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 mining machine, an electric clock or even a familiar emotion. 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 of 'less bites the dog,' seize 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 wise 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 the 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 you should always use a pair of insulated pliers, with insulated handles, and a pair of rubber gloves to 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 clucking "radio engineers" (save the mark!) have been found to be thoroughly dishonest. In one case recently brought before the Plymouth City Magistrate, a radio engineer 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 8 of his customers' sets valued at £3,208 10s., component parts valued at £197 19s., and other property entrusted to him for repair to the value of £78 17s. 6d.

When inquiries 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. When the sets were working order when recovered, 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. People 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 £5,000 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 is the comfort and safety of 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. We 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 almost earnestly—for immediate reconsideration in those cases where the 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.'"
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.B.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 Japanesecapital
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 broad-
casting 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" field officers 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. In a wadi and
letting them listen to you broadcasting from home..."

"Life is full of interests and excitement, but here
now, 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 our
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 international touch to the audience.

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 new comers, 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 12½ hours of the day.

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

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

West Africa: 16.84 m., 23.29 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 W KID: 606, 723, 957, 1187, 1529, 1776 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 200-315 metres on the M.W. band and 19-50 metres on the S.W. section. The circuit diagram is shown in Fig. 1.

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 across 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 2 MO 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-capacitance 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 mmfd. minimum capacity; an 8 mmfd. 150 volt working electrolytic condenser would be quite satisfactory here.

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

Construcational 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 C3 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 and weight 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 1 in. in...
with Fig. 3 (above).—Constructional details of the coils and H.F. choke.

The shortwave coil, Fig. 5 (a), consists of 15 close turns of 24 S.W.G. enameled 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 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 rim by 1 in. diameter, as shown in Fig. 5 (e).

The H.F.C. together with the aerial capacity must not resonate within the frequency range of the receiver, and it 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.

Switching

On-off and wavechange switching are achieved by the use of an Oak or Xaxley 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 ivory, ruled with lines by means of a sharp metal point and a steel ruler; if indiar 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 indiar 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 C1, 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.
A Portable Record Amplifier

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 1.25 V—but satisfactory results were obtained with a bias resistor of 1,000 Ω, with which a 25 μF electrolytic condenser was used for by-passing. The makers specify an anode load of 50,000 Ω, the anode circuit being decoupled by a 0.2 μF condenser and a 20,000 Ω 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-capacitance 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:

\[ C \times R = 0.05 \]

where the values are expressed in micro-farads and megohms, but, by experiment, using a 5 MΩ resistor, it was found that a 0.05 μF was a most suitable value for C. This means the CR is 0.005, which is high, so that if you experience "top-cut," the value of C should be decreased to, say, 0.1 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.

R requires 
\[ Rg = \frac{v_r}{I_a} \times 1,000 = \frac{8.5}{40} \times 1,000 = 212.5 \Omega \]

250Ω being a practical value. Another 250μF 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 5,200\(\Omega\), and the 5\textit{i}\textbf{n}. 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 1W4/350 was used. This is an indirectly heated full wave rectifier, giving 120 mA maximum output.

\section*{Smoothing}

Smoothing is carried out by the two electrolytic condensers of 8 \(\mu\)F and 16 \(\mu\)F, in conjunction with the energising field of an old speaker which serves the purpose of an L.P. 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 3,000\(\Omega\), 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 turned 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 2,000\(\Omega\) in series, so as not to reduce the volume too much. This tends back the 50 cycle hum out of phase with that present at the grid of the first valve,

so that one cancels off 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.

\section*{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 5\textit{i}\textbf{n}. 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.

\section*{LIST OF COMPONENTS}

- One gramophone cabinet, motor and turntable.
- One gramophone pick-up.
- One Mazda AC2/4L.
- One Mazda Pen 45.
- One Mullard 1W4/350.
- One potentiometer 1\% megohm.
- One fixed resistor 1,000\(\Omega\).
- One fixed resistor 20,000\(\Omega\).
- One fixed resistor 50,000\(\Omega\).
- One fixed resistor 0.5 M\(\Omega\).
- One fixed resistor 250\(\Omega\).
- One fixed resistor 5,000\(\Omega\).
- One fixed resistor 2,000\(\Omega\).
- Two fixed condensers 22\(\mu\)F electrolytic.
- One fixed condenser 16\(\mu\)F-8\(\mu\)F electrolytic.
- One fixed condenser 0.2 \(\mu\)F.
- One fixed condenser 0.5 \(\mu\)F.
- One fixed condenser 0.05\(\mu\)F.
- One speaker field (D.C. resistance 3,000 \(\Omega\) 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 9\textit{i}. PM MC Rola speaker.
- One Output transformer, 40:1.
- One Chassis cut to fit cabinet.
- One reel of tinned copper wire.
- Three coils of sysloflex.
- 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.

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 treble valve V3, in which 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.

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

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.

The Discriminator

The only remaining stage in the receiver to be 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 of the detector that we desire to obtain, showing AF volts output against frequency deviation, and in the ideal case it would appear as in Fig. 4.

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 cutoff 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.
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 at a frequency 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 first 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 fairly tuned, so that when the IF deviates the voltage induced in the secondary sections 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 tuned 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 R1 and R2 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 R1 will be greater than that across R2, and some output voltage will result. This output voltage is the difference between the voltages across R1 and R2, 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 R2 than across R1. 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 highest 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 L is centre-tapped and connected via an RF choke to the centre-point of R1 and R2. In addition to inductive coupling between the two circuits there is also capacitive coupling via C3.

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 C3, 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 tested. 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 test, after disconnecting the condensers from the 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-buckling coil which, as readers are aware, is wound on or adjacent to the energising coil.

**Hum-buckling Coil**

Further investigation showed that one side of the hum-buckling coil was connected to the common negative earth line by means of a fifth lead to the speaker, but
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. Numbers prove that the workers have answered it too.

(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 products 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

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, comprising 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 worthwhile degree only when the overall resistance of R and W is high, and in parallel is high in relation to the resistance of the grid leak, R2.

In practice R1 would be of sufficiently high value only when a pentode or tetrode valve were used as V1. When using a pentode, however, R1 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 V1 and earth at frequencies near the resonant frequency of L.C.; at other frequencies L.C. 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 "Marcou" 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-mode 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...
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 Ioger 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 second stage 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, 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 I.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 the bias resistor, it is taken to a point which provides as negative potential relative to the earth line. The values of this 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 D 1 and rectification takes place, the grid becomes negative. As a result, anode current falls and so reduces the voltage drop across R 1 . 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 the grid. Should that happen, D 2 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 D 2 . As a result, any further rise in signal voltage will make the cathode still more negative. In turn, this will drive D 2 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 used to amplify 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 installed, 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 can be 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:

\[ L = \frac{3.2 \times A \times N^2}{A \times 10^8} \]

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 of 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 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-spreaders

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-spreaders are 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-spreaders 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-spreaders 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 33-27 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-spreaders 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-spreaders.
On your Wavelength

By - THERMION

Raf!

S

O

the B.B.C. has decided that Ralph is to be pro-

ounced as Raf! There seems to be no end to the

stupidity of the B.B.C. No one except a B.B.C.

announcer would adopt this effeminate pronuncia-

tion of a praenomen associated with all that is tough and cavanian:

"Sir Ralph the rover tore his hair"! Imagine the

twitterings in the classroom when our blonde male teachers

of the future, with right toe delicately placed and right

knee delicately bent, in elfin-like tones and velvet voice

instruct the pupils to say "Sir Raf 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,

Raf, and the announcers merely make themselves sound

stupid by adopting this invented pronunciation. Of

course, the Scots have always loved to invent a pro-

nunciation. 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 branch 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 dream-

ingly into the future with the evident desire to give an
colour-like, and professorial veneer to an otherwise vapid and

vaccuous countenance. Surely the B.B.C. can find

something better than to sit in conference on the

pronunciation of Ralph. Raf is almost as bad as gaff

golf. You know the type of man who says that he

is going to play a game of gaff, with a lazy and bored

drop of the lower jaw—the type of man who goes hunting,

shooting, fishing, etc. The B.B.C. has a tendency to

draw-room its pronunciations. I hope that none of

my readers, blessed with the Christian name of Ralph,

will be hailed by his friends as Raf. I can almost

imagine all the Ralphs vomiting at the thought.

