass through the iron cylinder, which means an additional fall in flux represented by the formula $B_1l_1\mu$, in which B_1, l_1 and μ_1 correspond to the flux density, length and permeability of the iron cylinder. The value thus obtained must, of course, be subjoined to that of the gap leakage in ascertaining the magnet's correct length.

One of the problems in the design of electric generators of small dimensions, electric motors, rotary transformers, and similar electrical instruments, is the prevention of field copper losses. This has largely been overcome of recent years by the development of permanent magnets made from the newest alloy magnet materials. Figs. 1, 2 and 3 represent characteristic magnets of this type. The steel columns indicated in Fig. 1 are rendered necessary by the brevity of the magnet when made from the Alnico alloy. In these instruments it is almost certain that demagnetising forces will be encountered, e.g., armature reaction, and this makes it advisable to aim at as high a B value as can be achieved, because this will minimise the change in B corresponding to a specific change in H.

Where generators are concerned estimation of leakage reluctance is so difficult that a leakage coefficient is usually adopted for purposes of calculation.

The Magnets

The next type of modern instrument in which permanent magnets are a necessity is the magneto. This apparatus comprises, as a rule, a permanent magnet field and rotating iron inductor occasioning a sharp alteration of the magnetic flux threading a stationary winding. The winding itself comprises a considerable number of turns of fine wire which is linked up with the automobile sparking plugs by means of a distributor. In essence, then, the magneto constitutes an A.C. generator. Here, again, vigorous demagnetising influences have to be allowed for, and, as a result, designers usually aim at a B value higher than the BH (maximum). The type of magnet mostly employed is shown in Fig. 4, and the material employed is Alnico.

A relatively new development is the permanent magnet chuck, for whose introduction we have to thank Messrs. James Neill and Co. (Sheffield), Ltd. The majority of chucks used to-day, and all chucks of magnetic type employed before 1934, were of electromagnet type. In the Neill chuck, permanent magnets are employed, and this means that the risk of breakdowns due to failure of electric power supply is eliminated, while installation expenses are also cut out, and the chuck itself is readily transferable from point to point as required. Both circular and rectangular chucks are available. The general principle of operation is as follows. When the parts being dealt with on a particular machine are gripped by the chuck, the flux traverses the parts and sets up a powerful magnetic retention force,

(*Continued on page 427*)

serving to hold them securely in position. When the operation is complete, and the parts have to be released, a lever is moved which operates a cam and transfers the magnet system to the right. The result of this is that the flux now passes through the top plate, and the magnetic retaining force exerted diminishes to virtually nil.

Residual magnetism is extracted by the aid of a demagnetising apparatus.

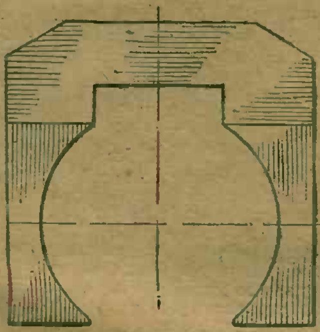


Fig. 4.—One type of P.M. which has a wide field of application.

We must now consider methods of magnetising and demagnetising. Magnetising has as basis the passage of an electric current along a wire coil, but the development of modern magnetic materials has made necessary considerable alteration in the design and construction of magnetising apparatus. To deal with Nial, Alnico, etc., it is now the practice to employ one or more turns of a copper conductor of heavy section, and to pass through this an electric current of 20,000 amps, the duration of the current being momentary only. The current itself is obtained by passing d.c. current through a transformer primary winding and short-circuiting a single turn secondary winding by giving the magnetising coil one or two turns.

Demagnetisation is usually achieved by placing the magnets in an alternating magnetic field from which they are gradually withdrawn to a point at which the field is of negligible strength. The initial value of the alternating magnetising force is identical with that of the usual magnetising force. When removed, the magnets are non-magnetic. The magnets of smaller dimensions are in most works placed in a solenoidal coil connected to a 50 C.P.S. supply, and gradually withdrawn. Where magnets of larger dimensions have to be demagnetised, it is desirable to use a lower frequency.

Ballistic Galvanometer

We have referred in earlier articles to flux measurement, but have not as yet indicated how these measurements are obtained. The instrument employed is known as the ballistic galvanometer. Its object is to measure the quantity of electricity passing through a circuit. To enable it to fulfil this function it is essential that it should possess a moving system with a considerable inertia moment, in order that the discharge through the galvanometer may be completed in advance of any considerable deflection of the coil. Secondly, it must not have a moving system with a large amount of damping, as a result of air friction and control suspension friction. If the galvanometer circuit is closed, electromagnetic damping will occur as a result of the passage of induced currents through the coil. The theory of the instrument is based on the assumption that the quantity of electricity is caused to pass through the moving coil in an extremely brief period. Thus, because of the considerable inertia moment, its movement from the rest position is virtually negligible by the time the discharge is completed. The discharge energy is afterwards dispelled by electromagnetic damping and friction. Fig. 5 shows the connections for the ballistic galvanometer magnetic test, used to determine the ballistic constant.

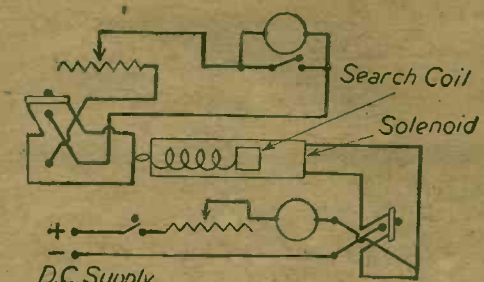


Fig. 5.—Circuit details and connections for the ballistic galvanometer test.

Because it demands a swift discharge of the quantity of electricity, the instrument cannot be employed as a means of measuring flux in electrical machinery magnetic circuits, because in these instances the appreciable "time constant" of the circuit prevents the swift growth and dissipation of the flux. For these purposes it is essential to use a different type of instrument termed the Grassot fluxmeter, with which we shall deal later.

The quantity of electricity passing through the ballistic galvanometer is represented by the equation Q=B⊗, where b is the ballistic constant and ⊗ the true or corrected deflection for the undamped swing. There are various ways of determining b, and that represented by Fig. 5 uses a mutual inductance of known value.

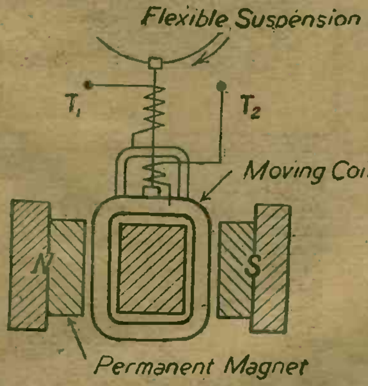


Fig. 6.—The fundamental details of the Grassot fluxmeter.

Grassot Fluxmeter

The fluxmeter is an apparatus by means of which the flux in a magnetic circuit to which it can be linked is directly measured. The Grassot fluxmeter (see Fig. 6) is essentially a galvanometer of pointer type with a freely suspended coil having no restriction upon its movement, and a powerful permanent magnet. A search coil of known turns is linked up with the galvanometer, and the moment that magnetic flux is led into the coil it (the coil) deflects. The return of the indicator to O is gradual, thus providing ample time for the necessary reading. Calibration of the instrument is with each search coil, and it makes a most effective piece of apparatus for measuring the distribution of flux in a magnet.

The advantage the Grassot fluxmeter has over the ballistic galvanometer is that when measuring magnetic flux changes the time comprised in the change need not be small, and, in fact, the result is identical for changes taking minutes or seconds. It is somewhat less sensitive than the ballistic galvanometer, but highly portable.

(To be continued)

Alternating Current

Circuit Considerations

(Continued from page 379, August issue)

THE resultant of VR and VL must be equal to the generator e.m.f. E and the angle by which E leads I is called the phase angle ϕ (from 0 deg. to 90 deg.).

The quantity Z which determines the current I which flows when an e.m.f. E is applied to the circuit is called the impedance of the circuit.

Then $E=ZR$.

Now consider the triangles of Fig. 12, the first of which has sides equal to the vector V_R, V_L and E respectively. This can be represented by what is known as an impedance triangle (second triangle) whose sides are R, Z and ωL respectively. Then from this latter we have, by the Theorem of Pythagoras:

$$Z^2=R^2+\omega^2L^2$$
$$Z=\sqrt{R^2+\omega^2L^2}$$
$$I=E/\sqrt{R^2+\omega^2L^2}$$

The phase relations between the voltage and current are also obtained from the impedance triangle, and being denoted by ϕ:

$$\tan\phi=\omega L/R=X/R$$

Similarly $\begin{cases}\sin\phi = X/Z\\ \cos\phi = R/Z\end{cases}$

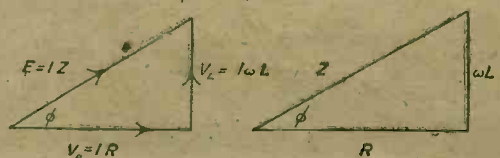


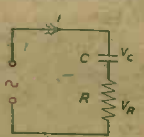
Fig. 12.—Production of the impedance triangle from which is obtained the expression $Z^2=R^2+\omega^2L^2$.

In some cases the values of L and R are such that the inductive reactance ωL is very much greater than the resistance R, the impedance of the circuit then being very nearly equal to ωL. Tan ϕ consequently tends to become infinite in value, that is, ϕ approaches 90 deg. The circuit is then in effect a pure inductance. In the case of R being much greater than ωL $\tan\phi$ approaches a zero value, and the circuit behaves as a pure resistance.

Resistance and Capacity in Series

This instance is dealt with as in the previous example, the reference vector I being taken, VR being in phase with this while VC lags by 90 deg. The impedance triangle (Fig. 13) gives us the result in a similar manner to the other case.

$$Z^2=R^2+1/\omega^2C^2$$
$$Z=\sqrt{R^2+1/\omega^2C^2}$$
$$\therefore\ I=E/\sqrt{R^2+1/\omega^2C^2}$$



The phase relations are given thus:

$$\tan\phi=X/R=1/\omega CR$$
$$\sin\phi=X/Z$$
$$\cos\phi=R/Z$$

In a mixed circuit of the type just described the power which the generator releases to the circuit is as follows:

(a) That supplied to the reactive component to build up the magnetic or electrostatic field during odd quarter cycles which is returned to the generator during the quarter cycles when the field is collapsing.

