1/-

Vol. 27. No. 536
JUNE, 1951

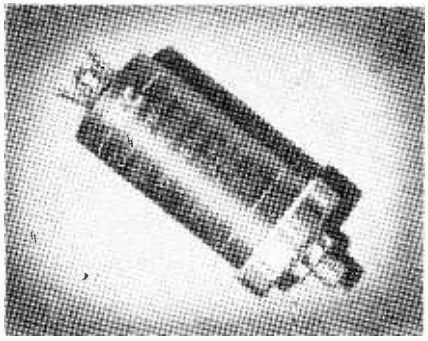
EDITOR:
F.J.CAMM

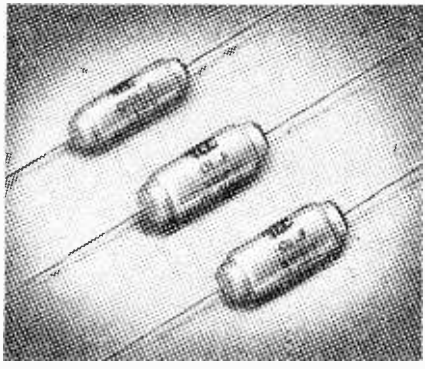
PRACTICAL WIRELESS

IN THIS ISSUE

CONDENSERS

The abbreviated ranges of two popular types given here are representative of the wide variety of T.C.C. Condensers available.





"VISCONOL CATHODRAY" CONDENSERS

Cap. Range: ·0005mfd. to 1 mfd.
Voltage Range: 750 to 25,000 at 60 C.

Cap. in µF.	Max. Wkg. at 60 C.	Dimens. (Overall) Length	Dia.	Type No.
·0005	25,000	5⅛ in.	1⅛ in.	CP.57.HOO
·001	6,000	2¼ in.	⅝ in.	CP.55.QO
·001	12,500	3 in.	1⅜ in.	CP.56.VO
·01	6,000	3 in.	1⅜ in.	CP.56.QO
·1	7,000	6¼ in.	2 in.	CP.58.QO
·25	5,000	5¼ in.	2⅜ in.	CP.59.MO

SUPER TROPICAL MINIATURE "METALMITES"
(in Aluminium Tubes)

Capacity µF.	Wkg. Volts D.C. at 71 C.	at 100 C.	Dimensions Length	Dia.	Type No.
·0002	500	350	⅝in.	·2 in.	CP110S
·0005	500	350	⅝in.	·2 in.	CP110S
·001	350	200	⅝in.	·2 in.	CP110N
·002	350	200	⅝in.	·22in.	CP111N
·005	200	120	⅝in.	·22in.	CP111H
·01	350	200	⅝in.	·34in.	CP113N

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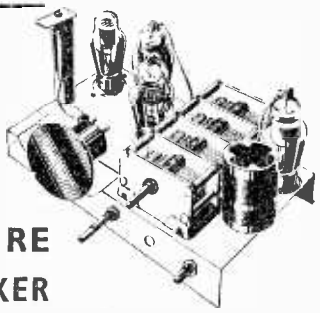

37/6 plus 2 6 carr. and ins.

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plus 1/6 post

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Practical Wireless

19th YEAR OF ISSUE

EVERY MONTH.
VOL. XXVII. No. 536. JUNE, 1951

Editor E.J. CAMM

COMMENTS OF THE MONTH

By THE EDITOR

Increased Purchase Tax

THE doubling of the Purchase Tax on radio and television receivers has evoked protests from dealers all over the country. Manufacturers themselves, already busy on electrical equipment for rearmament are not so vitally concerned, since what they are losing on the roundabouts they are gaining on the swings.

Some of the smaller manufacturers, however, will be badly hit. The new tax amounts to an increase of about 4s. 8d. in the pound, and this is bound to affect the sale of complete receivers. The new tax came as a great surprise in view of the statement made by Mr. Strauss, Minister of Supply, a few weeks before the Budget, that the Government were most anxious that civilian production should be continued on the largest possible scale for as long as possible. It turns out to be as short as possible!

In view of the developments taking and due to take place in connection with television, the tax is all the more surprising.

The Government is encouraging the development of TV on the transmission side and discouraging it on the viewing side! This is a complete paradox.

In these early days of the television industry the Government should not endeavour to strangle it, and that is what the new tax is likely to do. One effect, however, of the new tax has been to create a greatly increased demand for our booklet on the construction of our Television Receiver. More and more constructors are building their own receivers, and as this is now within the means and the ability of even inexperienced amateurs, this provides a solution. There is no Purchase Tax on certain television components.

When completed, our receiver is equivalent in performance and appearance to a commercial set costing very much more than the components required for its construction. Readers who were considering purchasing a television receiver should bear this point in mind.

Radio is not a luxury to-day, it is a necessity. It is the mechanical ear by means of which Government announcements and important news can be disseminated to the widest possible public in the shortest possible time. Government spokesmen do not hesitate to make use of broadcasts when they wish to catch the ear of the public.

Apparently it is lumped together with motor cars and jewellery, to be regarded as a tax producer. Coupled with the rising costs of raw material and labour, the new tax means that a receiver which before the war cost about £15 is now £50 or more. Here again, however, the constructor scores. He is unaffected by the new deodand.

The radio trade was having a bad time before the Budget, and it seems now that it is in for an even worse one.

Unlike the manufacturers who, as we have remarked above, will have the compensation of Government contracts, the dealer is left high and dry with receivers on his shelves which he is unable to sell. They might here usefully recall those properous days when they sold components and encouraged home constructors. They might now turn again to that excellent market which may help them to keep going. The sales of this journal prove that there is a large money-spending public anxious to buy modern components.

Fortunately, our readers are well served in this respect by our advertisers who are able to supply most of the components required for building modern receivers. They have also the benefit of the technical articles in this journal to guide them in the construction of all types of receiver. We are always glad to help them in their difficulties.

We appeal to radio manufacturers also to consider re-entering the component market, which they deserted so many years ago. The tax may hold up the development of television in Scotland where there has been a great outcry. The ever-growing demand for television receivers in districts not at present served has caused trade associations vigorously to protest against this new imposition, which is contrary to the spirit of the Beveridge Report, and various statements which have been made by Government spokesmen inside and outside Parliament.—F. J. C.

ROUND the WORLD of WIRELESS

Broadcast Receiving Licences

THE following statement shows the approximate numbers of licences issued during the year ended February 28th, 1951.

Region	*Number*
London Postal	2,353,000
Home Counties	1,646,000
Midland	1,745,000
North Eastern	1,900,000
North Western	1,618,000
South Western	1,063,000
Welsh and Border Counties	729,000
Total England and Wales	11,054,000
Scotland	1,116,000
Northern Ireland	207,000
Grand Total	12,377,000

South Africa Orders Marconi Navigational Aids

THE Civil Aviation Division of the South African Government has ordered three of the Twin Channel V.H.F. Direction Finding Equipments Type AD.200 designed and manufactured by Marconi's Wireless Telegraph Co. Ltd. This is the second such order to be placed by the South African authorities and one of these installations has already been delivered under the earlier order.

The AD.200 is one of the latest advances in modern aeronautical navigational aid equipments to come from the Marconi Research Laboratories. It is designed to facilitate the planned control of aircraft in the proximity of an airfield and allows a continuous bearing check to be maintained. The high speeds attained by modern aircraft—particularly jet-powered machines—necessitate fast, accurate bearings which cannot readily be taken by the normal aural-null method of direction finding. This problem is solved by using visual presentation meters with the AD.200 and the instantaneous presentation of sensed bearings can be repeated at remote points in airport buildings by using additional meters.

Persian Gulf Communications Developments

AN important extension of the telegraph and telephone systems operated by Cable and Wireless Ltd. in the Persian Gulf area will shortly be made.

Concessions have been granted to the company for the operation of an internal telephone system and the external communications of Doha, Qatar peninsular, and Dubai on the Trucial Coast. These towns are the centres from which oil interests are being rapidly developed.

From Doha, where a temporary telegraph office is being established, a wireless circuit will operate via the company's station at Bahrain to all parts of the world. Similar arrangements will be made at Dubai. Automatic telephone systems capable of development as the demand grows will be installed.