I must admit, however, that Raf 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 7 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. Sower, B.Sc., M.I.E.E., M. Brit. I.R.E., and

A. J. Tyrell, A.M.I.E.E., M. Brit. I.R.E. opened the

discussion, Mr. Sower discussing the "Soft" magnetic,
or high permeability materials, and Mr. Tyrell the

"Hard," or permanent magnet types.

Present-day achievements, said Mr. Sower, when

compared with the position 20 years ago, were aston-

ning, 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. Tyrell, in presenting the case for permanent

magnets, showed that similarly remarkable develop-

ments 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 10,000 domestic utility radio sets are in process of
manufacture, and that of these 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 utilitv.

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,

These to control our daily life.

Within this land so blest.

Will thus our fight for freedom end—

Dalton prohibits "noise and bed."

Or orders back to crystals?

Enforcement officers employed

To see no valve sets are enjoyed,

By threatening us with pistols.

Ah! Sad 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 befoul us.

To win the war we've stood a lot,

And seen our freedom go to pot.

When won, we will drown

Fanatics' fingers on the probe—

Which into fury freeman good;

They shall leave well alone.

"TORCH."
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 \( C_{sg} \) from the anode-tuned-circuit to the grid-tuned-circuit. Voltages are induced (by the magnetic field around \( L_1 \)) in \( L_2 \), hence, in the circuit \( L_2 C_2 L_3 \) oscillatory current is flowing, which, producing a magnetic field in \( L_1 \) causes voltages to be induced in \( L_2 \). Obviously radio-frequency, power-amplifiers in transmitters, when the use of a triode is advantageous.

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., \( C_{sg} \) and \( C_{af} \). Now let this screen be connected to the earth (filament or cathode end of the tuned circuits). Note that—Fig. 28 (b)—the \( C_{sg} \) has now become \( C_{gf} \) and \( C_{af} \), 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.)
The "Fluxite Quins" at Work

"Where's 01 with our FLUXITE? He's Dumb!"

"Cheer up!" replied EH. "Don't look glum!"

Our radio's gone soft,
So I've sent him aloft;
He'll be back in a minute, old chum."

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

Ask to see the FLUXITE SMALL SPACE SOLDERING SET—compact but substantial—complete with full instructions, 7/6.

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

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

ALL MECHANICS WILL HAVE

FLUXITE
IT SIMPLIFIES ALL SOLDERING

Write for Book on the ART OF "SOFT" SOLDERING and for Leaflets on CASEHARDENING STEEL and TEMPERING TOOLS with FLUXITE, also on "WIRED JOINTS." Price 1d. each.

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

ON SMALL PARTS...

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

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

We ask the kind indulgence of the public on delivery until peaceful conditions return.
YES! BE PREPARED

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

EARNING POWER IS A SOUND INVESTMENT
DO ANY OF THESE SUBJECTS INTEREST YOU?
Accountancy Examinations
Advertising and Sales Management
Agriculture
A.M.I. Fire Examinations
Applied Mechanics
Army Certificates
Attorneys and Estate Agents
Aviation Engineering
Aviation Wireless Banking
Blue Prints
Bolters
Bookkeeping—Accountancy and Modern Business Methods
B.Sc. (Eng.) Building, Architecture and Clerk of Works
Builders' Quantities
Cambridge Senior School Certificate
Civil Engineering
Civil Service
Commercial Art
Common Prelim. E.I.E.B.
Concrete and Structural Engineering
Draftsmanship—All Branches
Engineering—All branches, subjects and examinations
General Education
Heating and Ventilating
Industrial Chemistry
Institute of Housing
Insurance
Journalism
Languages
Mathematics
Matriculation

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

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

COUPON

CUT THIS OUT

To DEPT. 104, THE BENNETT COLLEGE, LTD., SHEFFIELD.
Please send me (free of charge)
Particulars of
Your private advice about

(Cross out line which does not apply)

PLEASE WRITE IN BLOCK LETTERS

Name
Address

---

Some Useful Books

EXPERIMENTAL RADIO ENGINEERING
By E. T. A. Rapson, assisted by G. Ackermann. This book sets out a number of experiments and methods of measurement suitable for a three or four years' course in radio engineering at a technical college. A few of them require rather specialised apparatus but the majority may be carried out with standard laboratory equipment. 6s. 6d. net.

INTRODUCING RADIO RECEIVER SERVICING
By E. M. Squire. This book provides a concise introductory guide to the practical operation of a radio receiver, so that new radio service engineers, test engineers, and dealers may be able to obtain a working knowledge of receivers and servicing equipment in the briefest time. 6s. net.

PRACTICAL MORSE
By John Claricoats, author of Radio Simplified. Written by the Secretary of the Radio Society of Great Britain, this book introduces a scientific method of learning the Morse Code, and its application to radio is well illustrated by many diagrams. Of special appeal to members of the A.T.C. and other pre-Service trainees. 1s. 3d. net.

WIRELESS OPERATING SIMPLY EXPLAINED
By W. E. Crook. This is one of Pitman's famous "Simply Explained" books. This well-known author gives a clear and interesting picture of the wireless operator in action—what he has to do and why and how he does it. 9d. net.

39, PARKER STREET, KINGSWAY

Pitman

CELESTION LTD.
(Engineers.)
KINGSTON-UPON-THAMES, SURREY.
Telephone: KINGSTON 5836-7, 8

VALVEHOLDERS
Manufactured under "Amphenol" Licence and supplied against Priority Orders only.
Preferred by radio engineers because of their Strength, Efficiency and Uniform Concact. Send for list of English and American types.

---

EXTRACT FROM THE MANAGEMENT

This Company is not responsible for the accuracy of any statement of fact or estimate of value given in this advertisement. If you do not see on your requirements above, write to us on any subject. Full particulars free.

To make sure of the best service, please see that your application is carefully completed and given to the nearest branch. Attention must be paid to the use of correct names and addresses. The above notice is not a guaranty that you will be admitted as a member of the Institute.
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 mF 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) \( r = 16.6 \); \( r_a = 10,000 \Omega; \) \( g_m = 1.6 \) m/a.p.v.
3. (b) 10,000 \( \Omega \)

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

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-
nating currents therein, thereby producing electro-magnetic 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).

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: (a) 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; (b) the “blocks” represent processes, and not necessarily separate pieces of apparatus for each purpose; (c) modulation is defined as the “alteration” of some factor of a steady R.F. wave to place intelligence upon it; (d) 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 of the carbon button upon the carbon granules, thereby reducing and increasing the contact area of the instrument.

Now \[ R = \frac{\rho}{A} \]
where \( \rho \) (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 variation 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. 33 (B).

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

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

**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 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 (l) 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 \( f_2 \) 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 \( f_1 - f_2 \). Thus: \( f_1 - f_2 \) = 100 kc/s.p.s.

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

The frequency of (c) Fig. 36 is the average frequency \( f_1 + f_2 \), 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 voltage (A) is 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. (fA) 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 signals 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 I.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, that is, "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 completed, 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 ease 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 the frequency provided by the heterodyne oscillator, if the I.F. is 112 kc/s and a note of 1,000 c.p.s. is required in the telephone?

Answers for article seven.

1. 150,200.00 hertz.

2. 25,35 hertz.

(To be continued)
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, S4, 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 conduction" 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 "set" 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 conduction test.

From sockets marked "Neon test" the Neon lamp is brought in 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 3 in. ebonite and carries 10 valve holders (see Fig. 3) made up of three English type, four American type, two side-contact, and one metal. 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 3 in. x 2 in., 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 dollys, 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. 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 metalised 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.

![Fig. 1—Complete circuit of the valve tester. Component values are given below.](image-url)
A Valve-testing Unit

(Continued from page 277, August, 1943)

Constructional Details of the Complete Valve Tester. By STANLEY BRASIER

American type, two side-contact and one metal. 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 ebolite control panel measuring 1½in. x 2½in. being screwed to the front edge and upon which are mounted all the variable resistors and the on/off switch S3. 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 dollys, a piece of 6 B.A. rod is slipped through and tightened up. The idea will be seen from the illustration. The variable resistors VR3 to VR4 are all of the wire-wound type. VR1 and VR2 must also be capable of carrying a fairly large current, say, 40 milliamperes for values of the D.X. 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—because 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 windings, leads are taken to 5 sockets equidistantly spaced round a circle of roughly 3½in. diameter on a small ebolite 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 milliamperes from each secondary, together with a 4v. 2amp, 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 8½-4 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 paraffin—under the rectifier valve holder which is of the baseboard mounting type. The grid battery for the null conductance test consists of two 1½ volt cells mounted
sting Unit

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 3 in. 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. 5 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. Mainsbridge 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.