(b) That supplied to pass a current I through a resistance which is dissipated as heat and the like i.e., actual power supplied $= I.\ V_R = I^2R$.

The product of E and I gives the apparent power that the generator supplies:

i.e., apparent power $= EI = I^2Z$.

We define *Power Factor* = actual power/apparent power.

$$=I^2R/I^2Z$$
$$=R/Z$$
$$=\cos\phi$$
$$\therefore\ \text{Power Factor}=\cos\phi$$

Resistance, Inductance and Capacity in Series

In the circuit of Fig. 14 the current flowing is the same in every part of the circuit, and a reference vector I can therefore be drawn as the basis for the complete vector representation of the arrangement. The p.d. across the resistance is IR volts and is drawn in phase with the current; the p.d. across the inductance is wLI volts and leading the reference current vector by 90 deg. while the voltage across the capacitance is $1/\omega C$ volts, this being drawn with a 90 deg. lag on the current vector.

It will be seen that the quantities ωLI and $1/\omega C$ are antiphase and the resultant of these will be either capacitive or inductive depending upon which is the greater. The resultant of the three vectors will therefore either lead or lag upon the current, being dependent upon whether ωLI is greater than, equal to, or less than $1/\omega C$. The three possible conditions are depicted by the three triangles of the figure. From the first of these the relationship of E and I is obtained in the following way:

$$E^2=(IR)^2+(\omega LI-1/\omega C)^2$$
$$\therefore\ E=I\sqrt{R^2+(\omega L-1/\omega C)^2}$$
$$\therefore\ I=E/\sqrt{R^2+(\omega L-1/\omega C)^2}$$

This expression $\sqrt{R^2+(\omega L-1/\omega C)^2}$ is the impedance Z of the circuit, the phase angle ϕ between the current and the applied voltage being given by:

$$\tan\phi=(\omega L-1/\omega C)/R$$

The relations:

$$\begin{cases}I=E/\sqrt{R^2+(\omega L-1/\omega C)^2}\\ \tan\phi=(\omega L-1/\omega C)/R\end{cases}$$

are true whether $1/\omega C$ is smaller than ωL or not. If $1/\omega C$ is greater than wL, the expression $\omega L-1/\omega C$ is negative in sign and ϕ is negative also. This is simply because the p.d. lags behind the current as in the second triangle of Fig. 14. Similarly when the quantities ωL and $1/\omega C$ are equal, the applied p.d. and the current are in phase and the circuit behaves as a purely resistive one.

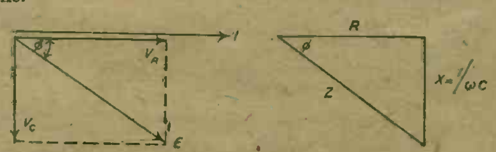


Fig. 13.—Phase relations of E and I and the impedance triangle for a resistance-capacity arrangement.

The Series Resonant Circuit

Consider again the series circuit of the previous example. Now, referring to the five vector conditions of Fig. 15, consider the effect of varying the frequency applied to the L, C and R circuit.

(a) When ω is very small:
ωL is very small; $1/\omega C$ is large; $(1/\omega C-\omega L)$ is very large; Z is very large; I is small; ϕ is large.

(b) When ω is small:
ωL is small; $1/\omega C$ is large; $(1/\omega C-\omega L)$ is large; Z is large; I is small; ϕ is large.

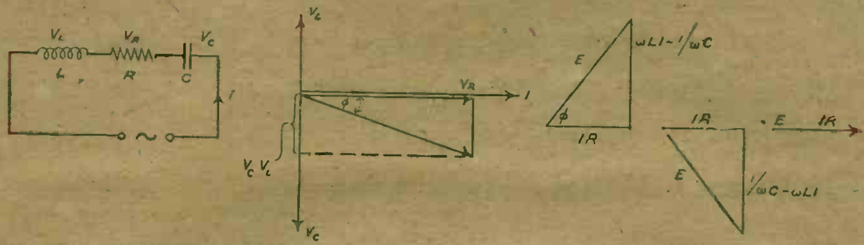


Fig. 14.—The phase relations and the three possible impedance triangles for a series circuit of L, C and R.

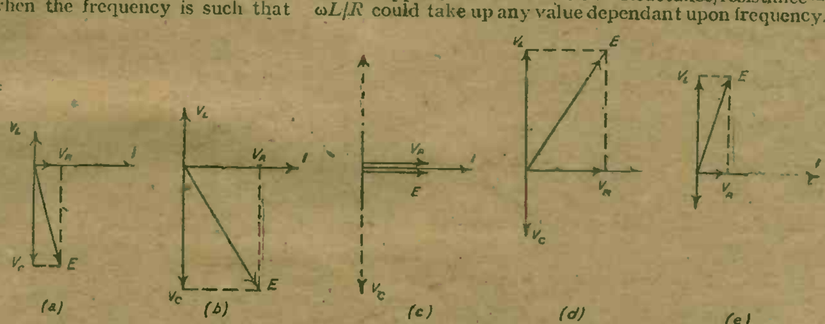
(c) When ω is such that $X_C = X_L$:
ωL is large; $1/\omega C$ is large; $(1/\omega C - \omega L)$ is zero; Z is equal to R; I is equal to E/R; ϕ is zero.

(d) When ω is large:
ωL is large; $1/\omega C$ is small; $(1/\omega C - \omega L)$ is large; Z is large; I is small; ϕ is large.

(e) When ω is very large:
ωL is very large; $1/\omega C$ is very small; $(1/\omega C - \omega L)$ is very large; Z is very large; I is very small; ϕ is large.

From this it will be seen that as ω increases (E being constant in magnitude) the current increases to a maximum value E/R, when the frequency is such that

Fig. 15.—What happens in a series resonant circuit as the frequency is varied, c showing the condition of resonance.



the inductive reactance equals the capacitive reactance. As ω increases further the current again decreases.

The condition when the circuit is purely resistive and the current is a maximum is known as the electrical resonance point, and the frequency at which this occurs is called the resonant frequency (f_0). The curves of Fig. 16 show this condition graphically, the current being plotted against the applied frequency and the impedance Z respectively.

If f_0 is the resonant frequency, then:

Frequency at resonance:

$$X_C = X_L$$

$$\therefore 1/\omega C = \omega L$$

$$\therefore \omega^2 = 1/LC \text{ or } \omega = 1/\sqrt{LC}$$

$$f_0 = 1/2\pi\sqrt{LC}, \text{ since } \omega = 2\pi f$$

The current at resonance I_0 is given by:

$$I_0 = E/Z_0 = E/R$$

The voltages present across each of the components at resonance are as follow:

$$\begin{cases} V_R = I_0 R = E \\ V_L = I_0 \omega_0 L = \omega_0 LE/R \\ V_C = I_0/\omega_0 C = E/\omega_0 CR \end{cases}$$

V_L and V_C are equal at resonance, and in normal radio circuits are much larger than the generator *e.m.f.* The series resonant circuit is generally referred to as the acceptor circuit.

Circuit Magnification

Before proceeding with the parallel cases of A.C. circuits we will deal with the applications of the series resonant circuit, which we have just examined, to radio circuits. Radio technique is really only a specialised branch of A.C. engineering, and great use is made of the resonant effect of a series circuit as well as the parallel one, which will be discussed later.

The ratio V_L/E or V_C/E is called the circuit magnification or Q factor. Since $V_L/E = I_0\omega L/I_0 R = \omega_0 L/R$, the Q factor of the circuit may also be defined as:

$$\frac{\text{Reactance of one kind}}{\text{Total circuit resistance}}$$

Thus, the Q factor $= \omega_0 L/R = 1/\omega_0 CR$

Also, since $\omega_0 = 1/\sqrt{LC}$ we have:—

$$Q = \omega_0 L/R = 1/\sqrt{LC}\; L/R = 1/R\sqrt{L/C}$$

Q Factor of a Coil

Consider a coil of inductance L and resistance R. If it has no association with the resonant circuit it would appear that the ratio: Reactance/resistance $= \omega L/R$ could take up any value dependant upon frequency.

In practice any one coil is designed for a certain frequency range. Also, it is found that the resistance of a conductor is not constant for alternating current; as the frequency increases the resistance is found to increase, due to the fact that the increased inductance of the central region of the conductor confines the current to the outer layers, thus effectively reducing the cross-sectional area. The relationship between resistance and frequency is a complicated one, but it is generally found that the ratio $\omega L/R$ remains fairly constant over the frequency range for which the coil is designed.

We define Q coil = Reactance/Effective resistance.

Q Factor of a Condenser

We define Q condenser = Reactance/Effective resistance.

In practice a condenser absorbs only a very small proportion of the energy supplied to it, and consequently has a much higher Q than the average coil.

Fig. 16.—Response curves of the series tuned circuit.

Relationships of the Q Factors

In a series circuit let the resistance of the coil be R_L, and the resistance of the condenser R_C.

Then total circuit resistance $= R_L + OR_C$

$\therefore Q$ circuit $= \omega_0 L / R_L + R_C$

For the coil alone at the resonant frequency:

Q coil $= \omega_0 L / R_L$

For the condenser alone, at the resonant frequency:

Q condenser $= 1/\omega_0 C R_C$

Now consider $1/Q$ coil $+ 1/Q$ condenser

$= R_L/\omega_0 L + \omega_0 C R_C$

$= R_L/\omega_0 L + R_C/\omega_0 L$ *since* $\omega_0 L = 1/\omega_0 C$

$= R_L + R_C/\omega_0 L$

$= 1/Q$ circuit.

$\therefore 1/Q$ circuit $= 1/Q$ coil $+ 1/Q$ condenser.