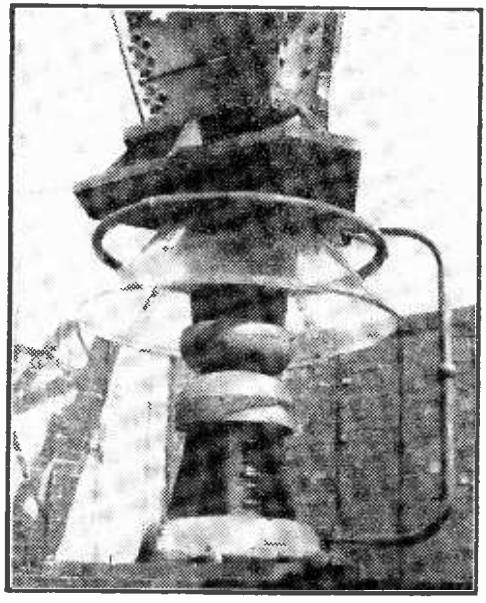
Chinese P.o.W.

IN connection with a report understood to have been broadcast by Peking Radio that the Chinese Communist authorities have agreed to forward letters from United Nations' troops captured in Korea, and that letters to prisoners-of-war can now be forwarded, the Postmaster-General announces that further details in regard to the facilities available for communicating with United Nations' prisoners-of-war are being sought by telegraph. Details of any means of addressing and forwarding correspondence to prisoners-of-war will be published as quickly as possible.

Jet Engines Tested by Radio

SOME interesting tests on jet turbine engines in flight have recently been undertaken by Rolls-Royce, Ltd., at their Development Aerodrome at Hucknall, Nottinghamshire.

This has involved the strain-testing of turbine blades. As far as is known, this is the first time that such a test has been made whilst the engine is actually propelling an aircraft in flight.



Base of the new mast at Daventry used for the Third Programme transmitter. The mast "pivots" on a ball in between the large insulators.

Electrical resistance elements are built into the turbine blades and electrical connections made to a radio transmitter in the aircraft by means of special mercury slip-ring contacts. When the jet engine is running, any strains which are set up will appear as an electric signal which is transmitted to the ground, where it is recorded on magnetic tape so that it may be examined and analysed under laboratory conditions. Due to the impracticability of using a high-speed camera for a flight period of about three-quarters of an hour, it was found that magnetic-tape recording was the only suitable method for obtaining an accurate record of these signals which may include frequencies up to 20 Kc/s. A standard E.M.I. studio-type tape recorder has been used by Rolls-Royce, Ltd., for the purpose. The recorded signals are examined so that it can be determined at what speeds any dangerous strains occur, and for this purpose a special frequency analyser is used to examine the recording. Both the recording and its analysis and a visual indication on a cathode-ray tube will be demonstrated on the Muirhead stand at the Physical Society's Exhibition which opens on Friday, April 6th.

Deep-sea Amplifiers

KEY WEST (Florida) and Havana (Cuba) were recently linked by two deep-sea cables containing built-in amplifiers spaced at approximately 40 miles apart. The cables are the coaxial type (developed at the Bell Telephone Laboratories) and provide 24 high-quality speech channels. The valves included in the amplifiers will operate for as long as 20 years without attention and will withstand the pressure of a mile of sea above them.

Ekco at the Festival

E. K. COLE, LTD., have been invited to supply for the 1951 Festival of Britain three Ekco-vision receivers (two of which will be working), table and portable radio receivers, and a radiogram. The Ekco Search Radar for aircraft is also being shown and the Portable Radioactive Ore Detector.

B.S. Golden Jubilee

FROM June 18th to 28th the British Standards movement will be celebrating its golden jubilee. Part of the celebration will take the form of an exhibition, supported by practically the entire industry, at the Science Museum. Admission will be free, and the exhibition will be open from 10 till 7 every day except Sunday.

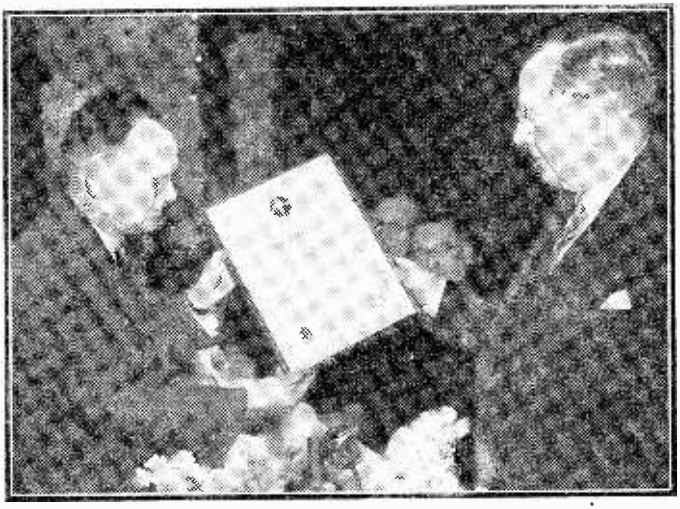
New T.C.C. Chairman

THE new chairman of The Radio & Electronic Component Manufacturers' Federation is Mr. W. F. Taylor, O.B.E., director of The Telegraph Condenser Company Ltd.

Mr. Taylor joined T.C.C. from the motor industry in 1925 and has spent most of his career with his company in looking after its sales interests, which cover a wide industrial field in addition to the more obvious outlets in the radio and electrical industries.

Whiteley Electrical Silver Jubilee

WHITELEY ELECTRICAL have just celebrated their silver jubilee, and in honour of the occasion a dinner was held in the works canteen at Mansfield, attended by a party of over 60 persons, comprising the directors, male staff and friends.



Mr. James presenting an Illuminated Address to Mr. A. H. Whiteley at the recent Silver Jubilee celebration.

Mr. A. H. Whiteley, M.B.E. (managing director and founder), was presented with an illuminated address signed by the staff, together with a silver microphone. In addition, a miniature Stentorian cabinet loudspeaker, embossed with the recipient's name on the rear, was given to everyone present.

Marconi Transmitters for South Africa

THE South African Broadcasting Corporation have for some time been engaged on enlarging and improving their service, and, in continuance of this policy, they have now placed an order with Marconi's for two further 5 kW. medium-frequency broadcasting transmitters, Marconi Type TBM.672. This order was won by the Marconi Company in face of keen international competition. The transmitters will be installed at the S.A.B.C.'s broadcasting stations at Maraisburg and Welgedacht.

This order brings the total of Marconi 5 kW. transmitters, ordered in recent months by the Union authorities, to eight. Five were recently delivered under an earlier order, two being installed at Grahamstown and three at Pietermaritzburg.

A sixth transmitter is now under construction at the company's Chelmsford Works. When completed, this is destined for Grahamstown.

P.A. for the Amateur—2

Description of a Complete Universal Unit for all Public Address Requirements

By S. A. DENNEY

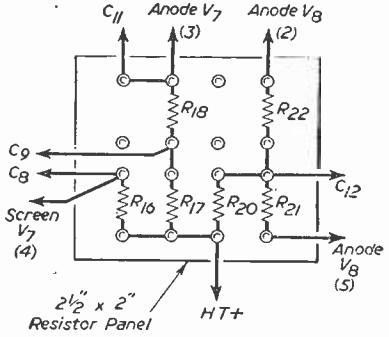
Adapting for Mobile or Outdoor Use

TO be really complete the outfit should contain a unit capable of functioning outdoors or from a car.

For the sake of simplicity it was decided to adapt the original circuit to suit this new rôle, the necessary modifications being small.

It will be seen from the photographs in the last issue that a slightly different layout has been used for the amplifier, due solely to the physical conditions imposed by the dimensions of the chassis and covers.

Primary consideration in an outfit of this nature is probably given to the power unit, and, in an endeavour to keep expenditure as low as possible,



Corrected Fig. 3 (a).—Note rearrangement of connecting points.

a further search was made in the surplus market for a suitable rotary transformer that would operate from a 6-volt car accumulator and supply high tension to the amplifier, not forgetting the desirability of low accumulator consumption. The stripped ex A.M. I.F.F. unit mentioned earlier was further examined, and it was decided that the rotary transformer Type 47, reference 10KB/1147, contained therein would probably be satisfactory. It was originally used with a 12-volt supply through a dropping resistor, its rating being marked as 9 volts 6.26 amps. input.