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.

This panel is of ebonite and carries switches S1, S2, S3 and S4. S1 is a D.P.D.T. O.M.B. toggle switch. S5 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 O.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
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 rear view of front panel, showing selector switches and neon tube, etc.

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
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.

The 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 valve 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. 1. It is covered in black rexine and for this reason, if plywood is not obtainable, even a stout carton 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 valve holders 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, St, S2, S3, S4 and S5 (see text).
Ten sockets.
Two closed circuit links (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 1/2 watt; two 1,000 ohm 1 watt, and two 500 ohm 1 watt.
Condensers: One 8.1/4 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.

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 ohms). Then, if R, the unknown resistance, is placed in series, the indicated voltage will drop to Vm (Fig. 1), where Vm = Rm x current I.

\[ V = \frac{R + Rm}{R} \times V \]

\[ Vm = \frac{Rm 	imes V}{R + Rm} \]

\[ Rm = \frac{V - Vm}{I} \]

or

Unknown Resistance:

\[ \text{Meter Resistance} \times \text{Drop in reading of meter} \]

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 10,000 ohms and a 15-volt G.B. battery was used as V, then if the meter reading with an unknown resistance in series was, say, 3.75 volts, \( R = \frac{10,000 \times (15 - 3.75)}{3.75} \)

= 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.
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 generated some little dodge which would interest other readers. Why not publish it on this page we will pay £1-10-0 for the best hint submitted, and for every other idea published on this page we will pay half-a-crown. Turn this idea of yours to account by sending it in to us addressed to the Editor, "PRACTICAL WIRELESS," George Newsome, Ltd., Tower House, Southampton Street, Strand, W.C.2. Put your name and address on every item. Please note that every notice sent in must be original. Make envelopes! Practical Hints. DO NOT enclose Queries with your hints.

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).

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).

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 two 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).

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 top 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).

A simple arrangement for a detachable morse key and oscillator.

A method of increasing the volume in 'phones when used for morse practice.
Permanent Magnets—VII

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 retarding effect on the flux, with the result that a torque is produced opposing the 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 "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.

Calculating Damping Torque

To calculate the damping torque the formula used is

\[ T = \frac{4Bv^2d}{6(4r^2+4r)} \]

where \( T \) is the damping torque, \( v \) is the disc's velocity in radians per second, \( d \) is the thickness of the former, \( r \) is the radius of the disc, and the result is expressed in dyne-cm.

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 \( B_H \mu \), in which \( B_H \) and \( \mu \) represent the flux density, length and permeability of the iron cylinder. The value thus obtained must, of course, be subtracted from 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 in 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. 2 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 Alnico.
FOR THE
RADIO SERVICE MAN,
DEALER AND OWNER

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

INTERNATIONAL CORRESPONDENCE SCHOOLS
Dept. 94, International Buildings,

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

Complete Radio Engineering
Radio Service Engineers
Elementary Radio
Television

If you wish to pass a Radio examination, indicate it below.

British Institute of Radio Engineers
P.M.G. Certificate for Wireless Operators
Provisional Certificate in Radio Telephony and Telegraphy for Aircraft
City and Guilds Telecommunications
Wireless Operator, R.A.F.
Wireless Mechanic, R.A.F.

Special terms for members of H.M. Forces.

Name
Age
Address

(Use penny stamp or unsealed envelope.)

THE CHLORIDE ELECTRICAL STORAGE COMPANY LTD.

Phone: VICToria 2299, Grams: Chloridic, Sewest, London.
In all communications—Condensers are at work

HUNTS
The Home of Condensers

ADVT. OF A. H. HUNT LTD., LONDON, S.W.18. EST. 1901.

WHAT PRODUCTION MODIFICATIONS IN SOLDERING PROCESSES ARE NECESSARY WHEN USING WAR-TIME ALLOYS?

This and numerous other queries are answered in reference sheet 2 of "Technical Notes on Soldering," published by the manufacturers of Ersin Multicore—the A.I.D. approved solder wire with three cores of non-corrosive Ersin activated flux.

Firms engaged on Government contracts are invited to write for a copy of this reference sheet and samples of Ersin Multicore Solder wire.

ERSIN MULTICORE
The Solder Wire with 3 Cores of Non-Corrosive Ersin Flux.

MULTICORE SOLDERERS LTD., BUSH HOUSE, LONDON, W.C.2. TEMpleBat551/F

DAGENITE
AND
PERTRIX
—the dependable
BATTERIES

FOR
RADIO, CARS
MOTOR CYCLES
COMMERCIAL VEHICLES
ETC.

Sales Concessionaires:
HOLSUN BATTERIES LIMITED
137 Victoria Street, London, S.W.1

D.9
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.

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 amperes, 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 with a result of 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.

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

\[
Q = b \phi,
\]

where \( b \) is the ballistic constant and \( \phi \) 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.

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 0 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 \( \phi \) (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 \( E/Z \).

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 \( \omega L \) respectively. Then from this latter we have, by the Theorem of Pythagoras:

\[
Z^2 = R^2 + \omega^2 L^2
\]

\[
I = E/\sqrt{R^2 + \omega^2 L^2}
\]

The phase relations between the voltage and current are also obtained from the impedance triangle, and being denoted by \( \phi \):

\[
\tan \phi = \omega L/R = X/R
\]

Similarly

\[
\sin \phi = X/Z
\]

\[
\cos \phi = R/Z
\]

\[E=IZ, \quad V_L=\omega L, \quad V_R=IR\]

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

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

In the case of \( R \) being much greater than \( \omega L \), \( \tan \phi \) 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 \( I \) 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.

\[
Z^2 = R^2 + 1/(\omega^2 C^2)
\]

\[
I = E/\sqrt{R^2 + 1/(\omega^2 C^2)}
\]

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 supplies to the circuit is as follows:

(a) That supplied to the reactance 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 dissipates as heat and the like i.e., actual power supplied \( = I^2 R + (1/\omega) I^2 L \).

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

\[
\text{i.e., apparent power } = EI = I^2 R + (1/\omega L)
\]

We define Power Factor as actual power/apparent power:

\[
= R/Z
\]

\[
\cos \phi
\]

\[
\text{Power Factor } = \cos \phi
\]

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 \( \omega LI \) 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 \( \omega LI \) 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 \( \omega LI \) 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:

\[
E^2 = (IR)^2 + (\omega LI - 1/\omega C)^2
\]

\[
E = I\sqrt{R^2 + (\omega LI - 1/\omega C)^2}
\]

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

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

The relations:

\[
1 = E, \sqrt{R^2 + (\omega L - 1/\omega C)^2}
\]

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

are true whether \( \omega L \) is smaller than \( \omega C \) or not. If \( \omega L \) is greater than \( \omega C \), the expression \( \omega L - 1/\omega C \) is negative in sign and \( \phi \) 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 \( \omega L \) 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.

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 \( \omega \) is very small:

\( \omega L \) very small; \( 1/\omega C \) is large; \( (1/\omega C - \omega L) \) is very large; \( Z \) is very large; \( I \) is small; \( \phi \) is large.

(b) When \( \omega \) is small:

\( \omega L \) is small; \( 1/\omega C \) is large; \( (1/\omega C - \omega L) \) is large; \( Z \) is large; \( I \) is small; \( \phi \) is large.
the resonant effect of a series circuit as well as the parallel one, which will be discussed later.

The ratio \( V_1/E \) or \( V_{RL}/E \) is called the circuit magnification or \( Q \) factor. Since \( V_{RL}/E = \omega L/R \)

\[ Q = \omega L/R \]

\( Q \) factor of the circuit may also be

defined as:

Reactance of one kind

Total circuit resistance

Thus, the \( Q \) factor is given by:

\[ Q = \omega L/R \]

Also, since \( \omega = 1/\sqrt{LC} \) we have:

\[ Q = \omega L/R = 1/\sqrt{LC} \]

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 = \( oL/R \) 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 \( oL/R \) 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.