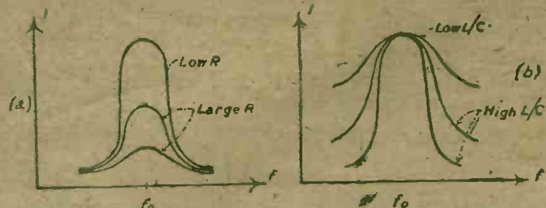


Fig. 17.—The effect of resistance, and the l/c ratio of the response curve respectively.

In practice, since Q condenser is very much greater than Q coil, to a good approximation Q circuit $= Q$ coil.

Selectivity of a Tuned Circuit

As readers know, the selectivity of a circuit is its ability to discriminate between signals of different frequencies. Clearly the peakiness of the response curve—the current against frequency graph as shown in Fig. 15—is a measure of the selectivity; the peakiness of such a curve depends upon the following factors:

(i) The resistance—the height of the peak given by E/R, is inversely proportional to the resistance and

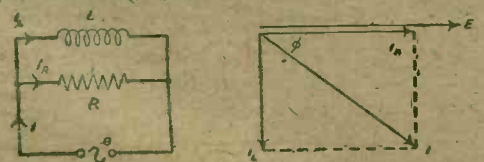


Fig. 19.—Phase relations in a parallel circuit of resistance and inductance.

therefore the selectivity varies as I/R. (Fig. 17(a).)

(ii) The L.C. ratio—response at resonance depends upon the resistance only as we have seen; response off resonance depends upon resistance and reactance.

It is found that with a low L/C ratio, the resistance increases slowly as frequency deviates from resonance.

Thus the impedance is small, giving inselective response curves; *i.e.*, the selectivity depends on the L/C ratio. (Fig. 17(b).)

It is possible to give the selectivity in terms of Q. Referring to Fig. 18, it will be seen that for high selectivity:

$$f_0 / f_2 - f_1$$

should be large. Suppose the curve is cut at a response level of $I/\sqrt{2}$; it can be shown that at this response level the resistance of the circuit is equal to the reactance, for

$Z = \sqrt{R^2 + X^2} = \sqrt{2R^2} = \sqrt{2}\,R$

Current $= E/Z = E/\sqrt{2}R = I_0/\sqrt{2}$

Now at f_1 the capacitance is predominant.

$\therefore 1/\omega_1 C - \omega_1 L = R$ .... (1)

while at f_2 the inductive reactance is predominant

$\therefore \omega_2 L - 1/\omega_2 C = R$ .... (2)

Multiply equation (1) by ω_1 and equation (2) by ω_2

$\therefore 1/C - {}_1{}^2 L = {}_1 R$

and $\omega_2{}^2 L - 1/C = \omega_2 R$

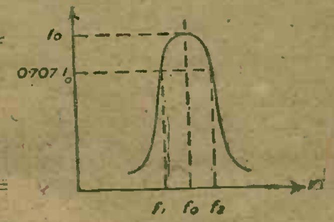


Fig. 18.—The response curve from which selectivity may be given in terms of Q.

Adding these:

$\omega_2{}^2 L - \omega_1{}^2 L = \omega_1 R + \omega_2 R$

$L(\omega_2 - \omega_1)(\omega_2 + \omega_1) = R(\omega_1 + \omega_3)$

$L(\omega_2 - \omega_1) = R$

Dividing both sides by ω_0:

$\omega_2 - \omega_{1_0}\ \ L/\omega_0 = R/\omega_0$

$\therefore \omega_0/\omega_2 - \omega_1 = \omega_0 L/R$

$\therefore f_0/f_2 - f_1 = \omega_0 L/R = Q$

Thus by choosing a particular response level we have shown that Q is a direct measure of the selectivity. We have already seen that $Q = 1/R\sqrt{L/C}$.

Parallel Circuits

We will now deal with parallel circuits. First a circuit with inductance and resistance in parallel as shown in Fig. 19. Since in this instance the voltage is the same across both components, a vector of the generator e.m.f. E is taken as the reference. The current through the resistance is drawn in phase with Em, while the current through the inductance lags it by 90 deg.

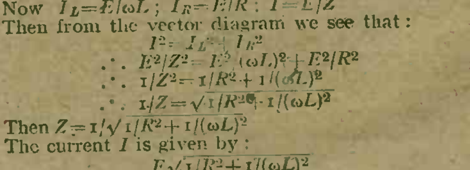


Fig. 20.—Phase relations in a resistance-capacity parallel combination.

Now $I_L = E/\omega L$; $I_R = E/R$; $I = E/Z$

Then from the vector diagram we see that:

$I^2 = I_L{}^2 + I_R{}^2$

$\therefore E^2/Z^2 = E^2/(\omega L)^2 + E^2/R^2$

$\therefore 1/Z^2 = 1/R^2 + 1/(\omega L)^2$

$\therefore 1/Z = \sqrt{1/R^2 + 1/(\omega L)^2}$

Then $Z = 1/\sqrt{1/R^2 + 1/(\omega L)^2}$

The current I is given by:

$E\sqrt{1/R^2 + 1/(\omega L)^2}$

and lags on the applied p.d. by an angle ϕ. The circuit is inductive.

Resistance and capacitance in parallel. This circuit is shown in Fig. 20, together with the vector presentation. The current through the resistance I_R is again in phase with the applied e.m.f. while the current through the capacitance leads the e.m.f. by 90 deg.

Then from this we obtain the following:

$I^2 = I_R{}^2 + I_C{}^2$

$\therefore E^2/Z^2 = E^2/R^2 + E^2\omega^2 C^2$

$\therefore 1/Z^2 = 1/R^2 + \omega^2 C^2$

$Z = \sqrt{1/R^2 + (\omega C)^2}$

The current I is given by:

$E/\sqrt{1/R^2 + (\omega C)^2}$

and leads the applied e.m.f. by the angle ϕ. This time the circuit is capacitive.

(To be continued.)

Midget Universal Receiver

To Assist Those Unable to Obtain the Parts Specified in the January Issue, Instructions are Given About the Use of Alternatives. By STANLEY BRASIER

Valves

MANY readers constructing the set wish to use valves other than those specified, and in this connection there is no reason why other makes should not be used, providing that they are of the same basic type. For instance, V1 must be of the variable mu variety in order that the system of volume control may be worked satisfactorily. Reference should be made to the original article where the importance of the correct value of R2—the fixed bias resistor—was stressed. The value of the volume control R1 may need to be increased if the particular valve used requires a negative bias of greater value than that provided by 5,000 ohms (the value specified). This will be apparent from the fact that the volume cannot be reduced to a low enough level. Similarly, the screen may require some voltage different from that provided by R3 and here it is best to experiment with the value of this resistor for optimum results.

The detector valve V2 differs from V1 inasmuch as it is of the "straight" or non-variable mu type and works on the anode bend principle. The resistor R5 should be suitable for all types, but the makers may recommend some other value of load resistor (R7) for best results. The screen voltage for this valve must be kept low—about 20 volts—and it is convenient to take it from the high potential end of the output valve's bias resistor, as is shown in the original circuit diagram. If this scheme is not convenient a dropping resistor from the high tension line may be employed but a fixed potentiometer system is rather more satisfactory.

Output Pentode

Practically any universal output pentode may be used for V3 as the optimum load for these valves is much about the same, and the only thing one need worry about is the value of the bias resistor, as this may vary between 150 and 1,000 ohms, according to the type of valve, so it is important to select the correct value. This is easily found, however, from the formula: $R = \frac{\text{Grid bias volts}}{\text{anode current}} \times 1{,}000$. For example, a valve taking an anode current of 45 milliamps and requiring a bias of 9 volts would develop this voltage across a resistor of $R = \frac{9}{45} \times \frac{1{,}000}{1} = 200$ ohms.

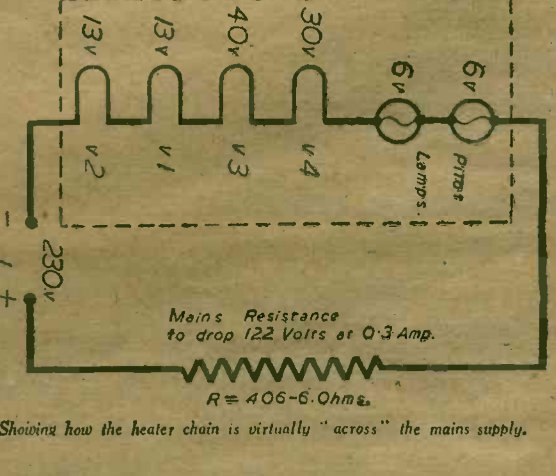
This, and other simple formulæ, is continually cropping up in set construction and to those readers who are unfamiliar with them it is most useful to record the data in a note-book kept especially for the purpose, together with any other information which might prove useful in the future. This would do much to save time and trouble as well as perhaps avoiding the necessity of asking the same question in the form of an inquiry to the Query Department.