The table (page 248) tabulates the results of a bench test to which the rotary transformer was submitted. After running for some two hours at the maximum loading there was no sign of distress, and it was therefore adopted for the power unit. Attached to one end was a rather elaborate box of

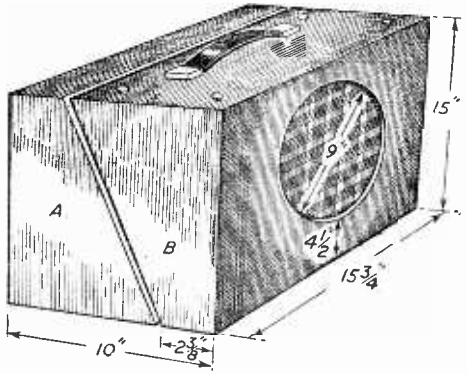


Fig. 7.—General view of the finished case.

gears performing various switching operations, this was removed, making the overall length much more reasonable.

Unfortunately, the smoothing capacitors and chokes had been removed, and therefore it was necessary in this specific instance to incorporate two capacitors as shown in Fig. 11. Normally, smoothing arrangements will already be incorporated.

The wiring arrangement of Fig. 11 shows a voltmeter permanently connected across the input and this provides an indication of the state of the accumulator.

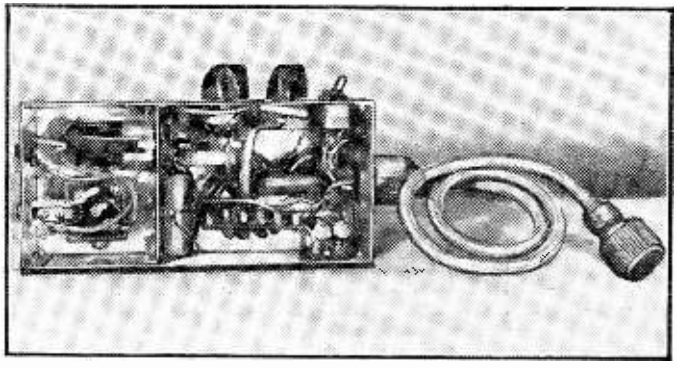


Fig. 8.—This underside view shows how V7 and T2 are neatly housed in the left-hand compartments.

Both the amplifier and the power unit are built on identical chassis, 12¾in. x 8in. x 2¼in. This allows us to utilise the two louvred covers from the I.F.F. unit which fit snugly over the top. Carrying handles were bolted on the top of them to facilitate transportation, and the two chassis are connected by a multi-way lead that can be seen in the photograph.

The Circuit

In its existing form, the current consumption is more than can be supplied from the rotary transformer and, therefore, some modification will be necessary. Reference to the table on page 248 shows that 215 volts H.T. is available with a current consump-

tion of 70 mA. A pair of EL32s (V.T.52 surplus type) with 200 volts on the anode drawing some 50 to 60 mA., will provide 5 watts of audio, and this is quite ample for most purposes. It was decided to use this valve in the positions V3 and V4. To avoid the voltage drop caused by the

(3) Alter T1 O.P. transformer ratio to 60 : 1.

(4) Connect two screened leads to pins 5 on V3 and V4 holders. Drill holes in chassis adjacent to them, feed through leads, and fit octal type valve caps to them.

(5) Replace V3 and V4 with EL32s.

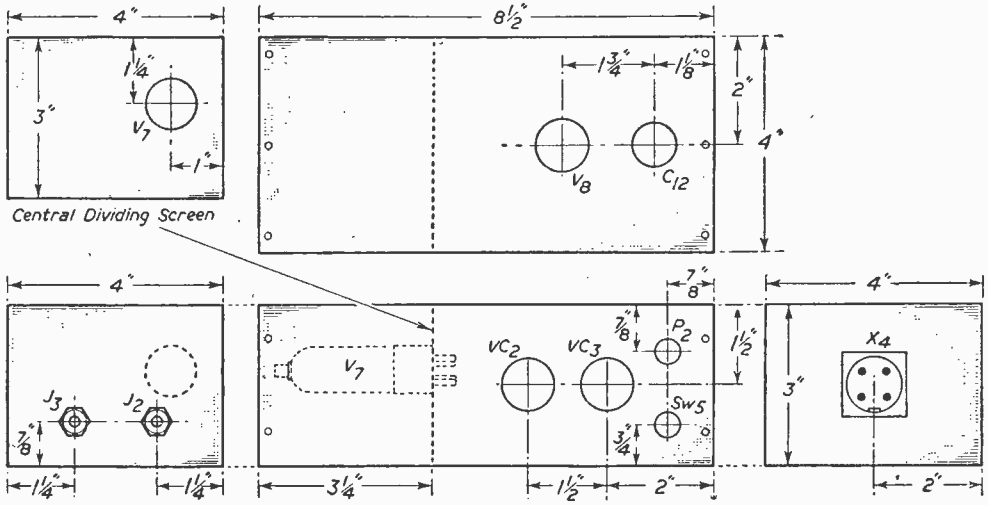


Fig. 6.—Chassis cutting and drilling data.

speaker energising, it is advisable to use a P.M type speaker for this type of job, and the author keeps an 8in. speaker in a cabinet. If necessary a metal horn can be bolted to the cabinet, giving a directional effect. An L.F. smoothing choke was found to be unnecessary, likewise the smoothing capacitors C5 and C6 (Fig. 1), any slight commutator ripple can be "ironed" out at the source.

To modify the circuit of Fig. 1, then, proceed as follows:

(1) Wire all valve filaments, pilot lamp, in parallel, and connect pins 1 and 2 on X2 to the same 6v. source.

(2) Replace R9 wih 300Ω 2 watt.

(6) Feed in H.T.+ and 6-volt filament supply from power unit via connector, ignoring V5, V6, R1, and the associated components, as these, of course, will not be required.

It will be remembered that when building the pre-amplifier/mixer unit, provision was made for switching the valve filaments to series or parallel, therefore no alteration is necessary to this unit, which can be used with either amplifiers.

To conclude, mention might be made of the fact that full use of the power available can be made by the addition of one or more speakers, but don't

LIST OF COMPONENTS.

CARRYING CASE.

Wood, ¼in. ply. Front baffle, ¼in. ply.
Rexine or leatherette, approx. 1½ yds.
Speaker grille fabric, 12in. x 12in.
Speaker (see text).
Carrying handle.
Rubber feet, 8.
Hinges (break open type), 2.
Catches, 2.
Corner protectors, 8.
Screws, glue, connector, etc.

Associated Equipment for the Complete Outfit:

Good quality moving-coil microphone.
Collapsible floor stand for same.
Gramophone turntable.
Crystal type pick-up.

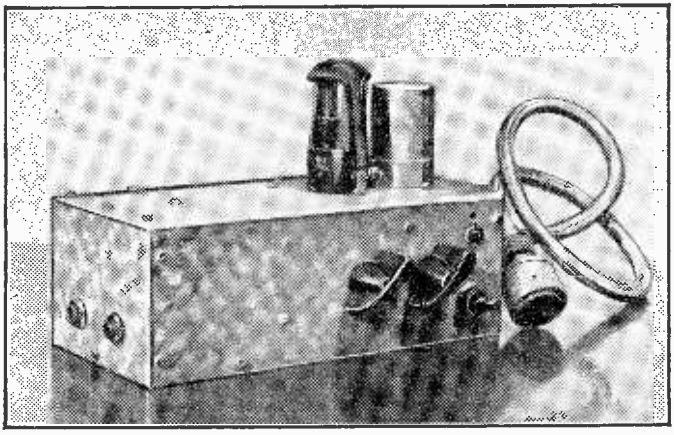


Fig. 9.—General view of the microphone pre-amplifier/mixer unit. Note the "Breeze" multi-cable for connecting the unit to either of the amplifiers described.

forget to alter the output transformer ratio accordingly.

Tone-control Unit

A worth-while addition to the complete equipment so far described is a tone-control unit. The circuit of a suitable arrangement is shown in Fig. 12 (below), and the additional components required are given in the small panel. It will be seen that these consist merely of a tubular condenser, a potentiometer, a knob and a suitable indicating scale.