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

---

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

*(c) When \( \omega \) is such that \( X_C = X_L \):

- \( \omega L \) is large; \( 1/\omega C \) is large; \( (1/\omega C - \omega L) \) is zero;
- \( Z \) is equal to \( R \); \( I \) is equal to \( E/R \); \( \phi \) is zero.

*(d) When \( \omega \) is large:

- \( \omega L \) is large; \( 1/\omega C \) is small; \( (1/\omega C - \omega L) \) is large; \( Z \) is large; \( I \) is small; \( \phi \) is large.

*(e) When \( \omega \) is very large:

- \( \omega L \) 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; \( \phi \) is large.

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

the inductive reactance equals the capacitive reactance.

As \( \omega \) 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:

\[ X_C = X_L \]

\[ \omega = \sqrt{LC} \text{ or } \omega = 1/\sqrt{LC} \]

The current at resonance \( I_0 \) is given by:

\[ I_0 = E/I_0 = L/R \]

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

\[ V_R = V_0 R \]

\[ V_L = V_0 oL = oLLE/IR \]

\[ V_C = V_0 oC = E/\omega_0 CR \]

\( V_L \) and \( V_C \) are equal at resonance, and in normal radio circuits are much larger than the generator \( E/\omega_0 f \). 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
Relationships of the Q Factors

In a series circuit let the resistance of the coil be \( R_L \),
and the resistance of the condenser \( R_F \).
Then total circuit resistance is \( R_T = R_L + \frac{1}{\omega C R_F} \).

- \( Q \) circuit: \( \omega L R_F = \alpha \)\( \omega C R_F \)
- For the coil alone at the resonant frequency:
  \( Q \) coil: \( \omega L = \frac{\alpha}{\omega C} \)
- For the condenser alone, at the resonant frequency:
  \( Q \) condenser: \( \frac{1}{\omega C R_F} \)

Now consider \( 1/Q \) coil + \( 1/Q \) condenser.

\[ \begin{align*}
  R_T &= R_L + \frac{1}{\omega C R_F} \\
  \omega L &= \frac{\alpha}{\omega C} \\
  \therefore 1/Q \text{ circuit} &= \frac{1}{\alpha} \quad \text{(a)}
\end{align*} \]

\[ \begin{align*}
  \text{Fig. 12} &- \text{The effect of resistance and the } 1/Q \text{ ratio of the response curve respectively.}
\end{align*} \]

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 selectivity of the response curve, the current against frequency graph as shown in Fig. 15, as a measure of the selectivity; the selectivity of such a curve depends upon the following factors:

\( G \): The resistance, i.e., the height of the peak given by \( V/V \), is inversely proportional to the resistance and

\[ \frac{1}{Q} \text{ circuit} = \frac{1}{\alpha} \quad \text{(b)} \]

\[ \begin{align*}
  \text{Fig. 13} &- \text{Phase relation in a parallel circuit of resistance and inductance.}
\end{align*} \]

therefore the selectivity varies as \( 1/R \) (Fig. 17(a)).

\( (ii) \) The \( L/C \) ratio—response at resonance depends
upon the resistance only as we have seen; response of \( R \) 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 insensible 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. 16, it will be seen that for high selectivity:

\[ \begin{align*}
  \text{Phase} &= \pi - 2f \pi \\
  \text{Voltage} &= \frac{1}{\sqrt{2}} \quad \text{(2)}
\end{align*} \]

should be large. Suppose the curve is cut at a response level of \( 1/\sqrt{2} \), it can be shown that at this response level, the resistance of the circuit is equal to the reactance, for

\[ \begin{align*}
  Z &= \sqrt{R^2 + X^2} = \sqrt{R^2 + \omega^2 L^2} \\
  \text{Current} &= I \quad \text{(3)}
\end{align*} \]

Now at \( 1 \) the capacitance is predominant,

\[ \therefore \alpha L = \omega C \quad \text{(4)} \]

\[ \begin{align*}
  \text{while at } f \text{ the inductive reactance is predominant} \\
  \therefore \omega L = \frac{1}{\omega C} = \frac{1}{\alpha} \quad \text{(5)}
\end{align*} \]

Multiply equation (4) by \( \omega \) and equation (5) by \( \omega \)

\[ \begin{align*}
  \omega^2 L = \omega^2 C = \omega^2 R \\
  \therefore \omega^2 L = \frac{1}{\alpha} \quad \text{(6)}
\end{align*} \]

Adding these:

\[ \begin{align*}
  \omega^2 L &= \omega^2 C = \omega^2 R = \omega^2 R \\
  (L - \omega^2 C) &= \frac{1}{\alpha} \\
  \text{Dividing both sides by } \omega \quad \therefore \omega^2 L &= \frac{1}{\alpha} \\
  \text{Thus by choosing a particular response level we have shown that } Q \text{ is a direct measure of the selectivity. We have already seen that } Q = \frac{1}{\sqrt{L/C}} \\
\end{align*} \]

Parallel Circuits

We will now deal with parallel circuits. First a circuit with resistance and reactance is 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 \( E \), while the current through the reactance lags it by 90 deg.

\[ \begin{align*}
  \text{Fig. 18} &- \text{The response curve from which selectivity may be given in terms of } Q.
\end{align*} \]

\[ \begin{align*}
  \text{Fig. 20} &- \text{Phase relation in a resistance-capacity parallel combination.}
\end{align*} \]

Now \( I_L = E/\omega L \), \( I_R = R/I \), \( I = E/\omega L \)

Then from the vector diagram we see that:

\[ \begin{align*}
  \frac{1}{\omega} &= \frac{1}{\omega} \quad \text{and } \omega^2 L = \frac{1}{\alpha} \\
  E/\omega L &= \frac{1}{\alpha} \quad \text{and } \omega^2 L = \frac{1}{\alpha} \\
  \text{Then } Z &= \frac{1}{\sqrt{R^2 + L^2}} \\
  \text{The current } I \text{ is given by:} \\
  \text{The current } I \text{ is given by:}
\end{align*} \]

\[ \begin{align*}
  E/\omega L &= \frac{1}{\sqrt{R^2 + L^2}} \\
  \omega^2 L &= \frac{1}{\alpha} \quad \text{and leads the applied e.m.f. by an angle } \phi. \quad \text{The circuit is inductive.}
\end{align*} \]

\[ \begin{align*}
  \text{Resistance and capacitance in parallel. This circuit is shown in Fig. 20, together with the vector presentation. The current through the resistance } I_L \text{ is again in phase with the applied e.m.f. while the current through the capacitance leads the e.m.f. by 90 deg.}
\end{align*} \]

Then from this we obtain the following:

\[ \begin{align*}
  \frac{1}{\omega} &= \frac{1}{\omega} \quad \text{and } \omega^2 L = \frac{1}{\alpha} \\
  E/\omega L &= \frac{1}{\alpha} \quad \text{and } \omega^2 L = \frac{1}{\alpha} \\
  I^2 &= \frac{1}{\alpha} \quad \text{and } \omega^2 L = \frac{1}{\alpha} \\
  Z &= \sqrt{R^2 + L^2} \\
  \text{The current } I \text{ is given by:}
\end{align*} \]

\[ \begin{align*}
  E/\omega L &= \frac{1}{\sqrt{R^2 + L^2}} \\
  \text{and leads the applied e.m.f. by an angle } \phi. \quad \text{This time the circuit is capacitive.}
\end{align*} \]

\( \text{(To be continued.)} \)

NEWNES SHORT-WAVE MANUAL

6/6 or 6/6 by post from
George Newnes, Ltd., Tower House, Southampton St.
London, W.C.2
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, V2 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 R3 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 bias 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 Vc 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:

\[ R = \frac{V_{a}}{I_{a}} \times 1,000 \]

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

\[ R = \frac{9}{45} \times 1,000 = 200 \text{ ohms} \]

This, and other simple formulas, 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,

\[ R = \frac{E}{C} \]

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 which 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 208 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 208 v. or 22 v. at 0.3 amps (the current of the valves),

\[ \therefore R = \frac{22}{0.3} = 406.6 \text{ ohms} \]

A still simpler way is to bring the current to milliamps and multiply by 1,000,

\[ 122 \times \frac{1,000}{3} = 406.6 \text{ ohms} \]

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:

\[ \text{mains voltage minus total voltage of heaters} \times 1,000 \]

\[ \text{heater current of valves in milliamps} \]

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 must be calculated at the

[Diagram of the heater chain is shown, indicating the voltage and current requirements.]