For instance, the calculation of the value for a mains dropping resistor seems to cause some readers a great deal of worry, yet the arithmetic involved is extremely simple. The voltage of the various heaters, since they are joined in series, does not matter, because the value of the dropping resistor is adjusted to suit. The *current*, however, *does matter*, because, in a series circuit it remains constant and one has to decide at the outset what this current will be, i.e., whether 0.3 amps or 0.2 amps, according to the valves in use, as the value of the mains resistor will depend upon this also. To calculate the resistance required, it is first necessary to add together the heater voltages of all valves including pilot lamps, and this figure is subtracted from the mains voltage. The remaining figure represents the voltage to be absorbed by the dropping resistor, the value of which may then be found by applying one form of Ohm's Law, i.e., $R = \frac{E}{C}$ where E = voltage (E.M.F.) to be dropped and C = the current taken by the valve heaters. When considering this little problem, it is easier to visualise the heater and pilot lamp chain as one piece of apparatus. This is shown in Fig. 1, where it is supposed that 0.3 amp valves are being used. At the voltages taken by the valves—within the dotted lines—the "apparatus" draws 108 volts at 0.3 amps from the 230 volt mains. A resistor, therefore, is required to absorb the surplus voltage in much the same way as an ordinary dropping resistor between high-tension positive and a valve anode, only that the current is very much heavier, thus necessitating a large wattage rating. Applying Ohm's Law to Fig. 1, we see that R has to absorb 230 v. minus 108 v. or 122 v. at 0.3 amps (the current of the valves), therefore $R = \frac{122}{0.3} = 406.6$ ohms. A still simpler way is to bring the current to milliamps and multiply by 1,000, i.e., $\frac{122}{300} \times \frac{1{,}000}{1} = \frac{1{,}220}{3} = 406.6$ ohms. Actually 400 ohms would be near enough in practice. Incidentally, the above is another handy formula for the note-book. Although it is the same as the bias resistor calculation shown earlier it could be expressed as: mains dropping resistance =

$$\frac{\text{mains voltage minus total voltage of heaters}}{\text{heater current of valves in milliamps}} \times \frac{1{,}000}{1}$$

Mixed Heater Currents

Where the valves are mixed, i.e., some requiring 0.2 and some 0.3 amps for their heaters, it is obvious that the mains resistance must be calculated at the



Showing how the heater chain is virtually "across" the mains supply.

higher current, and *shunts* provided for those valves taking the lower current. An example of this is shown in the original circuit diagram of the " Midget Universal Receiver," where 0.2 amp. valves were used, except for V_3, the output pentode, which consumes 0.18 amp. Thus, the difference of 0.02 amps. (or 20 milliamps) has to be by-passed by a shunt resistor at 20 volts—the voltage of V_3's heater. Therefore, resistance of shunt

$$= \frac{20}{20} \times \frac{1{,}000}{1} = 1{,}000 \text{ ohms.}$$

Condensers

Some readers have been unable to obtain the 8+8 mfd. can type electrolytic smoothing condenser, and ask if the cardboard block type will be suitable. The answer is yes, providing its working voltage is 350 or over and, of course, the capacity is as specified; but even here, if, say, a 4+4 mfd. is on hand it is well worth trying, for mains supplies vary so much that this capacity may be enough to provide sufficient smoothing. For instance, when the " Midget Universal Receiver " was undergoing its tests, there was absolute silence from the speaker on D.C., whereas on A.C. a slight buzz was usually discernible.

The Mansbridge type block condensers are also suitable, but in this case their bulk usually excludes the possibility of inclusion in a midget set. Regarding the small condensers, any of the advertised non-inductive tubular type with a working voltage of 350 or so are suitable.

Coils

The coils used in the original receiver are, unfortunately, not obtainable, that is why details were given in the article for home-constructed types. Any commercial midget coils that the reader may be able to secure will be suitable, providing they have a primary winding, which, in the case of the H.F. transformer, must be entirely separate (electrically) from the grid winding. If no primary winding is available, use can usually be made of a portion of the long-wave section—which in this case is not required—and was actually done in the original.

Loudspeaker

This is of the mains energised type having a field resistance of 1,000 ohms, but fields of higher or lower resistance, within reason, may be employed if one remembers that the former will reduce the available high tension to the valve anodes. The lower resistance will increase it; but most universal valves take up to 250 volts on the anode, so that some advantage may be gained providing the screen voltages are correctly adjusted. When using a high résistance unit, one must expect some slight reduction in all-round efficiency, due to the inevitably lower voltage, and it would not be wise to go above a 2,500 ohm field. On the other hand, if a speaker is available having a very high resistance [field] of about 8,000 ohms or more, it would be worth trying it in *parallel* with the H.T. supply, that is between cathode of the rectifier and high tension negative. It would then be necessary to include a smoothing choke connected in place of the speaker field shown in the circuit diagram in the original article. The size of the speaker unit has also come under discussion, since various readers wish to use one of 4in. or 5in. diameter. Obviously this would be quite satisfactory, although the output will naturally be reduced. It was suggested that an extra L.F. stage be introduced to compensate for this lack of output, but such an expedient would only tend to complicate matters for the receiver, as originally designed, would fully load a speaker of the truly midget type.

No mention has so far been made of the rectifying valve, V_4. This may be of any half-wave universal type, bearing in mind the heater current, but where an American Octal or U.X. type is used (these are usually full-wave), the anodes should be strapped together, likewise the cathodes.

Chassis

It is unlikely that a chassis of the size specified is obtainable commercially, therefore it has to be made at home, if metal construction is required, but a simple framework of wood, if covered with some metal foil or metallised paper, will be suitable.

A.C. Ripple on the S.W.'s

THE output from the smoothing choke is generally referred to as "D.C.," but it should be borne in mind that although a rectifier has been used the output will bear a ripple, the degree of this depending upon many factors. This ripple is not of great importance in broadcast apparatus, but on the short waves it is possible for this to be modulated, thus giving rise to audible hum in the output circuit. Feed-back between various stages is also possible as the choke is common to all stages, and it is these factors which concern the short-wave listener. A simple mains unit or battery eliminator will not, of course, employ such a high inductance smoothing choke as a speaker field and thus the trouble is even more pronounced.

The first step in removing those troubles is to isolate the detector stage, as it will be found that this is most prone to troubles from outside sources. Simple decoupling may prove effective, but where experimental work is to be avoided it may be preferable to adopt the following procedure right away. As we have stated that the detector stage is most likely to be the root of the trouble, this should be fed with a separate H.T. supply, and the easiest way of doing this is to take a separate lead from the D.C. point of the rectifier, i.e., before the smoothing choke, and connect in series a reliable make of L.F. choke. Two additional smoothing condensers will, of course, be required and connected in the usual manner. This now provides two H.T. circuits, each with their own smoothing arrangements, and one can be used for the H.F. and L.F. stages, and the other for the detector stage alone.

PRIZE PROBLEMS

Problem No. 447

THOMAS had a receiver of the 0-V-1 type which gave very good results when operated off batteries. Owing to the difficulty of obtaining new H.T.s, he decided to make up an eliminator to operate off his A.C. mains.

On test the unit was quite satisfactory, but when he tried it with the receiver, the performance of the latter was spoilt by pronounced " motor-boating." Thomas decided that anode decoupling was called for, so he found a suitable resistor and a 1 mfd. condenser in his junk box, and connected the resistor between the H.T. positive line and the H.T. terminal of the L.F. transformer. The condenser was then joined between the latter and the earth line. When he switched on, no signals could be obtained; thinking that the resistor might be faulty or too high in value, he short-circuited it, but still no signals or reaction. What was wrong?

Three books will be awarded for the first three correct solutions opened. Entries must be addressed to The Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Envelopes must be marked Problem No. 447 in the top left-hand corner, and must be posted to reach this office not later than the first post on Monday, August 16th, 1943.

Solution to Problem No. 446.

Jones, through being interrupted, did not secure the slow-motion drive to the spindle of the ganged condenser, therefore, when he rotated the tuning knob the condenser vanes did not move. The fact that he was able to receive one station, was due to the ganged condenser remaining at the same setting, i.e., tuned to the local station, as when he switched off prior to making the alteration.

The following three readers successfully solved Problem 445, and books have accordingly been forwarded to them. H. W. Wells, 30, Coombe Wood Hill, Purley, Surrey; R. Johnson, 37, Bulk Road, Lancaster; B. Dann, 33, High Street, Cottenham, Cambs.

Impressions on the Wax

Review of the Latest Gramophone Records

H.M.V.

H.M.V. have this month released the third of the series of important British works recorded by them under the auspices of the British Council. The recording is of "Concerto for Pianoforte and Orchestra," by Arthur Bliss, and it is performed by Solomon (pianoforte) and the Liverpool Philharmonic Orchestra, conducted by Sir Adrian Boult. The concerto, which is on a grand scale, and superb and powerful in conception and execution, was commissioned by the British Council for the British week at the New York World's Fair, and it was first performed on June 10th, 1939, at the Carnegie Hall by Solomon and the New York Philharmonic Orchestra under Sir Adrian Boult. It is particularly interesting to note that the work is dedicated to The People of the United States of America. The recording consists of five records, *H.M.V. C*3348–52.

Maggie Teyte, soprano, with Gerald Moore at the piano, has made two beautiful recordings in French, on *H.M.V. DA*1833. She has selected, this month, Bizet's "Chanson d'Avril" (Song of April) and "Le Colibri," Op. 2, No. 7, de L'Isle-Chausson. Maggie Teyte, an Englishwoman of Scots extraction, born in Wolverhampton, has rendered great artistic service to the Fighting French, and this was recognised by General de Gaulle, early in June, when he presented her with the Croix de Lorraine.

Ronald Frankau, with, of course, Monty Crick at the piano, asks "Or is it Just Wistful Thinking?" and then gives us "Post-war Midnight News," on *H.M.V. B*9321. These two pieces are typically Frankau-Crick, and, needless to say, original, subtle and very entertaining.

Glenn Miller and his Orchestra have made a good record, *H.M.V. BD*5808, with their presentation of "Serenade in Blue" and "Kalamazoo," both foxtrots. Joe Loss and his Orchestra offer "Why Say Goodbye," waltz, and "I've Heard that Song Before," foxtrot, which is featured in the film, "Youth on Parade." These are good numbers, and they are recorded on *H.M.V. BD*5807.

Columbia

"THE Children's Corner" (Suite for Pianoforte) is one of the few masterpieces of music written for children. It was written by Debussy for his daughter, who was a gifted pianist, and the suite is, undoubtedly, one of the most perfect examples of his genius. It consists of (1) Doctor Gradus and Parnassum; (2) Jimbo's Lullaby; (3) Serenade for the Doll; (4) The Snow is Falling; (5) The Little Shepherd, and (6) The Golliwog's Cake Walk. On the remaining side of the second record is "Traumerei" (Dreaming), from "Scenes from Childhood," Op. 15, No. 7, by Schumann, another masterpiece written for children of all ages.

Louis Kentner (pianoforte) gives us a wonderful solo interpretation of these works, which I think will appeal to all lovers of Debussy and Schumann. The recordings are on *Columbia DX*1121 and *DX*1122.

In the *DB* series, Nelson Eddy, baritone, has recorded two fine ballads, "To-morrow," from "Salt Water Ballads," and "The Blind Ploughman," on *Columbia DB*2114. Nelson Eddy has a fine, pleasing voice, the true qualities of which are revealed in these two enjoyable recordings.