Input		Output	
Voltage	Current	Voltage	Current
6	2.2A	320	No load
6	4.4	260	40 mA.
6	5.0	245	50
6	5.6	230	60
6	6.2	215	70
6	6.8	200	80

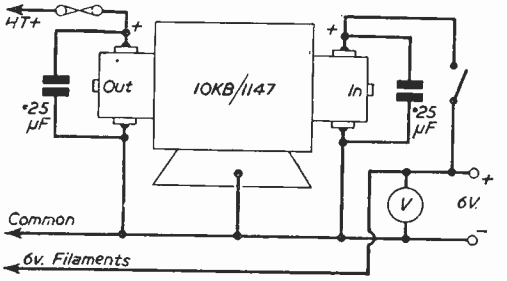


Fig. 11.—Arrangement of a suitable rotary transformer for a power supply.

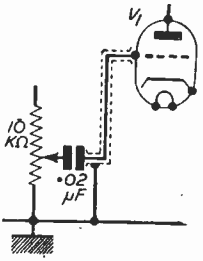


Fig. 12.—Circuit of a suitable tone-control.

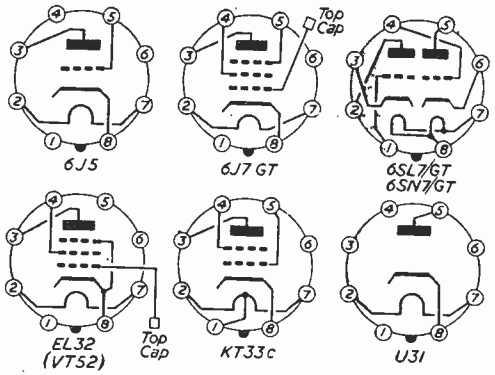


Fig. 10.—Details of valve base connections for all valves used in the equipment.

The potentiometer is mounted on the front panel just to the left of the volume control VC1 (see Fig. 4 on page 218 last month). The apron of the chassis carrying these controls is also shown in the illustration of page 217 of last month's issue. The fixed condenser is suspended in the wiring and does not need to be mounted on a component mounting strip.

TONE-CONTROL
One .02 μF tubular condenser.
One 10 kΩ potentiometer.
Control knob and scale.

V.H.F. for Drainage Works

THE commercial use of V.H.F. is well demonstrated by the communication network which has recently been installed by the General Electric Co. Ltd., for the Main Drainage Department of the Middlesex County Council.

This department operates in West Middlesex, one of the largest main drainage systems in the world, serving an area of 160 square miles and a population of 1,400,000. The district contains the complete areas of 15 local authorities, which are connected up by 70 miles of main trunk sewers to one central treatment works at Mogden, Isleworth. The average flow of sewage dealt with is 70 million gallons per day.

Maintenance of this large system of sewers is carried out by only three small gangs of workers, supervised by a travelling foreman. Because of the large area served, any of the maintenance groups may be as far as 20 miles from the headquarters at Isleworth, and in the past communication depended upon personal calls by car or use of the public telephone service.

A decision was therefore made to install a radio system so that all three parties, the foreman and headquarters could be in instantaneous communication at all times.

The headquarters (fixed-station) is at Mogden Works and transmits on a frequency of 85.375 Mc/s, with an aerial power of 15/20 watts. Power for operating the headquarters station is drawn from the works' own generating plant, the prime movers being driven by methane obtained from the digestion of sewage sludge.

Mobile equipments are installed in each of the maintenance vans and in the foreman's van. Transmission is on a frequency of 71.875 Mc/s, also with an aerial power of 15/20 watts. All the mobile equipments are battery-operated, with provision for recharging the batteries at the works.

It will be seen that the fixed and mobile stations transmit on different frequencies, the transmitting frequency of one being the receiving frequency of the other. The system of operation employed is known as "Two Frequency Simplex."

This is actually advantageous from an operational point of view in that the mobile stations must pass all their messages through headquarters, i.e., they cannot communicate directly with each other. At the same time, headquarters can call all stations at once, or individually by call sign, and each mobile station is aware of instructions given to the others.

R1155A, R1116 and R1116A

A Versatile Unit for Use with These Receivers

By A. W. MANN

THE R1155A and R1116 ex-R.A.F. receivers are widely used, and in my opinion deservingly popular. I do not propose to discuss the merits and demerits of either, and think it sufficient to say that I use both, and am well satisfied with them.

Because a receiver may be considered to be good, it does not follow that it cannot be improved. The performance of the receivers under discussion can be improved, and the purpose of this article is to explain how.

Both receivers were designed and used as headphone receivers. Short-wave listeners, however, prefer to use them for headphone and loudspeaker reception. The R1116 can be used as it stands, but in order to obtain the most satisfactory results a 6V6 or similar output stage must be added to the R1155A.

It is agreed that the loudspeaker volume obtained with the R1116 is not terrific but is reasonably good. It satisfies the writer who prefers clarity to terrific volume. Using it as a headphone receiver, which I often do, one can obtain more than sufficient volume, and backing down the gain control is usually necessary.

Before going further, I wish it to be understood that we are concerned with the R1155A and R1116 as they stand—that is, the latter as a headphones receiver or with headphone jack fitted, and the R1116 as a dual-purpose receiver. The reason will be given later.

Types of Headphones

Listening on either of these receivers when using the stalloy diaphragm type headphones is very uncomfortable, and somewhat dangerous should a very powerful transmission be inadvertently tuned in. Under conditions where the prevailing noise ratio is high, one cannot listen to best advantage without making volume control adjustments to reduce the overall sensitivity.

The most satisfactory solution is to replace the type of headphones mentioned by a pair of the low-resistance moving-coil type. Once having done so, you will, no doubt, use them exclusively. Moving-coil headphones must, of course, be correctly matched to the receiver output. A good match is not sufficient; they must be correctly matched, in the interests of sensitivity and output volume and quality of reproduction.

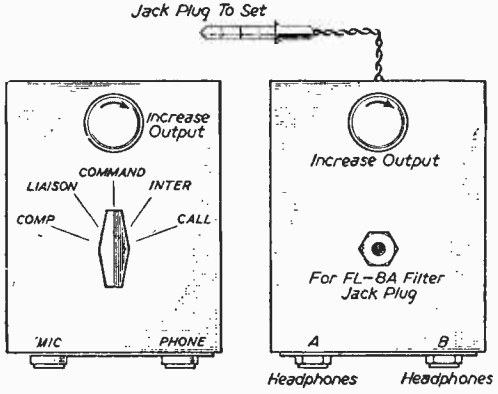


Fig. 1. (left).—The original unit—Signal Corps, U.S. Army, Jack Box BC366.

Fig. 2 (right).—The converted unit.

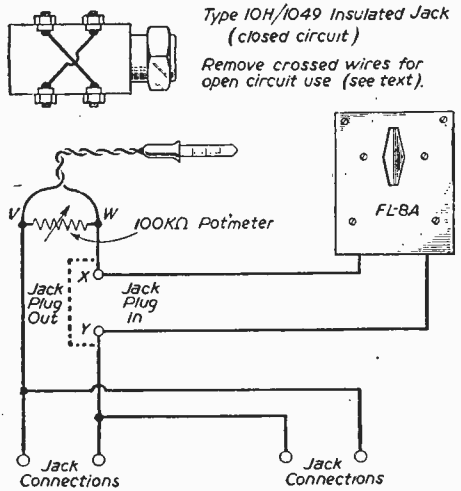


Fig. 3 (top).—Jack connections. Fig. 4 (bottom).—External wiring.

As mentioned in a previous article, the best within my personal experience with the associated MC385c plug-in matching transformer are the American Army Air Force type HS33. When correctly matched to the receiver this transformer is of the high-to-low impedance type.

In addition, some means is required whereby the audio output from the receiver can be regulated and controlled, in order to improve the signal-to-noise ratio on all signals. This can be accomplished in a simple yet most effective manner, with the result that the signal-to-noise ratio of the R1155A, R1116, R1116A type receivers when used for headphone reception compares most favourably with battery-operated TRF standards.

A Versatile Unit

At Fig. 1 is shown a sketch of the U.S. Signal Corps Jack Box type BC366 which may be obtained from most Government surplus radio stores.

It consists of a cast aluminium box divided into

two parts. In it are mounted the microphone jack, headphone jack, multi-wafer switch, plug and socket assembly, variable resistance, and associated wiring.