Showing how the heater chain is virtually "across" the mains supply.
higher current, and shunts provided for those values taking the lower current. An example of this is shown in the original circuit diagram of the "Midget Universal Receiver," where 0.2 amp. values were used, except for V3, the output pentode, which consumed 0.18 amp. Thus, the difference of 0.02 amps. (or 20 milliamps) has to be passed by a shunt resistor at 20 volts—the voltage of V3's heater. Therefore, resistance of shunt
\[
\frac{20}{\frac{1}{1000}} = 20000 \text{ ohms.}
\]

Condensers

Some readers have been unable to obtain the 8 μfd. type electrolytic smoothing condenser and ask what other 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, 4 μfd. 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 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.

Cables

The cables 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 and the latter, resistance will increase it; but most universal transformers take up 250 volts on the anode, so that some advantage may be gained providing the screen voltages are correctly adjusted. When using a high resistance 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 above, 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 4 in. or 5 in. 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 efficiency, 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, V4. This may be of any half-wave universal type bearing in mind that the heater current is low, but where an American Octal or U.N. 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 source of the trouble, this should be dealt 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 G-V-1 type which gave very good results. When operated of half-wave, with the valves and transformer in new H.T.s, he decided to make up a dimerizer to operate of his A.C. mains.

On test the unit was quite satisfactory, but when he tried it with the recovery, the performance of the latter was spoiled by pronounced "motor-boating." Thomas decided that some decoupling was called for, so he found a suitable resistor and a 1 μfd. condenser in his junk box, and connected the resistor between the H.T. line and the H.T. line 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 received. Entries must be addressed to the Editor, Practical Wireless, (George Newsom, Ltd., Tower House, Southampton Street, Strand, London, W.C.2). Envelopes must be addressed to the Editor as above, top left-hand corner, and must be posted to reach this office not later than the first post on Monday, August 19th, 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 values 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 446: and are now hereby forwards to them Mr. W. Wells, 39, Oodine Wood Hill, Purley, Surrey; R. Johnson, 57, Bury Road, Lancaster; B. Dunn, 52, High Street, Cottenham, Cambridgeshire.
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, 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. C3145-52.

Maggie Teyte, soprano, with Gerald Moore at the piano, has made two beautiful recordings in French, on H.M.V. D.4183. She has selected, this month, Bizet's "Chanson d'Avril" (Song of April) and "L'Oiseau-Lyre," Op. 2, No. 7, de l'Ile-Chausson. Maggie Teyte, an Englishwoman of Scots extraction, born in Wolverhampton, has rendered great artistic service to the French and, this was recognized 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 gives us "Post-war Midnight News," on H.M.V. B932x. 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. BD5808, 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 it Before," foxtrot, which is featured in the film, "You on Parade." These are good numbers, and they are recorded on H.M.V., BD5807.

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 Parnassus; (2) Jimbo's Lullaby; (3) Serenade for the Doll; (4) The Snow is Falling; (5) The Little Shepherd, and (6) The Goathog's Cake Walk. On the remaining side of the second record is "Traumeri" (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 DX1123 and DX1122.

In the DB series, Nelson Eddy, baritone, has recorded two fine ballads, "To-morrow," from "Salt Water Ballads," and "The Blind Ploughman," on Columbia DB5514. 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 Sander Trio has selected for its recording on Columbia DB5575. Victor Silvester and his Ballroom Orchestra have two records this month. They are Columbia FB2937 and FB2938. 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'll 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 I," coupled with "When You Were 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 F82936, in first-class style.

Jimmy Leach and the "New Organolians," Dudley de Lorraine, have made a fine recording of "The Shale of Araby," and "Star Dust."

"Polar Star," waltz, and "Monte Cristo," 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 RQ2862, 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.

"Ten 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 On Eye on Your Heart," is on Parlophone F583. 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 F581. 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 MR669, and on it Harry has recorded "Don't Get Around Much Anymore," and "Best Wishes," both foxtrots. The other recording is by Reginal Dixon at the organ playing, in first-class style, "Rustle of Spring" and "Auronne," two fine numbers played in a masterly manner.

A REMINDER

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

### H.F. PENTODES

<table>
<thead>
<tr>
<th>BATTERY TYPES</th>
<th>Typical Operating Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nominal Rating</strong></td>
<td><strong>Vols.</strong>, <strong>Volts</strong></td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td><strong>M.A.</strong></td>
</tr>
<tr>
<td>1S2G</td>
<td>1.5</td>
</tr>
<tr>
<td>1S2V</td>
<td>1.5</td>
</tr>
<tr>
<td>1A4E</td>
<td>1.5</td>
</tr>
<tr>
<td>200 V.P.T.</td>
<td>2</td>
</tr>
<tr>
<td>219 V.P.A.</td>
<td>2</td>
</tr>
<tr>
<td>210 S.E.T.</td>
<td>2</td>
</tr>
</tbody>
</table>

### MAINS TYPES

#### H.F. PENTODES—(Continued)

<table>
<thead>
<tr>
<th>BATTERY TYPES</th>
<th>Typical Operating Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nominal Rating</strong></td>
<td><strong>Vols.</strong>, <strong>Volts</strong></td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td><strong>M.A.</strong></td>
</tr>
<tr>
<td>M.S./Pen</td>
<td>4</td>
</tr>
<tr>
<td>M.S./Pen, B</td>
<td>4</td>
</tr>
<tr>
<td>M.V.S./Pen</td>
<td>4</td>
</tr>
<tr>
<td>MOE</td>
<td>6.5</td>
</tr>
<tr>
<td>D.7</td>
<td>6.5</td>
</tr>
<tr>
<td>67E</td>
<td>6.5</td>
</tr>
<tr>
<td>728</td>
<td>6.5</td>
</tr>
<tr>
<td>39/44E</td>
<td>6.5</td>
</tr>
<tr>
<td>6KG</td>
<td>6.5</td>
</tr>
<tr>
<td>77E</td>
<td>6.5</td>
</tr>
<tr>
<td>11 V.P.A.</td>
<td>13</td>
</tr>
<tr>
<td>12 V.P.A.</td>
<td>13</td>
</tr>
<tr>
<td>D S.Ben</td>
<td>16</td>
</tr>
<tr>
<td>D.V.S.B.</td>
<td>16</td>
</tr>
<tr>
<td>200 V.P.</td>
<td>20</td>
</tr>
<tr>
<td>202 V.P.B.</td>
<td>20</td>
</tr>
<tr>
<td>202 S.P.B.</td>
<td>20</td>
</tr>
</tbody>
</table>

### SCREEN-GRID VALVES

<table>
<thead>
<tr>
<th>BATTERY TYPES</th>
<th>Typical Operating Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nominal Rating</strong></td>
<td><strong>Vols.</strong>, <strong>Volts</strong></td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td><strong>M.A.</strong></td>
</tr>
<tr>
<td>220 E.G.</td>
<td>2</td>
</tr>
<tr>
<td>220 R.G.</td>
<td>2</td>
</tr>
<tr>
<td>220 V.S.G.</td>
<td>2</td>
</tr>
<tr>
<td>220 V.S.</td>
<td>2</td>
</tr>
</tbody>
</table>

### BATTERY TYPES DIODES, DIODE TRIODES AND DIODE PENTODES

<table>
<thead>
<tr>
<th>BATTERY TYPES</th>
<th>Typical Operating Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nominal Rating</strong></td>
<td><strong>Vols.</strong>, <strong>Volts</strong></td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td><strong>M.A.</strong></td>
</tr>
<tr>
<td>1R6G</td>
<td>DT</td>
</tr>
<tr>
<td>219 D.D.T.</td>
<td>DD</td>
</tr>
<tr>
<td>218 D.D.</td>
<td>DD</td>
</tr>
</tbody>
</table>

### MAINS TYPES

<table>
<thead>
<tr>
<th>BATTERY TYPES</th>
<th>Typical Operating Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nominal Rating</strong></td>
<td><strong>Vols.</strong>, <strong>Volts</strong></td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td><strong>M.A.</strong></td>
</tr>
<tr>
<td>D.D.T</td>
<td>DD</td>
</tr>
<tr>
<td>DT</td>
<td>DT</td>
</tr>
<tr>
<td>D.PEN</td>
<td>DD</td>
</tr>
<tr>
<td>220 B.G.</td>
<td>DD</td>
</tr>
</tbody>
</table>

*Indirectly Heated* | *Separate Cathode* | *At Screen Volts 100* | 1 DT = Diode Triode | 2 DT = Double Diode Triode | 3 DT = Double Diode | 4 DT = Double Diode Pentode
ELECTRADIX BARGAINS

Trained men get
GOOD JOBS

Now is the time to prepare yourself for the future. There will be splendid opportunities for technically trained men to secure well-paid employment, or start radio businesses of their own.