"Chanson Hindoue" and "Kashmiri Song" are the two ever-popular compositions which the Albert Sandler Trio has selected for its recording on *Columbia DB*2115.

Victor Silvester and his Ballroom Orchestra have two records this month. They are *Columbia FB*2937 and *FB*2938. On the former, they have recorded "Keep an Eye on Your Heart" and "Sentimental Feeling," quickstep and slow foxtrot respectively. For the second record they selected "You'd be so Nice to Come Home To," quickstep, and "Why Say Goodbye," waltz. Two good records for those who like their dance music in strict dance tempo.

"You and the Waltz and I," coupled with "When You Wore a Tulip," featured in the films "Seven Sweethearts" and "For Me and My Girl," respectively, are two good numbers performed by Carroll Gibbons and the Savoy Orpheans on *Columbia FB*2936, in first-class style.

Jimmy Leach and the "New Organolians," Dudley Beaven at the Hammond organ, on *Columbia FB*2933, have made a fine recording of "The Sheik of Araby" and "Star Dust."

"Polar Star," waltz, and "Monte Christo," also a waltz, are the two numbers selected by The Bohemians, a light orchestra of most pleasing composition and style. A very enjoyable record.

Parlophone

MY first record from the Parlophone list is that on which is reproduced the latest recording by Richard Tauber. The number is *Parlophone RO*20522, and I advise you to make a note of it, as Tauber is outstandingly good and the songs he sings give his magnificent voice and technique full scope. "Dearly Beloved," featured in the film "You were Never Lovelier," and "My Heart and I," from "Old Chelsea," are the two compositions he renders with such good effect.

On *Parlophone R* 2876, Duke Ellington and his Orchestra have recorded, in the 1943 Super Rhythm-Style Series, No. 89, "Drop Me at Harlem" and "Clarinet Lament." This record should have wide appeal among Duke's fans, but personally, I like my music several degrees cooler.

"Tin Pan Alley Medley, No. 56," which introduces "Whispering Grass," "Three Dreams," "There's a Harbour of Dreamboats," "Where's My Love," "The Lady Who Didn't Believe in Love," and "Keep an Eye on Your Heart," is on *Parlophone F*1983. The medley is played, as usual, by Ivor Moreton and Dave Kaye, on two pianos, with string bass and drums.

Geraldo and his Orchestra offer two very good numbers, "Moonlight Mood" foxtrot, and "Pavanne," also foxtrot, on *Parlophone F*1981. I recommend this to all dance enthusiasts.

Regal

I HAVE only two Regal selections this month, but both are good in their individual classes. The first is one which will be welcomed by all supporters of Harry Roy and his Band; it is numbered *Regal MR*3699, and on it Harry has recorded "Don't Get Around Much Anymore" and "Best Wishes," both foxtrots. The other recording is by Reginald Dixon at the organ playing, in first-class style, "Rustle of Spring" and "Automne," two fine numbers played in a masterly manner.

A REMINDER

PLEASE take at least one old record with you when purchasing new ones.

The need for materials for making new records is most urgent. Ask your dealer for full details about the allowance given on certain old records, even if they are chipped, scratched or cracked.

The supply of new records depends upon the return of old and unwanted ones.

Valve Data Sheets

COSSOR

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H.F. PENTODES

BATTERY TYPES

TYPE	Nominal Rating: Fil. or Heater Volts	Fil. or Heater Amps.	Max. Anode Volts	Max. Screen Volts	Typical Operating Conditions: Anode Volts	Screen Volts	Grid Bias Volts	Anode Current mA.	Screen Current mA.	Mutual Cond. mA/v.	Impedance (Ohms)	BASE	Base Index No.
1N5G	1.4	.05	90	90	90	90	0	1.2	0.3	.75	1,500,000	Octal	59
1N5VG	1.4	.05	90	90	90	90	0	1.6	0.3	.65	1,000,000	Octal	59
1A4E	2	.06	150	67.5	150	67.5	3	2.3	0.8	.75	1,000,000	4-pin UX	74
34E	2	.06	150	67.5	135	67.5	3	2.8	1.0	.6	600,000	4-pin UX	74
210 V.P.T.	2	.1	150	80	150	60	1.5	1.5	0.7	1.1	600,000	4-pin 7-pin	5 32
210 V.P.A.	2	.1	150	150	120	90	3	2.2	1.0	1.1	600,000	7-pin	32
210 S.P.T.	2	.1	150	80	150	60	1.5	1.2	0.7	1.3	600,000	4-pin 7-pin	5 32
220 I.P.T.†*	2	.2	150	80	150	60	1.5	2.5	0.8	1.0	—	7-pin	35
15*	2	.22	135	67.5	135	67.5	1.5	1.85	0.3	.75	800,000	5-pin UX	83

* Indirectly Heated. † Detector Pentode.

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H.F. PENTODES—(*Continued*)

MAINS TYPES

TYPE	Nominal Rating: Fil. or Heater Volts	Fil. or Heater Amps.	Max. Anode Volts	Max. Screen Volts	Typical Operating Conditions: Anode Volts	Screen Volts	Grid Bias Volts	Anode Current mA.	Screen Current mA.	Mutual Cond. mA/v.	Impedance (Ohms)	BASE	Base Index No.
M.S./Pen	4	1.0	200	100	200	100	1.5	5.0	1.3	2.8	800,000	5-pin 7-pin	21 33
M.V.S./Pen	4	1.0	200	100	200	100	1.5	4.3	1.3	2.2	600,000	5 or 7-pin	21–33
M.S./Pen-B	4	1.0	200	100	200	100	1.5	5.0	1.3	2.8	800,000	7-pin	34
M.V.S./Pen-B	4	1.0	200	100	200	100	1.5	4.3	1.3	2.2	600,000	7-pin	34
OM5	6.3	.2	250	100	250	100	2	3.0	0.8	1.8	2,500,000	Octal	61
OM6	6.3	.2	250	100	250	100	2.5	6.0	1.7	2.2	1,200,000	Octal	61
6J7G	6.3	.3	250	100	250	100	3	2.0	0.5	1.225	1,500,000	Octal	61
78E	6.3	.3	250	125	180	75	3	4.0	1.0	1.1	1,000,000	6-pin UX	92
39/44E	6.3	.3	250	90	180	90	3	5.8	1.4	1.0	750,000	5-pin UX	83
6K7G	6.3	.3	250	125	180	75	3	4.0	1.0	1.1	1,000,000	Octal	61
77E	6.3	.3	250	100	250	100	3	2.3	0.5	1.25	1,500,000	6-pin UX	92
13 V.P.A.	13	.2	200	100	200	100	8	7.0	1.7	1.8	800,000	7-pin	34
13 S.P.A.	13	.2	200	100	200	100	3	2.3	0.6	1.25	1,000,000	7-pin	34
D.S./Pen	16	.25	200	100	200	100	1.5	4.7	1.3	2.3	—	5-pin	21
D.V.S./Pen	16	.25	200	100	200	100	1.5	5.5	1.3	2.0	—	5-pin	21
202 V.P.	20	.2	250	100	250	100	1.5	4.3	1.3	2.2	600,000	7-pin	33
202 V.P.B.	20	.2	250	100	250	100	1.5	4.3	1.3	2.2	600,000	7-pin	34
202 S.P.B.	20	.2	250	100	250	100	1.5	4.8	1.3	2.8	800,000	7-pin	34

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SCREEN-GRID VALVES

BATTERY TYPES

TYPE	Nominal Rating: Fil. or Heater Volts	Fil. or Heater Amps.	Max. Anode Volts	Max. Screen Volts	Typical Operating Conditions: Anode Volts	Screen Volts	Grid Bias Volts	Anode Current mA.	Screen Current mA.	Mutual Cond. mA/v.	Impedance (Ohms)	Amplification Factor	BASE	Base Index No.
32E	2	.06	150	67.5	135	67.5	3	1.7	0.4	.64	950,000	610	4-pin UX	74
215 S.G.	2	.15	150	80	120	60	1	1.25	0.3	1.1	300,000	330	4-pin	4
220 S.G.	2	.2	150	80	120	60	1	1.4	0.3	1.6	200,000	320	4-pin	4
220 V.S.G.	2	.2	150	80	120	60	2.5	1.25	0.4	1.6	110,000	—	4-pin	4
220 V.S.	2	.2	150	80	120	60	2.5	1.0	0.5	1.6	400,000	—	4-pin	4

MAINS TYPES

TYPE	Fil. or Heater Volts	Fil. or Heater Amps.	Max. Anode Volts	Max. Screen Volts	Anode Volts	Screen Volts	Grid Bias Volts	Anode Current mA.	Screen Current mA.	Mutual Cond. mA/v.	Impedance (Ohms)	Amplification Factor	BASE	Base Index No.
24E	2.5	1.75	250	90	180	90	3	4.0	1.7	1.0	400,000	400	5-pin UX	81
M.S.G./H.A.	4	1.0	200	100	150	80	1.5	2.1	—	2.0	500,000	1,000	5-pin	17
41 M.S.G.	4	1.0	200	80	130	60	1.5	0.8	—	2.5	400,000	1,000	5-pin	17
M.S.G./L.A.	4	1.0	200	100	150	80	1.5	5.2	—	3.75	200,000	750	5-pin	17
M.V.S.G.	4	1.0	200	100	200	80	1.5	7.8	0.75	2.5	200,000	—	5-pin	17
36E	6.3	.3	250	90	180	90	3	3.1	—	1.05	500,000	525	5-pin UX	81
D.V.S.G.	16	25	200	100	200	80	1.5	7.5	0.75	2.5	—	—	5-pin	17

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DIODES, DIODE TRIODES AND DIODE PENTODES

BATTERY TYPES

TYPE		Nominal Rating: Fil. or Heatr Volts	Fil. or Heatr Amps	Max. An. V.	Max. Scn. V.	Typical Operating Conditions: Ano. Volts	GridB. (Volts)	Anode Cur'nt	Mu. C. mA/V	Imp. (Ohms)	Ampli. Factor	BASE	BULB	Base In. No.
1H5G	DT	1.4	.05	90	—	90	0	0.15	0.275	240,000	65	Octal	Clear	56
210 D.D.T	DDT	2	.1	150	—	100	0	2.3	1.1	25,000	27.5	5-pin	Met.	16
2102	DDT	2	.12	150	—	100	0	2.5	1.3	23,000	30	6-pin UX	Clear	89
220 D.D.*	DD	2	.2	—	—	—	—	—	—	—	—	5-pin	Clear	12