With this to hand, proceed as follows. Remove the small bolts and open out the box. Remove the microphone jack, wafer switch, plug and socket assembly, and all wiring.

All that should remain are the headphone jack and variable resistance. The microphone jack which has been removed has a socket of which the bore is less than the outside diameter of the standard headphone jack plug.

In order that we may use two pairs of the specified moving-coil headphones, an additional open circuit jack is required, and a closed circuit jack for use in the audio filter position.

The New Assembly

At Fig. 2 is shown the new assembly, the two headphone jacks and the audio filter jack, all of which are insulated from the metal box. The headphone jacks are of the open circuit type, and the filter jack is of the closed circuit type. Also included is the variable resistance. If you are unfamiliar with jack switching, a continuity test between contacts, via associated soldering tags, with and without the jack plug inserted, will usually remove any doubts.

While standard types of jack may be used in all instances, providing that they are insulated from the metal box, I have used an ex-service type 10-1049 in the filter and one headphone position respectively.

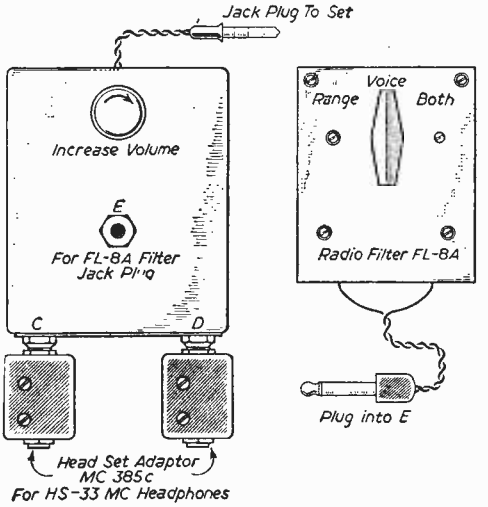


Fig. 5 (left).—Plug arrangement, and Fig. 6 (right).—Jack plug fitted to the filter leads.

If these are used in your version of this apparatus, note Fig. 3. With crossed leads is the closed circuit filter jack. Without crossed leads, the open circuit headphone jack. Check by continuity which two soldering tags of the four fitted you require. The body of this service type is of insulating material, so no insulating bushes and washers are in this case required.

The Theoretical Circuit

Let us now discuss the theoretical circuit, Fig. 4, the jack connections of which are shown in simple form. In doing so we will follow the exact point to point wiring procedure. First, wire the two headphone jacks in parallel. Starting now with the left hand jack, take a lead from the left hand soldering tag to one side of the variable resistance. From the right hand tag a lead to one side is the filter jack, another from the remaining tag to the other side of the variable resistance. Finally, a twin flex lead is soldered to the two variable resistance contacts, and is fitted with a receiver output jack plug. Reverse leads V and W if variable resistance volume control works in reverse.

Practical Application

Having completed the unit and checked over the wiring, it is ready for testing. We will at first assume that the operator has only one pair of HS33 moving-coil headphones, and has not an FL8A audio filter unit. Plug-in the matching transformer, using either socket C or D. Follow by plugging the headphones into the matching transformer. Plug the unit coupling jack plug into the receiver output. Switch on and tune in a fairly loud 'phone transmission, with the set volume control fully open.

We now have a signal tuned in which is too loud for comfortable headphone listening. Control the gain with the volume control in the unit, and if the noise level is too high, try a slight adjustment of the set volume control.

It is good practice to keep the set volume control fully open while searching and thus be certain that the maximum sensitivity is being obtained.

It will be found that when two pairs of HS33 moving-coil headphones are used, the unit will function efficiently, and that the audio volume control is equally effective. Whilst the unit can be used with one pair of headphones, and a moving-coil loudspeaker, it is preferable to plug the speaker directly into the R1116 output socket, in the usual way. During the foregoing test the audio filter was not used.

Using the Audio Filter

The audio filter is a real asset when used on phone and C.W., and can be used to clear up interference on the S.W., B.C. bands in order to identify by station announcement. The filter is wired in series with the headphones. The insertion of the jack plug into the filter jack E, Fig. 5, brings about this condition.

Fig. 6 shows the jack plug fitted to the two filter leads. One point I would like to emphasise is that constructors should examine plugs and jacks and make quite sure that when the plug is inserted the desired mechanical and electrical contact is being made.

Warning

This unit has been developed for use in conjunction with R1155A, R1116 and R1116A receivers only. I mention this because these receivers are all fitted with a built-in output transformer. If this were not the case it would be necessary to insulate the variable resistance from the metal box.

On your Wavelength

by THERMION

Sponsored Programmes

I OBSERVED that once again the question of sponsored programmes has been raised by interested parties, and by interested parties I mean those large manufacturers who feel that such programmes provide them with opportunities for combining advertising with entertainment and so keeping their names before the public. They point out that because of paper shortage periodicals and newspapers are unable to accommodate their announcements and that this is adversely affecting sales. They argue that as a temporary measure until the paper position is improved it would help them to maintain and increase sales.

Whereas the printed announcement circulates only at home an announcement over the air reaches all over the world.

This, however, is a specious argument. A radio programme of the Luxembourg type is a costly business. First-class artists are not permitted by their Associations to partake in such broadcasts and so from the entertainment point of view alone the entertainment is quite often second class.

Moreover, the pleasure of listening to a programme is always damped when it is interlarded with announcements inviting you to buy somebody's polish or pills. It is false logic to compare this country with America, where sponsored programmes are the order of the day. The two publics have different tastes. It is only in quick-fire gag stuff that the American programme becomes palatable to the British public. Indeed, most of our cross-talk acts are largely based on the American model.

And we must not forget that the arguments in favour of sponsored programmes which were perfectly valid before the war, when Lord Reith's Sunday programmes gave rise to so much criticism because of their gloominess, no longer apply. Our Sunday programmes have improved enormously. They are much more cheerful and more varied. There was every reason why in those days people tuned in on Sunday to Normandie and Luxembourg. Their programmes were more cheerful than ours even though they were blatantly advertising programmes.

In this country in the early days of 2LO the B.B.C. tried the experiment of sponsored programmes. They were, however, on too dignified a scale. All the sponsor of the programme got in return for the heavy fee he paid for half an hour's programme time was a brief announcement that the programme was sponsored by Messrs. So and So. Advertising in those days was regarded by the B.B.C. almost as an unclean thing. It does not hesitate, however, to plug its own publication over the air, whilst denying others the same privilege.

So what is needed is a plain statement from the B.B.C. on the subject of sponsored programmes. It is suggested by some that we should build a commercial broadcasting station entirely devoted to sponsored programmes. This scheme would thus not interfere with the normal programmes and would leave the listener the choice of a pill or polish programme in place of a normal programme which does not appeal to him. There is little possibility at the present time of such a venture even being considered. The B.B.C. has its hands full with the development of the TV service and with implementing the recommendations of the Beveridge Report. It is also in that report asked to exercise certain economies, the first move in this connection being the dismissal of a large number of people from the Overseas Service.

Protagonists of sponsored programmes should not apply a 1939 mind to a 1951 public. Public taste in programmes has undoubtedly changed. The B.B.C. output has changed, too, as its Directors General have changed. I personally doubt whether the British public really does want sponsored programmes.

I readily admit that before the war, when I was one of the fiercest critics of B.B.C. policy and the iconoclastic attitude of its officials, I thought that sponsored programmes were necessary. If the same conditions applied I should still think so. In my view the day of the sponsored programme is over. In any case the Government in these frugal days is hardly likely to sanction the spending of English money abroad on advertising ventures of this sort.

The times, we must remember, are not normal if we regard the year 1939 as the level of normality. It is doubtful indeed whether they will return in the course of our lifetime. It is a matter of simple arithmetic to see that the enormous financial burden the country is incurring must remain an incubus on the British taxpayer for many years to come. We have, therefore, to make the best of conditions as they are, in a world which is undergoing a grave and rapid metamorphosis.

The P.T. Receiver

DURING the course of the year I give a number of lectures, and the other evening in the Croydon area I delivered one to a discussion group on a subject which is quite remote from radio and television. In the general chat with members of the audience which preceded and followed the lecture and discussion I was astonished to learn that no fewer than six had built the *Practical Television* receiver with highly satisfactory results.

I found myself giving a further lecture on television!