Even if you know nothing about radio, we can train you. Our specialised method of Home-Study Tuition is a proved success. Hundreds of our students now doing important work owe their progress solely to our training.

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

T. & C. RADIO COLLEGE,
2, THE MALL, EALING, W.5

Please send request for further information of your Home-Study Mathematics and Radio Courses.

NAME
ADDRESS

P. 43

RELAGS

TWO STEP RELAY LF/FS
(Hearv Silver Contacts)
first impulse
"On.

Impulse "Off."
A.C. and D.C.

CHANGE OVER RELAY

Ask for leaflet 86xP.W.

LONDON LTD.

Anerley Works, 887, Anerley Road, London S.E.25. Phone: SYD 0690

ELECTRIC LIGHT CHECK METERS, with motors and dials. A.C. or D.C. meters electrically guaranteed for A.C. mains 200/250 volts 50 cy. 1-phase 5 amp. load, 100/- each. 300/350 volts, 250/-.

K.W. TRANSFORMER, input 100 volts at 100 cycles, single phase, output 10,500 volts, complete for 30/-.

MATERIAL METRECTORS, by famous makers, no full load, convert your D.C. meter to 150 A.C. contrary.

STEP-UP TRANSFORMERS, 31/2in., dia. a pole mounted on spring stands, also two high quality pure silver-coated 31/2in., dia., also mounted on spring blocks for heavy duty, new and unused: there is enough base to remove for different purpose. Price each, 25/-, post free.

HEAVY DUTY CABLE, V.I.R. and braided in first-class cordage, size 2,600 volts, 500 yards. By the length, 6/- per yard, carriage forward. 22/8 each, post free, or 30/- nurse.

SOLID BRASS LAMPS (swing type), one-hole mountng, double contact small B.C. holder and 12 volt small bulb, 2/8 each, post free.

APPENDIXES, description as above, range 3/- amps. Price 21/6 post free.

KLAZON MOTORS, 220 v., D.C. 1/10 H.P. shunt wound, ball-bearing, fitted reduction gear for electrically supplied 220 volt, no carriage charge, condition as new. Price 50/- each, carriage paid.

D.C. MOTOR, shunt wound, condition as new, high grade, ball-bearing, H.P. can be supplied in both D.C. and A.C. only.

Price 40/-, carriage paid.

MOY COIL, movements, needing slight repair, modern type, 3 inch, 4100 No. leave 4 inch long, 50/6, carriage charge.

RIGHT ANGLE DRIVE, mounted in metal box, all ball-bearing, fin, dia. 6 in., 12 volts, 500 amps., carriage charge.

KLAZON MOTORS, 220 v., D.C. 1/10 H.P. shunt wound, ball-bearing, fitted reduction gear for electrically supplied 220 volt, carriage charge.

AUTO TRANSFORMER, Ratings 2,000 watts, tapped 110-300-220, 115/230 volts as new. Price £9, carriage paid.

PENDER VIGOROUS resistances, six fin, by lin., 5,000 ohms to carry 100 or 150 amp. two sizes, Price 2/- each. post free.

RESISTANCE MATS and fin, by 6 in., set of four, 30-60-150 and 600 ohms to carry 100 amp. Price, set of four, 5/-, post free.


CHROMETON DYNAMO, wound 50/55 volts 25 cycles, 4 poles, speed 1250 r.p.m., massive construction, in perfect working order, 20/- each. carriage paid.

MOTOR DRIVEN PUMP, 100 v., D.C. motor, "Keith Blackburn," 1 fin., in line overflow, gear type pump, in perfect working order, 20/- each. carriage paid:

W.8.

ELECTRICAL STORES

"FAIRVIEW."

LONDON RD., WROMTHAM, KENT.

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

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

ELECTRIC LIGHT CHECK METERS, with motors and dials. A.C. or D.C. meters electrically guaranteed for A.C. mains 200/250 volts 50 cy. 1-phase 5 amp. load, 100/- each. 300/350 volts, 250/-.

K.W. TRANSFORMER, input 100 volts at 100 cycles, single phase, output 10,500 volts, complete for 30/-.

MATERIAL METRECTORS, by famous makers, no full load, convert your D.C. meter to 150 A.C. contrary.

STEP-UP TRANSFORMERS, 31/2in., dia. a pole mounted on spring stands, also two high quality pure silver-coated 31/2in., dia., also mounted on spring blocks for heavy duty, new and unused: there is enough base to remove for different purpose. Price each, 25/-, post free.

HEAVY DUTY CABLE, V.I.R. and braided in first-class cordage, size 2,600 volts, 500 yards. By the length, 6/- per yard, carriage forward. 22/8 each, post free, or 30/- nurse.

SOLID BRASS LAMPS (swing type), one-hole mountng, double contact small B.C. holder and 12 volt small bulb, 2/8 each, post free.

APPENDIXES, description as above, range 3/- amps. Price 21/6 post free.

KLAZON MOTORS, 220 v., D.C. 1/10 H.P. shunt wound, ball-bearing, fitted reduction gear for electrically supplied 220 volt, no carriage charge, condition as new. Price 50/- each, carriage paid.

D.C. MOTOR, shunt wound, condition as new, high grade, ball-bearing, H.P. can be supplied in both D.C. and A.C. only.

Price 40/-, carriage paid.

MOY COIL, movements, needing slight repair, modern type, 3 inch, 4100 No. leave 4 inch long, 50/6, carriage charge.

RIGHT ANGLE DRIVE, mounted in metal box, all ball-bearing, fin, dia. 6 in., 12 volts, 500 amps., carriage charge.

KLAZON MOTORS, 220 v., D.C. 1/10 H.P. shunt wound, ball-bearing, fitted reduction gear for electrically supplied 220 volt, carriage charge.

AUTO TRANSFORMER, Ratings 2,000 watts, tapped 110-300-220, 115/230 volts as new. Price £9, carriage paid.

PENDER VIGOROUS resistances, six fin, by lin., 5,000 ohms to carry 100 or 150 amp. two sizes, Price 2/- each. post free.

RESISTANCE MATS and fin, by 6 in., set of four, 30-60-150 and 600 ohms to carry 100 amp. Price, set of four, 5/-, post free.


CHROMETON DYNAMO, wound 50/55 volts 25 cycles, 4 poles, speed 1250 r.p.m., massive construction, in perfect working order, 20/- each. carriage paid.

MOTOR DRIVEN PUMP, 100 v., D.C. motor, "Keith Blackburn," 1 fin., in line overflow, gear type pump, in perfect working order, 20/- each. carriage paid:

W.8.

ELECTRICAL STORES

"FAIRVIEW."

LONDON RD., WROMTHAM, KENT.