MAINS TYPES

TYPE		Fil. or Heatr Volts	Fil. or Heatr Amps	Max. An. V.	Max. Scn. V.	Ano. Volts	GridB. (Volts)	Anode Cur'nt	Mu. C. mA/V	Imp. (Ohms)	Ampli. Factor	BASE	BULB	Base In. No.
D.D.4	DD	4	.75	—	—	—	—	—	—	—	—	5-pin	Clear	12
D.D.T.	DDT	4	1.0	200	—	200	3	3.4	2.4	17,000	41	7-pin	Met.	28
D.D/PEN	DDP	4	1.0	250	200	200	2.5	‡5.0	2.7	—	—	7-pin	Met.	30
6B8EG	DDP	6.3	.3	250	125	250	3	‡10.0	1.325	600,000	800	Octal	Clear	64
OM3†	DD	6.3	.2	—	—	—	—	—	—	—	—	Octal	Met.	52
OM4	DDT	6.3	.2	250	—	200	4.5	4.0	2.0	15,000	30	Octal	Met.	57
6B7E	DDP	6.3	.3	250	125	250	3	‡9.0	1.125	650,000	730	Octal	Clear	98
6H6G†	DD	6.3	.3	—	—	—	—	—	—	—	—	Octal	Clear	52
6R7G	DDT	6.3	.3	250	—	250	9	9.5	1.9	8,500	16	Octal	Clear	57
6Q7G	DDT	6.3	.3	250	—	250	3	1.1	1.2	58,000	70	Octal	Clear	57
75	DDT	6.3	.3	250	—	250	2	0.8	1.1	91,000	100	6-pin UX	Clear	90
85	DDT	6.3	.3	250	—	250	20	8.0	1.1	7,500	8.3	6-pin UX	Clear	90
13D.H.A.	DDT	13	.2	250	—	250	1.5	1.0	1.5	83,300	125	7-pin	Clear	28
D.D.T.16	DDT	16	.25	200	—	200	3	5.0	2.5	16,000	40	7-pin	Met.	28
202 D.D.T.	DDT	20	.2	200	—	200	3	3.5	2.4	17,000	41	7-pin	Met.	28

* Indirectly Heated. † Separate Cathodes. ‡ At Screen Volts 100. § DT=Diode Triode; DDT=Double Diode Triode; DD=Double Diode; DDP=Double Diode Pentode.

Valve Data Sheets

COSSOR

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BATTERY TYPES — TRIODES

TYPE	Fil. or Heater Volts	Fil. or Heater Amps.	Max. Anode Volts	Impedance (Ohms)	Mut. Cond. mA/V	Amplification Factor	Typical Operating C'dit'ns: Anode Volts	Grid Bias Volts	Anode Current mA.	BASE	BULB	Base Index No.
30	2	.06	150	7,500	1 25	9.4	135	9	3.0	4-pinUX	Clear	73
210 R.C.	2	.1	150	50,000	8	40	125	1.5	0.45	4-pin	Clear	3
210 H.L.	2	.1	150	22,000	1.1	24	125	1.5	2.0	4-pin	Clear/Met.	3
210 H.F.	2	.1	150	15,800	1.5	24	125	1.5	2.25	4-pin	Clear/Met.	3
210 DET	2	.1	150	13,000	1.15	15	125	1.5	4.5	4-pin	Clear/Met.	3
210 L.F.	2	.1	150	10,000	1.4	14	125	3	4.5	4-pin	Clear/Met.	3

MAINS TYPES

TYPE	Fil. or Heater Volts	Fil. or Heater Amps.	Max. Anode Volts	Impedance (Ohms)	Mut. Cond. mA/V	Amplification Factor	Anode Volts	Grid Bias Volts	Anode Current mA.	BASE	BULB	Base Index No.
27†	2.5	1.75	250	9,250	.975	9	180	13.5	5.0	5-pin UX	Clear	80
41 M.R.C.	4	1.0	200	19,500	2.6	50	150	1	2.5	5-pin	Clear	13
41 M.H.	4	1.0	200	18,000	4.0	72	150	1.5	1.5	5-pin	Clear/Met.	13
41 M.H.F.	4	1.0	200	14,500	2.8	41	150	2	2.5	5-pin	Clear	13
41 M.H.L.	4	1.0	200	11,500	4.5	52	200	3	4.0	5-pin	Clear/Met.	13
41 M.L.F.	4	1.0	180	7,900	1.9	15	160	4.5	7.5	5-pin	Clear	13
76†	6.3	.3	250	9,500	1.45	13.8	250	18.5	5.0	5-pin UX	Clear	80
37†	6.3	.3	250	8,400	1.1	9.2	250	18	7.5	5-pin UX	Clear	80
6K5G	6.3	.3	250	42,000	1.65	70	100	1.5	0.35	Octal	Clear	55
D.H.L.	16	.25	200	13,000	4.5	58	150	1.5	3.8	5-pin	Met.	13

† General Purpose Types.

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BATTERY TYPES — OUTPUT TRIODES

TYPE	Fil. or Heater Volts	Fil. or Heater Amps.	Max. Anode Volts	Mut. Cond. mA/V	Impedance (ohms)	Amplification Factor	Typical Operating Conditions: Anode Volts	Grid Bias Volts	Anode Current m/A.	Optimum Load (ohms)	BASE	BASE INDEX No.
215 P.	2	.15	150	2.25	4,000	9	150	7.5	10.0	9,000	4-pin	3
220 P.	2	.2	150	2.25	4,000	9	150	7.5	11.0	9,000	4-pin	3
220 P.A.	2	.2	150	4.0	4,000	16	150	4.5	10.0	9,000	4-pin	3
230 X.P.	2	.3	150	3.0	1,500	4.5	150	18	22.0	3,500	4-pin	3

MAINS TYPES

TYPE	Fil. or Heater Volts	Fil. or Heater Amps.	Max. Anode Volts	Mut. Cond. mA/V	Impedance (ohms)	Amplification Factor	Anode Volts	Grid Bias Volts	Anode Current m/A.	Optimum Load (ohms)	BASE	BASE INDEX No.
2 P.*	2	2.0	250	7.0	1,150	8	250	22	40.0	3,000	4-pin	3
2 X.P.*	2	2.0	300	7.0	900	6.3	300	36	50.0	4,000	4-pin	3
45*	2.5	1.5	275	2.05	1,700	3.5	250	50	34.0	3,900	4-pin UX	73
41 M.P.	4	1.0	200	7.5	2,500	18.7	200	7-5	24.0	3,000	5-pin	13
41 M.X.P.	4	1.0	200	7.5	1,500	11.2	200	12.5	40.0	2,000	5-pin	13
4 X.P.*	4	1.0	250	7.0	900	6.3	250	28.5	48.0	3,000	4-pin	3
6J5G	6.3	.3	250	2.6	7,700	20	250	8	9.0	7,000	Octal	54
6B4G*	6.3	1.0	250	5.25	800	4.2	250	45	60.0	2,500	Octal	53
6A3*	6.3	1.0	250	5.25	800	4.2	250	45	60.0	2,500	4-pin UX	73
D.P.	16	.25	200	6.0	2,800	17	200	7.5	25.0	3,500	5-pin	13
402 P.	40	.2	200	7.5	1,330	10	150	9.5	30.0	2,500	7-pin	26

* Directly heated

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BATTERY TYPES — OUTPUT PENTODES AND TETRODES

TYPE	P = Pentode T = Tetrode	Fil. or Htr. Volts	Fil. or Htr. Amps	Max. Anode Volts	Max. Screen Volts	Mut. Cond. mA/V.	Typical Operating Conditions: Anode Volts	Scrn. Volts	Grid Bias Volts	Anode Current m/A.	Screen Current m/A.	Optimum Load (ohms)	Base	Base Index No
1C5G	M	1.4	.1	90	90	1.55	90	90	7.5	7.5	1.6	8,000	Octal	60
2101	P	2	.12	150	150	1.8	135	135	4.5	8.0	2.6	15,000	5-pinUX	82
220 P.T.	P	2	.2	150	150	2.5	120	120	7.5	13.5	3.0	8,000	4/5-pin	6-19
220 H.P.T.	P	2	.2	150	150	2.5	120	120	4.5	4.3	1.0	20,000	4/5-pin	6-19
220 O.T.	T	2	.2	150	150	2.5	120	120	4.5	4.3	1.0	20,000	5-pin	18
230 P.T.	P	2	.3	150	150	2.0	150	150	15	14.0	3.0	10,000	4/5-pin	6-19

MAINS TYPES

TYPE	P = Pentode T = Tetrode	Fil. or Htr. Volts	Fil. or Htr. Amps	Max. Anode Volts	Max. Screen Volts	Mut. Cond. mA/V.	Anode Volts	Scrn. Volts	Grid Bias Volts	Anode Current m/A.	Screen Current m/A.	Optimum Load (ohms)	Base	Base Index No
47E*	P	2.5	1.75	250	250	2.5	250	250	16.5	31.0	6.0	7,000	5-pin UX	82
P.T. 41*	P	4	1.0	250	200	3.0	250	200	12.5	30.0	6.0	8,000	5-pin	19
P.T. 41B.*	P	4	1.0	400	300	2.25	400	250	40	30.0	6.0	8,000	5-pin	19
M.P./Pen	P	4	1.0	250	250	3.5	250	250	16	30.0	6.0	10,000	5/7-pin	20-36
42 M.P./Pen	P	4	2.0	250	250	7.0	250	250	5.5	32.0	6.0	8,000	7-pin	36
P.T. 10	P	4	2.0	250	250	9.0	250	250	7.5	40.0	8.0	5,000	7-pin	36
42O.T.	T	4	2.0	250	250	7.0	250	250	5.5	34.0	7.0	6,500	7-pin	29
42O.T.D.D.†	T	4	2.0	250	250	7.0	250	250	5.5	34.0	7.0	6,500	7-pin	31
OM9	P	6.3	.2	250	250	2.8	250	250	18	32.0	5.0	8,000	Octal	63
38E	P	6.3	.3	250	250	1.2	250	250	25	22.0	3.8	10,000	5-pin UX	83
6K6G	P	6.3	.4	250	250	2.2	250	250	18	32.0	5.5	7,600	Octal	62
41E	P	6.3	.4	250	250	2.2	180	180	13.5	18.5	3.0	9,000	6-pin UX	93
42E	P	6.3	.7	250	250	2.35	250	250	16.5	34.0	6.5	7,000	6-pin UX	93
6F6EG	P	6.3	.7	250	250	2.5	250	250	16.5	34.0	6.5	7,000	Octal	62