Wide-range Loudspeakers

Facts About Single and Dual Speakers Designed for High-quality Reproduction

By R. E. B. HICKMAN

SUBJECTIVE tests of frequency range preference of reproduced sound which have been made from time to time in recent years have shown that the average listener appears to prefer a restricted frequency range in non-aural reproduced speech and music. Similar tests carried out with "live" sound tend to reverse this preference. Various explanations have been offered of the results of these tests. One such explanation is the suggestion that the modern listener, after years of listening to music reproduced by a radio receiver or electric gramophone, has become conditioned to a restricted frequency range and accepts this as the natural state of affairs. It may also be that the distortions and deviations from exact reproduction of the original sound are less objectionable when reproduced with a restricted frequency range.

Distortion and deviation from true reproduction of the original sound may be due to a combination of any of the following:

1. Amplitude distortion.
2. Non-linear distortion.
3. Spatial distortion:
   (a) single point source.
   or (b) separated sources in two-way loudspeaker systems.
   (c) non-uniformity with respect to frequency.
4. Phase distortion.
5. Transient distortion.
6. Limited dynamic range.
7. Difference in level of the original and reproduced sound.
8. Noise.
9. Conditions at the transmitting or recording studio:
   (a) Microphone placement.
   (b) Microphone balance.
   (c) Studio acoustics.
10. Acoustics of the listening room.

For many applications, notably monitoring of radio and television broadcasts, disc and sound film recording and other high-quality sound systems, it is essential to use wide frequency range, low distortion loudspeakers capable of handling large amounts of acoustic power. This article will deal with the factors leading up to the development of such a loudspeaker which is now commercially available.

Direct Radiator Loudspeakers

From the earliest days of broadcasting the weakest link in attempting to provide high-fidelity reproduction of the original sound has been the acoustic channel. The problem of efficiently converting electrical energy to acoustic energy has proved a difficult one. The converse problem has not proved so difficult and velocity microphones capable of reproducing efficiently and with high fidelity the audio-frequency range from 15 to 15,000 cycles per second have been commercially available for some time.

The volume range of the human ear is tremendous. It can accommodate an amplitude range in the middle audio frequencies of one million to one in pressure. It is impossible to build reproducing equipment with linear response to accommodate such a range and hence the full volume range of an orchestra can never be satisfactorily reproduced.

One of the earliest types of reproducer, and one which is still in almost universal use in sound systems, is the direct radiator loudspeaker. It has the advantages of simplicity of construction, small space requirements and a relatively uniform frequency response characteristic over a restricted frequency range. It is difficult with a direct radiator loudspeaker to reproduce the extreme ends of the audio spectrum with efficiency comparable to that obtainable in the mid-frequency

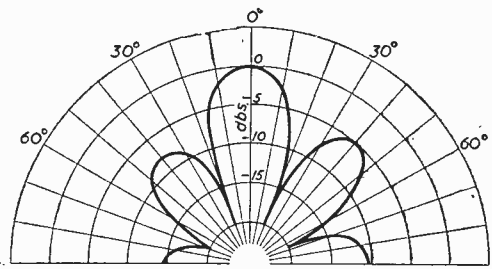


Fig. 1.—Directional characteristics of co-planar combination of L.F. and H.F. direct radiator units.

band. Since, however, the portion of the speech range required for intelligibility and the fundamental frequencies of most horn, reed and string instruments falls within this mid-frequency band, this limitation is not serious in non high-fidelity sound systems.

The directional characteristic of the conventional direct radiator loudspeakers used in most present day radio receivers is quite adequate for the restricted frequency range of these receivers. If, however, the reproduced frequency range is extended upwards by one or two octaves, the directional pattern of such a loudspeaker becomes objectionably narrow. Increasing the upper frequency response increases the non-linear distortion, as does any increase in the volume range. Good transient response becomes important as the frequency range is increased, although it has been found that a poor transient response in a loudspeaker of limited response may actually enhance the reproduction.

Two-unit Loudspeakers

From the above discussion it will be apparent that any attempt to increase the power handling capacity and the frequency response of a loudspeaker greatly increases the complexity of its design and manufacture. The next logical step from the single-unit direct radiator loudspeaker is the two-unit loudspeaker, various types of which have become very popular as wide-range reproducers with good directional properties.

The simplest two-unit loudspeaker employs a cone unit of about 2in. to 6in. diameter for reproduction of the higher frequencies, with a larger unit of 12in. to 18in. diameter to handle the lower frequencies, both units being mounted side by side on a large flat baffle. An inductor-capacitor cross-over unit giving a change-over frequency of 1,500 to 2,000 c.p.s. is used to separate the signals fed to each unit. The directional pattern

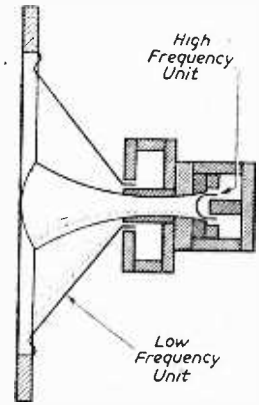


Fig. 2.—Co-axial combination of direct-radiator low-frequency unit with horn high-frequency unit.

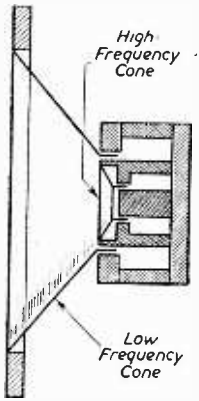


Fig. 3.—Sectional view duo-cone loudspeaker.

at the cross-over frequency of such a combination is shown at Fig. 1. It will be seen that due to destructive interference, frequency discrimination occurs at points removed from the axis of the reproducer.

Another method of mounting the two units is to have the high-frequency unit placed co-axially inside the cone of the low-frequency unit. This effectively reduces the spacing between the two units, decreases the interference and considerably improves the directional pattern in the cross-over frequency region. However, diffraction and reflection of sound around the high-frequency unit interferes with the direct radiation and a non-linear response characteristic results.

Horn Loudspeakers

Replacing the high-frequency cone in both the above arrangements by a small cellular horn loudspeaker results in directional patterns and diffraction characteristics similar to those previously noted. Some additional undesirable factors are, however, introduced. The source of the high-frequency sounds is several inches behind the source of the low-frequency sounds. Phase differences due to this variation in path length lead to a deterioration in the transient response of the combination in the cross-over frequency region. The efficiency of a horn loudspeaker is from 10 to 20 decibels greater than that of a direct radiator loudspeaker, so that an attenuation network is required in series with the horn unit to obtain comparable efficiencies and uniform response from the two-unit combination. The best results using a high-frequency horn are obtained by making the pole of the low-frequency unit a portion of the high-frequency horn as shown in Fig. 2. This combination gives a fairly good frequency response characteristic, and an improved directional characteristic. The difference in path length of sound from the two units is still, however, an undesirable feature.

Duo-cone Loudspeakers

To overcome most of the defects outlined above the so-called "duo-cone" loudspeaker has been evolved. (H. F. Olson and J. Preston, "R.C.A. Review," Vol. VII, No. 2.) In this assembly two cone loudspeakers are combined so that the large low-frequency cone is a continuation of the small high-frequency cone, Fig. 3. Such a combination

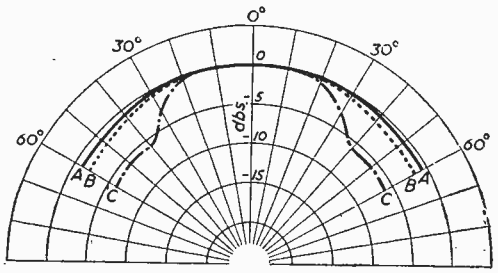


Fig. 4.—Directional characteristics of duo-cone loudspeaker.

virtually eliminates the path difference factor and the need for accurately phasing the two units since in the crossover frequency range the two cones vibrate together as a single cone.

Low-frequency Unit

The low-frequency unit employs a shallow angle 15in. rigid diaphragm with a massive voice coil. The efficiency of a loudspeaker is the ratio of acoustic power output to electrical input and is a maximum at the resonant frequency, decreasing very rapidly at frequencies below resonance. In a direct radiator loudspeaker, therefore, the lower limit of the frequency response is determined by the resonant frequency of the system. The fundamental resonant frequency of the cone of the low-frequency unit is approximately 35 cycles per second.