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

Regret no Orders can be accepted from Eire or Northern Ireland.
## Valve Data Sheets

### BATTERY TYPES

#### TRIODES

<table>
<thead>
<tr>
<th>Type</th>
<th>Fil. or Heater</th>
<th>Max. Volts</th>
<th>Impedance</th>
<th>Mat. Cond.</th>
<th>Anode Grid</th>
<th>Anode Current</th>
<th>Amplification Factor</th>
<th>Base</th>
<th>Bulb</th>
<th>Base Index No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>210</td>
<td>120</td>
<td>250</td>
<td>.005</td>
<td>1.5</td>
<td>900</td>
<td>5</td>
<td>100</td>
<td>P, 4</td>
<td>Clear/Met.</td>
<td>40</td>
</tr>
<tr>
<td>220</td>
<td>140</td>
<td>250</td>
<td>.005</td>
<td>1.5</td>
<td>900</td>
<td>5</td>
<td>100</td>
<td>P, 4</td>
<td>Clear/Met.</td>
<td>40</td>
</tr>
<tr>
<td>230</td>
<td>160</td>
<td>250</td>
<td>.005</td>
<td>1.5</td>
<td>900</td>
<td>5</td>
<td>100</td>
<td>P, 4</td>
<td>Clear/Met.</td>
<td>40</td>
</tr>
<tr>
<td>240</td>
<td>180</td>
<td>250</td>
<td>.005</td>
<td>1.5</td>
<td>900</td>
<td>5</td>
<td>100</td>
<td>P, 4</td>
<td>Clear/Met.</td>
<td>40</td>
</tr>
</tbody>
</table>

#### OUTPUT TRIODES

<table>
<thead>
<tr>
<th>Type</th>
<th>Fil. or Heater</th>
<th>Max. Volts</th>
<th>Impedance</th>
<th>Mat. Cond.</th>
<th>Anode Grid</th>
<th>Anode Current</th>
<th>Amplification Factor</th>
<th>Base</th>
<th>Bulb</th>
<th>Base Index No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>215</td>
<td>250</td>
<td>250</td>
<td>.005</td>
<td>1.5</td>
<td>900</td>
<td>5</td>
<td>100</td>
<td>P, 4</td>
<td>Clear/Met.</td>
<td>40</td>
</tr>
<tr>
<td>220</td>
<td>250</td>
<td>250</td>
<td>.005</td>
<td>1.5</td>
<td>900</td>
<td>5</td>
<td>100</td>
<td>P, 4</td>
<td>Clear/Met.</td>
<td>40</td>
</tr>
<tr>
<td>230</td>
<td>250</td>
<td>250</td>
<td>.005</td>
<td>1.5</td>
<td>900</td>
<td>5</td>
<td>100</td>
<td>P, 4</td>
<td>Clear/Met.</td>
<td>40</td>
</tr>
<tr>
<td>240</td>
<td>250</td>
<td>250</td>
<td>.005</td>
<td>1.5</td>
<td>900</td>
<td>5</td>
<td>100</td>
<td>P, 4</td>
<td>Clear/Met.</td>
<td>40</td>
</tr>
</tbody>
</table>

#### MAINS TYPES

<table>
<thead>
<tr>
<th>Type</th>
<th>Fil. or Heater</th>
<th>Max. Volts</th>
<th>Impedance</th>
<th>Mat. Cond.</th>
<th>Anode Grid</th>
<th>Anode Current</th>
<th>Amplification Factor</th>
<th>Base</th>
<th>Bulb</th>
<th>Base Index No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>215</td>
<td>250</td>
<td>250</td>
<td>.005</td>
<td>1.5</td>
<td>900</td>
<td>5</td>
<td>100</td>
<td>P, 4</td>
<td>Clear/Met.</td>
<td>40</td>
</tr>
<tr>
<td>220</td>
<td>250</td>
<td>250</td>
<td>.005</td>
<td>1.5</td>
<td>900</td>
<td>5</td>
<td>100</td>
<td>P, 4</td>
<td>Clear/Met.</td>
<td>40</td>
</tr>
<tr>
<td>230</td>
<td>250</td>
<td>250</td>
<td>.005</td>
<td>1.5</td>
<td>900</td>
<td>5</td>
<td>100</td>
<td>P, 4</td>
<td>Clear/Met.</td>
<td>40</td>
</tr>
<tr>
<td>240</td>
<td>250</td>
<td>250</td>
<td>.005</td>
<td>1.5</td>
<td>900</td>
<td>5</td>
<td>100</td>
<td>P, 4</td>
<td>Clear/Met.</td>
<td>40</td>
</tr>
</tbody>
</table>

### BATTERY TYPES

#### OUTPUT PENTODES AND TETRODES

<table>
<thead>
<tr>
<th>Type</th>
<th>Fil. of Htr.</th>
<th>Max. Volts</th>
<th>Anode Grid</th>
<th>Anode Current</th>
<th>Amplification Factor</th>
<th>Base</th>
<th>Bulb</th>
<th>Base Index No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>215P</td>
<td>250</td>
<td>250</td>
<td>.005</td>
<td>1.5</td>
<td>900</td>
<td>5</td>
<td>100</td>
<td>P, 4</td>
</tr>
<tr>
<td>220P</td>
<td>250</td>
<td>250</td>
<td>.005</td>
<td>1.5</td>
<td>900</td>
<td>5</td>
<td>100</td>
<td>P, 4</td>
</tr>
<tr>
<td>230P</td>
<td>250</td>
<td>250</td>
<td>.005</td>
<td>1.5</td>
<td>900</td>
<td>5</td>
<td>100</td>
<td>P, 4</td>
</tr>
<tr>
<td>240P</td>
<td>250</td>
<td>250</td>
<td>.005</td>
<td>1.5</td>
<td>900</td>
<td>5</td>
<td>100</td>
<td>P, 4</td>
</tr>
</tbody>
</table>

### MAINS TYPES

<table>
<thead>
<tr>
<th>Type</th>
<th>Fil. or Heater</th>
<th>Max. Volts</th>
<th>Impedance</th>
<th>Mat. Cond.</th>
<th>Anode Grid</th>
<th>Anode Current</th>
<th>Amplification Factor</th>
<th>Base</th>
<th>Bulb</th>
<th>Base Index No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>215P</td>
<td>250</td>
<td>250</td>
<td>.005</td>
<td>1.5</td>
<td>900</td>
<td>5</td>
<td>100</td>
<td>P, 4</td>
<td>Clear/Met.</td>
<td>40</td>
</tr>
<tr>
<td>220P</td>
<td>250</td>
<td>250</td>
<td>.005</td>
<td>1.5</td>
<td>900</td>
<td>5</td>
<td>100</td>
<td>P, 4</td>
<td>Clear/Met.</td>
<td>40</td>
</tr>
<tr>
<td>230P</td>
<td>250</td>
<td>250</td>
<td>.005</td>
<td>1.5</td>
<td>900</td>
<td>5</td>
<td>100</td>
<td>P, 4</td>
<td>Clear/Met.</td>
<td>40</td>
</tr>
<tr>
<td>240P</td>
<td>250</td>
<td>250</td>
<td>.005</td>
<td>1.5</td>
<td>900</td>
<td>5</td>
<td>100</td>
<td>P, 4</td>
<td>Clear/Met.</td>
<td>40</td>
</tr>
</tbody>
</table>

### QUIESCENT OUTPUT TRIODES AND PENTODES

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Volts</th>
<th>Amps</th>
</tr>
</thead>
<tbody>
<tr>
<td>210B</td>
<td>Batt. B. D. Tr.</td>
<td>100</td>
<td>9</td>
</tr>
<tr>
<td>220B</td>
<td>Batt. B. B. D. Tr.</td>
<td>100</td>
<td>9</td>
</tr>
<tr>
<td>230B</td>
<td>Batt. B. B. D. Tr.</td>
<td>100</td>
<td>9</td>
</tr>
<tr>
<td>240B</td>
<td>Batt. B. B. D. Tr.</td>
<td>100</td>
<td>9</td>
</tr>
<tr>
<td>250B</td>
<td>Batt. B. B. D. Tr.</td>
<td>100</td>
<td>9</td>
</tr>
</tbody>
</table>

### Notes

- General Purpose Types.
- Directly heated.
- Double-diode Tetrode.

---

*Data from Cossor Valve Data Sheets*
Station Identification


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

Both these stations I received on a 3-valve homemade battery set (det., 1 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 25.06 metres, English language programme, 01.00—02.00 hours; Ankara, Turkey, on 31.20 metres; calling C.B.S., New York, 02.25 hours; and Brazzaville, F.E. Africa, on 26.06 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 as described in the October, 1912, issue of Practical Wireless. Results have been pretty good, using a 25t. inverted-I aerial. I have logged a good number of stations in two days, including WRUL, WRCA, WCBX, PR18, "Voice of Free India," Radio Metropole, Volta City. PR18 is situated at Rio de Janeiro and is announced as Radio Nacional and uses a directional beam directed on Great Britain. The wavelength is 25.60 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 Nacional 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).