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MAINS TYPES OUTPUT PENTODES AND TETRODES *(continued)*

TYPE	P = Pentode T = Tetrode	Fil. or Htr. Volts	Fil. or Htr. Amps	Max. Anode Volts	Max. Screen Volts	Mut. Cond. mA/V.	Typical Operating Conditions: Anode Volts	Scrn. Volts	Grid Bias Volts	Anode Current m/A.	Screen Current m/A.	Optimum Load (ohms)	Base	Base Index No.
2151	P	14	.3	250	250	2.3	250	250	30	48.0	11.5	4,000	6-pin UX	93
18E	P	14	.3	250	250	2.5	250	250	16	35.0	6.5	7,000	6-pin UX	93
D.P./Pen	P	16	.25	250	250	3.5	200	200	10	31.0	6.0	10,000	7-pin	36
43E	P	25	.3	180	135	2.5	180	135	20	38.0	7.5	5,000	6-pin UX	93
40 P.P.A.	P	40	.2	150	150	4.0	150	150	25	36.0	6.0	4,000	7-pin	36
402 Pen	P	40	.2	250	250	7.0	200	200	6.7	40.0	7.0	5,500	7-pin	37
402 Pen/A	P	40	.2	150	150	8.0	150	150	9	56.0	11.0	2,500	7-pin	37
402 O.T.	T	40	.2	250	250	7.0	200	200	6.6	40.0	7.0	5,500	7-pin	30

* Directly heated. † Double-diode Tetrode.

QUIESCENT OUTPUT TRIODES AND PENTODES

TYPE	DESCRIPTION	Volts	Amps									
220.B	Batt. Cl. B. Dbl. Triode	2	.2	—	120	—	0	2.5	—	12,000	7-pin	27
19	Batt. Cl. B. Dbl. Triode	2	.26	—	135	—	0	5.0	—	10,000	6-pin UX	88
240.B	Batt. Cl. B. Dbl. Triode	2	.4	—	120	—	0	4.0	—	8,000	7-pin	27
2103	Batt. Q.P.P. Double Pen.	2	.26	1.6	135	135	7.5	4.0	1.2	35,000	7-pin UX	99
240 Q.P.	Batt.Q.P.P. Double Pen.	2	.4	2.5	120	120	9	2.9	0.6	24,000	7-pin	38
79	Mains. Cl. B. Dbl. Triode	6.3	.6	—	250	—	0	10.6	—	14,000	6-pin UX	91
6N7G	Mains Cl. B. Dbl. Triode	6.3	.8	—	300	—	0	35.0	—	10,000	Octal	58

Open to Discussion

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

Station Identification

SIR,—In answer to Mr. A. J. Newman, who asked in the August issue of PRACTICAL WIRELESS for information concerning stations Allied Force H.Q., North Africa, and American stations on the 23 metre band, I have received these transmissions regularly.

Allied Force H.Q., North Africa, has no cal. sign, but just announces as A.F.H.Q., and sends dispatches to news agencies in New York and London. It also calls the N.B.C. and C.B.S. in New York. The time of transmissions of the dispatches varies, but is usually between 23.00 and midnight.

The American station Mr. Newman mentions I take to be WKRD, not WKRB as he suggests. It does not announce the location of the transmitter.

Both these stations I received on a 3-valve home-made battery set (det., 2 L.F.) at a strength of R 5-6.

Here are particulars of one or two other stations that may interest some readers:

Quito, Ecuador, on 25.08 metres, English language programme, 01.00—02.00 hours; Ankara, Turkey, on 31.20 metres; calling C.B.S., New York, 01.25 hours; and Brazzaville, F.E. Africa, on 25.06 metres, news in English at 20.45 hours and 22.45 hours, times B.D.S.T.—N. W. HOARE (Southampton).

Simple S.W. One-valver

SIR,—Being at present without a RX, and wanting one as soon as possible, I built the o–v–o described in the October, 1942, issue of PRACTICAL WIRELESS. Results have been pretty good, using a 25ft. inverted-L aerial. I have logged a good number of stations in two days, including WRUL, WRCA, WCBX, PRL8, "Voice of Free India," Radio Metropole, Vatican City. PRL8 is situated at Rio de Janeiro and is announced as Radio Nationale and uses a directional beam directed on Great Britain. The wavelength is 25.61 metres, time received 22.30. "Voice of Free India" was heard on 26.1 metres, giving talks in Hindustani and Bengali. I would be very grateful if any reader could help me to identify the following stations. Radio Nationale and a station on the 25 metre band which closes down with "Bon jour, Madame, Bon jour, Monsieur, Bon jour, mademoiselle," then the French National Anthem was played.—G. REEVE (Norton-on-Tees).

[*We have received numerous reports confirming the efficiency of this set. The design is available in blueprint form. P.W.88*—ED.]

Logged on an O.V.1 Receiver

SIR,—I recently constructed an o.v.1 Rx similar to F. G. Rayer's, but while waiting for the correct parts to arrive, I built it as follows: Det. with pentode output, a 4-pin coil, .0001 tank, .0003 reaction, a 5 meg. leak on output, 3 meg. leak on det., a 60,000 ohm resistor, 1 meg. on the negative bias, and a .01 condenser on the chokes. I never had a smoother working Rx. Four days later the specified parts arrived, and now the receiver is built exactly as F. G. Rayer's diagram, except for the tank (.0001) and the 4-pin coil. Two dets. are used, a Mazda H.L.2 and Mullard PM1HF for output. If I reverse these valves, the set will not work. FZI comes in twice as loud, and very clear now, and recently I logged a B.C. calling itself Radio Cameroon on approximately 25.85 metres. Only once, the first time I tuned it in accidentally, did I hear it announced in English. They are on the air from 18.15 to 19.15 G.M.T., mostly in French, with a musical item for the last 10 minutes.

Other stations I have logged are: Berne, Swiss B. Corp., 5 min. news at 21 hours G.M.T. on 48.66 metres; Radio Andorra, 49 metres approximately; United Nations Radio, French N. Africa, 33 metres approximately, and lastly, XGOY, in Chungking calling K.K.W. in San Francisco for time check, 25 metre band. To those who use a proper reaction condenser for this Rx, and the set does not work, here is a tip: put a wire across both fixed terminals.—A. ROBINSON (Biggleswade).

Harkness Reflex Circuit

SIR,—I was very interested to see the "Harkness" reflex circuit described by Mr. N. A. Webb, in the March, 1943, issue of PRACTICAL WIRELESS, but, being busy at that time, I did not try it out. Now, having a spare afternoon, I made it up and found it excellent. I used a plywood chassis, with two separate tuned circuits (spaced about 6ins. apart). The coils are a pair of standard R.F. transformers in metal cans, but I did not earth the cans. The detector is an ordinary crystal and catswhisker type. The bypass condensers are smaller values than those in Mr. Webb's circuit, being .0005 and .00025 mfd. (instead of .001 mfd.).

The valve is an American type 49 battery tetrode, and with this 6 volts H.T. is sufficient.

The results were excellent and I endorse Mr. W. E. Bodell's opinion of the circuit (in the April, 1943, PRACTICAL WIRELESS). The volume is as good as that which a 2-valver with reaction could give. I have no doubt that with a well-designed set of coils (mine are not a good quality) the results would be even better.

When the catswhisker is lifted off the crystal, there is a tendency to oscillate; however, a little attention to screening and general layout should eliminate this, while the use of a permanent detector would also cure the trouble. Apart from this, there is no instability at all. Without an earth, the results are still very pleasing; both the Home and Forces programmes are a little too loud for comfort with headphones.—P. D. THOMAS (Ayr).

Schwerzenburg on 31.45 Metres

SIR,—As it may be of general interest to readers I report that the Swiss English Service from Schwerzenburg (which transmits on the 48 and 25 metre bands) was changed from 25.28 metres to 31.45 metres as from June 20th. The previous wavelength of 48.66 metres is unchanged.—A. McGUGAN (Agbeston).

Replies to Queries

Changing Over to Variable-mu

"Would you be good enough to inform me what changes are necessary when replacing an ordinary S.G. stage with variable-mu valves?"—P. S. (Cheltenham).

IF a potentiometer is at present employed for obtaining the S.G. voltage, this should be removed and a fixed potentiometer made up of separate resistances used in its place. The actual values will depend upon the voltage existing across the positive and negative sides of the supply and the voltage required by the particular valves in use. A grid-bias battery should be joined across a 50,000-ohm potentiometer, and a switch fitted to cut out the potentiometer, or a third contact fitted to the present two-point on/off switch. The lower end of the tuning coils should then be removed from the earth line and connected to the arm of the potentiometer. To ensure stability this connection may be made through a 100,000-ohm fixed resistance, and a .1 or 1 mfd. condenser joined between earth and the lower end of the tuning coil.

Removing Hum

"I had a commercial superhet which was assembled on two chassis, and as I have obtained a new, smaller cabinet, I split the two sections and have the mains pack now in the bottom of the cabinet and the set in the top. There was a 7-way connecting cable between the two chassis, and I have replaced this with a longer cable, but otherwise have made no alterations. There is a very bad hum now on the set, and I should be glad if you could suggest how this has arisen and how it may be corrected."—B. C. (Letchworth).