Lack of homogeniety in the suspension system of a loudspeaker cone gives rise to non-linear distortion since the stiffness of the support is not constant but is a function of the amplitude of deflection. Decreasing the fundamental resonant frequency tends to eliminate distortion due to the non-linearity of the suspension. Above the resonant frequency the velocity of the cone is not appreciably affected by the suspension system since the

mechanical reactance of the suspension is small compared with the mechanical impedance of the remainder of the system. Due, therefore, to its low resonant frequency, the low-frequency cone of the duo-cone assembly has minimum distortion.

A further source of non-linear distortion is the cone itself. Non-linearity of the cone produces both harmonic and sub-harmonic distortion in the frequency range from 100 c.p.s to 1,000 c.p.s. Since this part of the audio spectrum corresponds to that of maximum power in both speech and music, it is essential that any distortion in this range be reduced to a minimum. This may be achieved effectively by using a very rigid cone. In the duo-cone loudspeaker the thickness of the cone is about two and one-half times that of its equivalent in a conventional loudspeaker, and its rigidity is increased by a factor of about 15 times. Since the efficiency of a cone loudspeaker is a maximum when the mass of the cone is equal to the mass of the voice coil, it follows that with such a cone structure as has been described a heavy voice coil will be required. The voice coil of the low-frequency portion of the duo-cone combination is about 25 times the mass of the corresponding coil of a normal radio type loudspeaker.

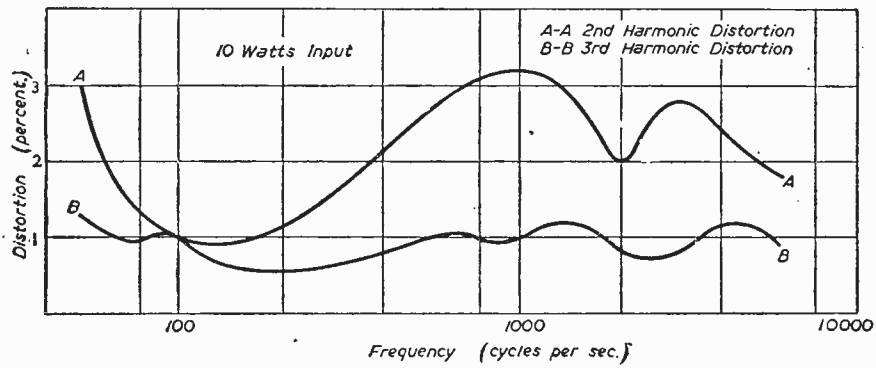


Fig. 5.—Harmonic distortion frequency characteristics duo-cone loudspeaker.

High-frequency Unit

The high-frequency unit employs a 2in. cone with an aluminium wire-wound voice coil. The non-linearity of the cone, due to the suspension system, is minimised by making the mechanical reactance due to the air chamber behind the cone considerably greater than that due to the suspension system itself. The low effective mass of the high-frequency system maintains uniform efficiency up to about 15,000 cycles per second, with a resonant frequency at about 1,500 c.p.s. Fig. 5 shows the values of second and third harmonic distortion for the duo-cone combination at an output level of 10 watts. Since normal monitoring and listening level is seldom more than 200-300 milliwatts, it can be seen that an extremely low distortion level can be achieved.

Directional Characteristics

It is desirable that the directional properties of a high quality loudspeaker system should be independent of the frequency over a distribution angle of at least 90 deg. The directional characteristic of a normal cone type loudspeaker is a function of the frequency of the sound emitted. Such a loudspeaker is non-directional at low frequencies, where the dimensions of the system are small compared with a wave length, but at higher frequencies, where the dimensions of the cone become comparable with a wavelength, the system becomes highly directional, the effect increasing with frequency. The cone angle also affects the directional pattern and by increasing the angle of the cone, the high-frequency distribution pattern may be broadened. A relatively wide angle is used for the cones of the duo-cone loudspeaker, and Fig. 4 shows the resultant directional characteristics at 1,000, 7,000 and 15,000 cycles per second. It will be seen that the response is reasonably uniform over a distribution angle of 120 deg.

Cross-over Network

It was noted in the discussion on two-unit loudspeaker systems that destructive interference occurred between the two units in the cross-over frequency region. In order to minimise this effect, it is usual to employ a tuned filter cross-over network with relatively sharp frequency discrimination characteristics. This inevitably leads to an increase in the distortion. In the duo-cone loudspeaker the two cones vibrate in unison in the cross-over frequency region and hence it is not necessary to limit the cross-over frequency range to a sharply-defined band. The impedance of the massive low-frequency voice cell is large, and it is, therefore, possible to dispense with the usual series inductance.

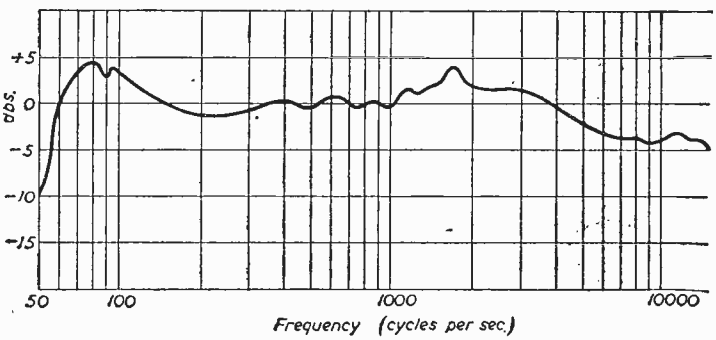


Fig. 6. Frequency response of duo-cone loudspeaker in reflex cabinet.

Alternative I.F. Couplings

Experimental Circuits for Use in Superheterodyne Receivers

By W. NIMMONS

THE modern superheterodyne receiver has settled down with transformer coupling between the frequency-changer stage and the I.F. stage, and between the I.F. stage and the second detector, which is a double-diode-triode in the majority of cases. The transformer usually does all that is required of it, providing a degree of selectivity which is ample for all ordinary requirements, while the efficiency of modern valves, particularly H.F. pentodes, ensures that the sensitivity is of the required order for a domestic receiver. Receivers for special purposes can have two or more I.F. stages, and even a couple of H.F. stages before the frequency-changer valve.

But all this means giving away a lot of power. There are tremendous losses in the I.F. transformers (necessary in the cause of selectivity) which are made good by the valves. The diode detector does not amplify (though the triode section of the double-diode-triode valve makes it equal to, or better than, a leaky-grid detector without reaction).

Is there, then, another method of transferring the signal from the frequency-changer to the I.F. valve, and from the I.F. valve to the second detector?

Alternative

That there is another method is obvious from the video stages of a television receiver. Here we have to deal with a relatively enormous band-width which the ordinary transformer would not pass. We are dealing with a band-width of as much as 2 megacycles, whereas the ordinary transformer will only pass about 10 kilocycles. So in a vision receiver we use resistance-capacity coupling, which is relatively independent of frequency.

That is one method. Another is sometimes used in fault finding. When an I.F. transformer is not working satisfactorily, either due to a break in the windings or to the trimmers having been altered or become inoperative, it is helpful, to see if the stage works, to try the choke and condenser method of coupling. This is shown in Fig. 1. An H.F. choke is connected between the anode of the F.C. valve and H.T. positive, and a condenser of .0002 μF. is connected between the anode and the grid of the following valve. A grid-leak of 1 megohm is also connected to the grid, and either returned to filament or cathode or to a source of negative potential. If the set then operates we know that the source of the trouble was in the I.F. transformer.

Another method makes use of the secondary of the I.F. transformer, providing this is intact and tuned to the intermediate frequency. As Fig. 2 denotes, an H.F. choke is used as before, but instead of the secondary of the I.F. transformer being cut out it is left connected and the fixed condenser is taken to the grid, or top of the secondary winding.

Tuned-grid

This can be recognised as a tuned-grid coupling, and as such requires to be tuned. But in this case it is a fixed tuning, set to the intermediate frequency, instead of the variable tuning of the T.R.F. circuit. As such, it can be made to have a high Q, and in most cases the secondary of the I.F. transformer provides a satisfactory Q, though there is no reason why a separate coil and condenser should not be used in an experimental receiver. The combination of coil and condenser should, of course, tune to 465 kc/s, or whatever is the intermediate frequency. A coil with more turns than the customary medium-wave winding and a small condenser is very efficient, and will provide a voltage step-up far in excess of the customary I.F. transformer.