I have received numerous reports confirming the efficiency of this set. A 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, 0.001 tank, 0.003 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 0.2 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 (0.001) and the 4-pin coil. Two detectors are used, a Mazda H.L. and a Mazda N light bulb for output. If I reverse these valves, the set will not work. FZ1 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 18.66 metres; Radio Andorra, 49 metres approximately; United Nations Radio, French N. Africa, 33 metres approximately, and lastly, XGOX, 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 0.65 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 0.0005 and 0.00025 mfd. (instead of 0.001 mfd.)

The valve is an American type 19 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 of 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 Foreign programmes are a little too loud for comfort with headphones.—P. D. THOMAS (Ayr).

Schwerenbugz on 31.45 Metres

SIR,—As it may be of general interest to readers I report that the Swiss English Service from Schwerenbugz (which transmits on the 48 and 25 metre bands) was changed from 35.28 metres to 31.45 metres, as from June 20th. The previous wavelength of 48.66 metres is unchanged.—A. McguGAN (Agheston).

MASTERING MORSE

By the Editor of PRACTICAL WIRELESS

3rd EDITION

This handbook, written with special regard for service requirements, will enable even the beginner rapidly to become proficient in sending and receiving.

Of all Booksellers, or by post 1/- from

GEORGE NEWNES, LTD. (Book Dept.),
net Tower House, Southampton Street,
net London, W.C.2
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. (Chelthenham).

If a potentiometer is at present employed for obtaining the S.G. voltage, then it is advisable to remove this and replace it by 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 10,000-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 10,000-ohm fixed resistance, and a J or mild condenser joined between earth and the lower end of the tuning coil.

Removing Hum

"I had a commercial superhet which was assembled on two chassies, and as I have obtained a new, smaller cabinet, I split the two sections and bent the mains plug into the bottom of the cabinet and the set in the top. There was a 7-way connecting cord between the two chassies, and I have replaced this with a longer cable, but others have made similar alterations. There is a very bad hum in 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 account 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 potentiometer is ineffective. Alternatively, it may be desirable to remove them from the mains plug and place them near the valves, then adjusting the centre tap to balance out the hum. We assume that you have 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 others, 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 we doubt the frequency-change 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 on 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 diodes, 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 so long, and am wondering if the lights may be 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 dial lights there should not be excessive current in the L.F. 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 drain. If such a switch is not available, it may be made through a 10,000-ohm fixed resistance, and a J or mild condenser joined between earth and the lower end of the tuning coil.

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. (Worthing).

If the valves are identical and no changes in wiring or circuit have taken place the usual 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 to ensure correct contact. If not, bare wire should be twisted round the metal surface and joined to the appropriate filament pin and we think this will cure your trouble.

A Correction: The Valve Voltmeter

If reference is made to Fig. 1—page 330, July issue—we will be seen that the junction of R5 and VR7 is connected to the moving arm of the latter. This should not be so; the correct connection made to the moving arm is that from one side of the L.F. choke in the H.T. smoothing circuit.
LONDON, im_le post to 4 nuax.) PADDERS. TORS, September, 1911.

- Switches, midget, 10 c. each.
- Also short wave coils on paplonformer, 15-50 metres, approx., 1/8 each.
- Aerial and Osc. transformer, with reaction, colour coded connections.
- 8 spoke per pair.
- TF TRANSFORMERS. 430-470 kva.
- Iron core permeability tuned, once tapped, first-class component, new, 12/6 per pair.
- MAINS VOLT DROPPING RESISTORS
  - 2 amp. 1,000 ohms, 2 variable sliders, 4.6; 3 amp. 500 ohms, 1 variable slider.
- 10-WATT WIRE-BOUND RESISTORS
  - 2,000 and 1,500 ohms, 2/6 each.
- PADDED TUBULAR CARBON, .00015 (max.) and .0008 (max.), each.
- Also short wave coils on paplonformer, 15-50 metres, approx., 1/8 each.
- Chassis, Steel painted, new, 10 x 8 x 3 x 3/4 in., 7/6; 8 x 8 x 2 1/2 in., 4/6 each.
- 8 x 8 x 2 1/2 in., steel painted new, drifted, 3/4 each.
- WESTGROTES. Type W6, 5/6 each.
- Switches. New, Taxlot type. Midnite, single bank, single pole, 4-way, 2 1/2 each. Single bank, 3 pole, 4-way, 3/6 each. Single bank, 3 bank, 2-pole, 1-way, 2 each.
- SPEAKER OUTPUT TRANSFORMER
  - Heavy duty Pentole, 10-channel.
  - A good selection of shop-soiled and odd components available to callers only.
- VOLUME CONTROLS
  - 1 and 7 meg., with wiper switch, 3/6 each.

VALVE HOLDERS
- 4, 5, 6-pin paplon, 6d. each.
- International Mole, molekate, 6d. each.
- Short wave ceramic clipin, 1/6 each.

VARIABLE COMPONENTS
- Single .0005 mf., 2-speed drive with points, knob, shaft, and holder, 2/6 each.
- Single .0005 mf., single knob, single holder for potable, Mason or sets, etc., 6/6. 0.003 mf. reaction condensers, 2/6 each.

Experience in short wave, Northern Ireland and Irish Free State. Please add postage for enquires and mail orders. C.O.D. orders accepted.

51-52 CHANCERY LANE, LONDON, W.C.2. Telephone HOLBORN 4561.
WIRE. Silk-covered, 2 oz., reels, 36, 38 or 50 gauge, 1/3 reel.

CRYSTAL DIODES. New type on 1/4 each.

CRISTAL and CUT Cathodes in metal box, 6d. each.

METERS. One and two dial, 2/6 each.

MLILES. 31/2 Portuguese, 6/6 each.

SOLDERING Liquid, 1d. per yard length, 1 doz. lengths.

Soldering Acid, 8d. per yard length, 7/8 doz. lengths.

T.C.C. Acid, 5/-, 6d. each, 6 1/2 doz. also, 20/-,- ml, at 6/-, 8/-.

TRANSMITTER. Complete, 5/-.

GRIL LEAKS. 1 1/2 mfd., 10/- each.

ECAL. 10/- each.

ROSETTE. 10/- each.

ACET. 10/- each.

AC/DC. 10/- each.

GRID LEAKS. 1 1/2 mfd., 10/- each.

LEVEL MADE. Easy. 10/- each.

METAL. Ready for all types of Sound Boxes and Pick-Up Heads, 3/6 each.

ACE "P.O." Microphones, complete with transmitter. Ready for use with any receiver.

METAL. Panels, unlined, rigid, 18/- each.

CHRISTLAR Magnets, very powerful, 11 mm. diameter by 1 in. thick, 10/- each.

ERIE. Resistors, 3/6 each.

MULTICN. Master Mica Condensers, 3each.

SPECIAL ASSORTED PARCEL FOR REPAIRS.

100 ERIE resistances (description above), 24 assorted Tubular Condensers, 8 Resonance Condensers, 8/6 each.

12 lengths Insulated-Sleeving, 10/6.

Push-back Connectors, 3/ each.


1.5 mm., 100 resistors for 300v., 8/.

MULTICN. Master Mica Condensers, 30 each.

Screws in one from 999, etc., 2/- each.

BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY (Dept. 1243).

REPLACEMENT. Pifco All in one meter. Price.

RELIANCE RADIO SERVICE.

S. Kennington Park Road. S.E. 11.

WANTED. Piccolo All in one meter. State price.

AFTER THE WAR!

The advance in Radio Technique after the war will offer unlimited opportunities of high pay and secure posts for those Radio Engineers who have had the foresight to become technically qualified. How you can do this quickly and easily in your spare time is fully explained in our unique handbook.

Full details are given of A.M.E.E., A.M.I.E.E. and other Exams, and particulars of up-to-date courses in Wireless Engineering, Radio Transmitters, Television Systems, Mathematics, etc.

We guarantee "No PASS—No FEE."

PREPARATION for all courses of study connected with wireless communication for sending for this unique free course requires NO—FEE and without obligation.

MAK and save your own WIND CHARGER. Complete kit for dashboard balance with pull-push, 10/-.

ERIE. Transformers, 20 ratings, 3/6 each.

MULTICN. Transformer, 3/6.

ACH. Transformer, 50 ratings, 3/6 each.

REPAIR of ERA or other Mica Condensers, 3/6 each.

S. Kennington Park Road. S.E. 11.

RELIANCE RADIO SERVICE.

S. Kennington Park Road. S.E. 11.

Tuition.

LEARN MORSE CODE. The Candler way.

Situations Vacant.