ASSUMING that nothing has become damaged during your modification, there is only one probability which can answer for the hum trouble. The heater supply for A.C. valves is centre-tapped, and the centre-tap is joined to earth. An alternative to this scheme is to use a centre-tapped potentiometer or two pilot lights across the heater wiring, and we imagine that in your set the potentiometer device was employed. The lengths of the heater leads were such that the adjustment of the potentiometer removed the hum, but now that longer leads are employed the heater winding has become unbalanced, and the potentiometers need adjusting. Alternatively, it may be desirable to remove them from the mains pack and place them near the valves, then adjusting the centre tap to balance out the hum. We assume that you have so placed the loudspeaker that there is no possibility of interaction between the speaker transformer and the mains transformer or smoothing choke.

A.V.C. Distortion

"My set has developed a fault which is puzzling me. On the long-distance stations there is now perfectly good quality, much better than it has ever been since I bought the set. The volume is up on those stations, too. On the locals, however, there is bad distortion, even when I turn the volume right down. I have tried a new output valve but cannot cure the trouble, and two or three of my friends have suggested different things which have been unsuccessful. I should be glad if you could help."—P. R. (Weymouth).

THE most likely cause of a trouble of this nature is a defect in the A.V.C. system. This is borne out by the fact that you state that distant signals are now louder, which indicates that the bias applied by the A.V.C. system is lower than previously. A powerful signal no doubt applies too much bias, and this gives the distortion as no doubt the frequency-changer and I.F. stages are controlled together from the A.V.C. line. We advise you to obtain a good meter and measure the values of the various resistors in the A.V.C. circuit, and check all condensers which are joined to it, when no doubt you will locate the faulty component which has introduced this trouble.

Accumulator Drain

"I had a Fury Four which I built when it first came out, and I modernised this recently. At the same time I made a change of my own, fitting new condensers and dials, and the only circuit alteration which I made at this time was to fit indicating lights for medium and long waves, as in a recent reader's wrinkle. I am finding, however, that the accumulator now does not last nearly as long, and I wonder if the lights are responsible. If this is so, how can I overcome it without buying a larger accumulator?"—T. B. (Clapham).

IF you have used the correct type of lamp for your dials there should not be any undue increase in the L.T. consumption, but if you have used the ordinary type of flash-lamp bulb there would be an increase. If you are still using two separate condensers and have fitted lamps to both, it would be desirable to fit an ordinary on/off switch in the leads to the lamps so that they may be switched off after you have tuned to a station and thus avoid the additional current drain. Special low-consumption bulbs are, however, normally obtainable and will avoid the difficulty of additional consumption.

Switch Troubles

"I am experiencing a peculiar fault with my set which, rightly or wrongly, I attribute to the switch. This is of the wafer type with seven sections, and when turned to the medium waves I sometimes cannot obtain a signal. By turning the switch backwards and forwards once or twice there is a plop in the speaker and signals can be obtained. Do you agree with my suggestion and, if so, what would be the best way of curing the trouble?"—S. L. (York).

IF your switch is of the type having a bent-over finger which runs across small contact points there is a possibility that, owing to excessive solder or a connecting wire which has become bent, the moving arm has caught and been twisted. Thus, in one position the drag would cause this to fold back, and although in the remaining sections correct contact would be made, on that particular section the arm may rest between two adjacent contacts. These may be short-circuited or no contact may be obtained, depending upon the make of the switch and we advise you to look carefully at the various sections, and if you cannot locate the faulty one, perhaps it would be advisable to have the set examined by a local service engineer.

H.F. Instability

"I had an S.G. Four set, and this had given good results for a long time. I bought two new valves, which I am assured are of identical characteristics to the original S.G. and detector valves, but there is marked instability, especially on the lower part of the medium waveband. I find that this may be stopped by holding the valve with the hand (detector), and wonder if this will indicate the trouble to you. It is fairly good on the rest of the band and can be used satisfactorily, although I cannot turn up the volume too much."—F. G. N. (Brockley).

IF the valves are identical and no changes in wiring or circuit have taken place the most useful suggestion we can make is that the metallising on the valve is not earthed properly. This can occur due to the small seal which is affixed on the metal surface becoming loose, or the wire connected to it from the filament pin may have become broken. Examine the point carefully, and if there is a paper label marked "E" stuck over it, remove this and see if the metal is sprayed over the wire and seal correctly. If not, a bare wire should be twisted round the metal surface and joined to the appropriate filament pin and we think this will cure your touble.

A Correction: The Valve Voltmeter

IF reference is made to Fig. 1—page 330, July issue—it will be seen that the junction of R5 and VR1 is connected to the moving arm of the latter. This should not be so; the only connection made to the moving-arm is that from one side of the L.F. choke in the H.T. smoothing circuit.

F.H.WILSON

CONSTRUCTORS' KITS

See August issue for details of Constructors' A.C. and Battery 3-v. Kits. Delivery approximately one month.

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

SOLDER, 1lb. reels, fine all-tin instrument solder, 3/6 lb., or ¼lb. reel, 1/-.

(*Continued on page 440*)

•VALVES•

AMERICAN VALVES

01A, 11/-; **0Z4**, 15/3; **1A4**, 15/3; **1A6**, 16/6; **1B4**, 15/-; **1B5**, 15/-; **1B7**, 15/-; **1C7**, 18/3; **1D5**, 18/3; **1D7**, 18/3; **1E5**, 15/-; **1E7**, 18/3; **1F5**, 15/-; **1F6**, 18/3; **1F7**, 18/3; **1G5**, 15/-; **1G6**, 18/3; **1H4**, 15/-; **1H6**, 18/3; **1J5**, 15/-; **1J6**, 18/3; **1P5**, 15/-; **2A6**, 14/-; **2A7**, 15/-; **2B6**, 14/-; **2B7**, 15/-; **2E5**, 15/-; **5Y3**, **5Y4**, **5Z4**, 14/6; **6A3**, 18/3; **6A4**, 18/3; **6A8**, 14/-; **6B4**, 18/3; **6B6**, 13/-; **6B7**, 14/-; **6B8**, 15/3; **6C8**, 17/6; **6D5**, 15/-; **6E6**, 15/-; **6F5**, 9/2; **6F6**, 12/10; **6F8**, 18/3; **6J6**, 18/3; **6H6**, 6/10; **6J5**, 13/6; **6J7**, 12/10; **6J8**, 12/10; **6K6**, 13/-; **6K7**, 12/10; **6K8**, 14/-; **6L5**, 15/-; **6L6**, 18/3; **6L7**, 12/10; **6N6**, 18/3; **6Q7**, 11/7; **6R7**, 11/7; **6SA7**, 14/-; **6SC7**, 13/3; **6SK7**, 12/10; **6T5**, 15/3; **6THSG**, 14/-; **6V6**, 12/10; **6X5**, 11/-; **6Y5**, 15/-; **6Y6**, 18/3; **6Z3**, 18/3; **6Z5**, 18/3; **6Z7**, 18/3; **7A6**, **7A7**, **7AS**, **7B7**, **7B8**, **7C6**, 15/3; **10**, 18/3; **12A**, 15/-; **12A5**, 15/-; **12B8**, 15/3; **12C8**, 18/3; **14**, 18/-; **15**, 18/-; **17**, 18/-; **19**, 18/-; **24**, 15/-; **25A6**, 12/10; **25L6**, 12/10; **25Z6**, 11/-; **26**, 15/-; **27**, 9/2; **29**, 14/-; **30**, 12/10; **31**, 12/10; **32**, 15/-; **33**, 14/-; **34**, 15/-; **35**, 13/-; **36**, 12/10; **37**, 15/-; **38**, 17/6; **39**, 12/10; **40**, 15/-; **42**, 12/10; **46**, 15/-; **48**, 22/6; **49**, 18/6; **50**, 25/-; **52**, 23/-; **53**, 16/6; **55**, 13/6; **56**, 15/-; **57**, 14/-; **58**, 15/-; **59**, 16/6; **71A**, 14/6; **75**, 14/6; **77**, 12/10; **78**, 12/10; **79**, 18/3; **80**, 14/6; **81**, 21/-; **85**, 14/6; **89**, 18/3.

Mullard Numbers generally quoted but we may send B.V.A. equivalents. Prices quoted are current retail. **PM12**, 11/-; **PM12M**, 11/-; **SP2**, 11/-; **VP2**, 11/-; **VP2B**, 11/-; **FC2**, 12/10; **FC2A**, 12/10; **PM1HL**, 5/10; **PM2HL**, 5/10; **PM2A**, 7/4; **PM22A**, 11/-; **PM22D**, 11/-; **TDD2**, 9/2; also Marconi Osram **P2**, 12/3; **LP2**, 7/4.

4-VOLT A.C. MAINS TYPES

ACTP, **TH4B**, **TH4B**, **FC4**, 14/-; **VP4**, **SP4**, **VP4B**, **SP4B**, **W42**, **AC5Pen**, 12/10; **TDD4**, **MHD4**, 11/7; **H42**, **354V**, **HL4**, 9/2; **FW4-500**, 18/3; **PenB4**, 14/8; **Pen 428**, 30/6; also Cossor **MS Pen**, **MVS Pen**, **MS Pen B**, **MVS Pen B**, 12/10; **41MPG**, 14/-.

A.C./D.C. TYPES

C1, **C1C**, 10/6; **FC13**, **FC13C**, **TH21C**, **TH30C**, **15D2**, 14/-; **VP13A**, **VP13C**, **SP13C**, **9D2**, **8D2**, 12/10; **HL13C**, **2D13C**, **2D13A**, 9/2; **TDD13C**, 11/7; **CL33**, 12/10; **CBL1**, 15/3; **KTW61**, **KTW63**, **KT61**, **KT63**, 12/10; also Cossor **VP13A**, **SP13A**, 12/10; **VP20** and **SP20**, equivalent, 15/3.

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PHILCO and other AMERICAN

25RE, 15/6; **35RE**, 15/6; **43**, 17/6; **2101**, 15/6; **2102**, 14/6; **2103**, 19/9; **18**, 18/6; **Pen DD61**, 19/9; **2151**, 17/6; **76**, 15/6; **523**, 22/9; **84/GZ4**, 15/6.

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(Continued top of column 2)

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