Thus in an experimental receiver with a leaky-grid second detector, I.F. transformer coupling just loaded the detector comfortably. With tuned-grid coupling, however, the detector was swamped, the reproduction turning thin and distorted at optimum settings of the tuning control. This is a familiar symptom of overloading when a leaky-grid detector is supplied with too large a grid swing.

This, incidentally, is one method of "pepping up" a superhet. If the receiver has been well designed, and the tracking holds reasonably well

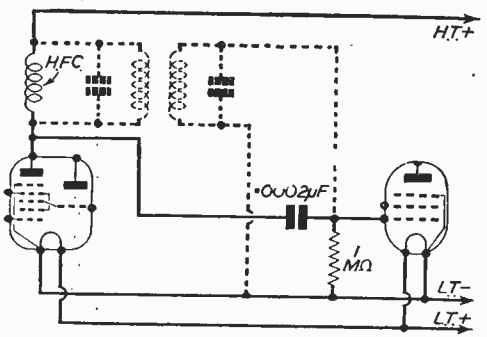


Fig. 1.—An alternative (untuned) I.F. coupling. The broken lines show the original I.F. transformer.

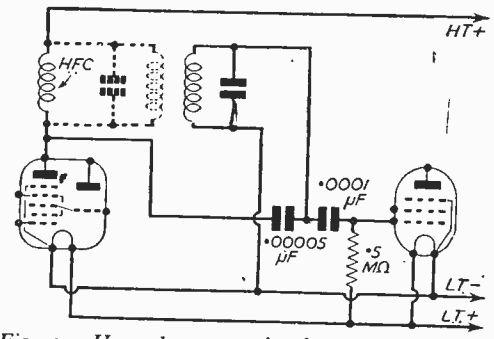


Fig. 2.—How the conventional I.F. transformer may be changed to tuned-grid with power-grid rectification.

over the dial, it should provide a good selection of stations. If not, results may be disappointing. By changing to tuned-grid between the frequency-changer and the I.F. valve it may be possible to "pep up" the set out of all recognition. This is doubtless due to the somewhat larger acceptance of the tuned-grid stage, which makes the tuning not quite so critical and masks tracking errors.

A small condenser as a coupling is usually all that is needed, around .00005 μF. being satisfactory. Larger condensers can be tried, but are apt to spread the tuning too much. If a separate coil is specially wound for the purpose, it is an advantage to tap it two-thirds down, the condenser then going to the tap. This will provide adequate selectivity, and a somewhat larger condenser can be employed.

Leaky Grid

Mention was made previously of a leaky-grid detector. This was employed so that the useful effects of reaction could be used to increase sensitivity, and the result was a 3-valve superhet. of unusual design which is capable of a good performance.

As Fig. 3 will show, the valves employed are a triode-heptode frequency changer, H.F. pentode detector, and tetrode output. The absence of an I.F. stage should be noted. This is largely overcome by the effects of reaction which, however, is "fixed." That is, the reaction condenser is set or chosen so that a fair amount of feedback is achieved without the set actually going into oscillation, and as the tuned-grid coupling is also fixed there can be no possibility of the set breaking into oscillation when tuning over the band.

It is possible to use the primary of an I.F. transformer as the reaction winding, the secondary being, of course, the tuned-grid winding. It is advisable, however, to move the primary and secondary windings closer together to obtain optimum results. Otherwise a specially-wound coil can be used, which should be screened. The coil should consist of about 120 turns on a 1½in. former, tuned by a .0005 μF. trimmer. The reaction winding should be about 60 turns, and this can be pile wound by the side of the main winding if the windings look like becoming too long. The wire can be No. 28 enamelled or D.S.C.

As it is almost essential to have some form of A.V.C., and as a double-diode-triode is not used, a system of automatic control is employed after the leaky-grid detector. This consists of a .001 μF. fixed condenser, a 100,000 ohms resistor, and a rectifier—a "Westector." With this arrangement, the bias varies in proportion to the strength of the signals applied to the detector valve, the H.F. energy being converted into a negative potential bias which is applied to the grid of the signal frequency portion of the F.C. valve. Thus on a powerful station such as the local the bias is greater and this cuts down the strength of signals, thus avoiding overloading of the detector valve. As a further precaution against overloading of this valve, semi-power-grid detection is used, with a grid condenser of .0001 μF. and a grid-leak of ½-megohm.

As a still further precaution against overloading the detector valve, it is recommended that the anode circuit should have as little resistance as possible, thus avoiding voltage-drop. Thus in Fig. 3 "straight" transformer coupling is employed, with a decoupling resistance of 10,000 Ω; the load of the valve is represented by the L.F. transformer

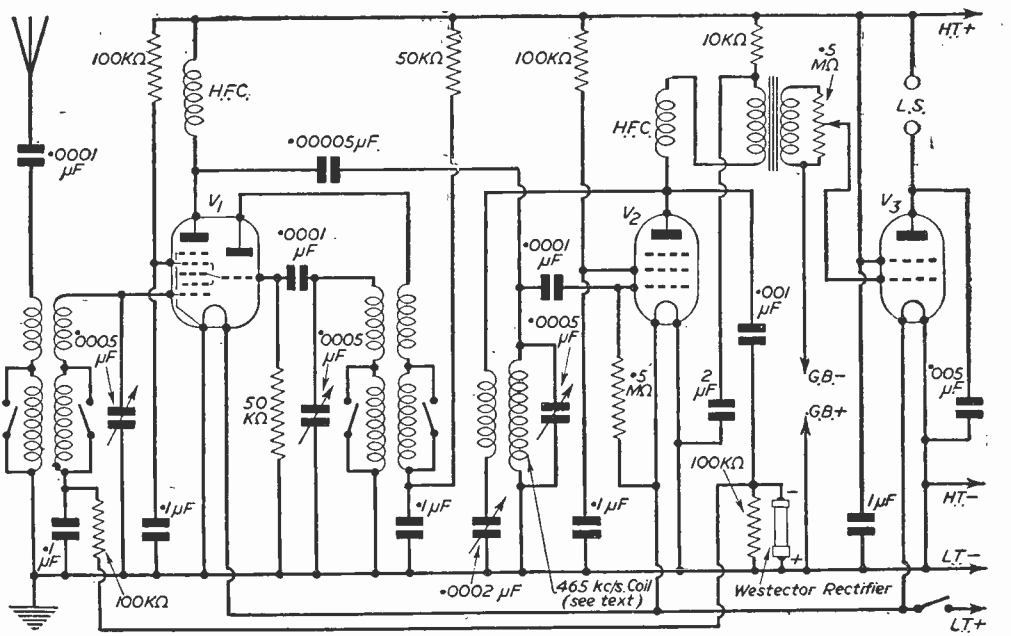


Fig. 3.—A complete circuit for a 3-valve superhet, embodying the suggestions contained in the text. The suppressor grid of V2, if not internally joined to the filament, should be connected to earth.

primary, and as this has a resistance of around 1,500 Ω in a good component the voltage drop will be very small. It is essential, however, to use an L.F. transformer which can carry the current; a parallel-feed transformer will not give good quality reproduction when used in the load circuit of the valve.

Screen Voltage

With regard to the screen voltage of the H.F. pentode employed as a detector, this is somewhat critical. Before the advent of the H.F. pentode which uses the same voltage on anode and screen, the screen voltage was even more critical and this gave the H.F. pentode a bad name as a detector. I have found, however, that H.F. pentodes such as the Mullard SP2, Osram Z21 or Z22, and Cossor 210 P.V.A., when operated with the maximum voltage on the anode and a voltage of about half this on the screen make excellent power-grid detectors.

To achieve this a resistor of around 100,000 Ω is included in the screen circuit. This reduces the voltage to approximately half the anode voltage.

Manual volume control is also included. This takes the form of a 500,000 Ω potentiometer across the secondary of the L.F. transformer. If the A.V.C. system is not wanted, the volume control should be used to apply a bias to the F.C. valve, providing this is variable-mu. In this case a potentiometer of 50,000 Ω should be used. If a non-variable-mu F.C. valve is used it would be better to use the volume control across the transformer secondary.

For best results it is essential to use a high H.T. voltage of around 150 volts; a mains unit is therefore indicated. If batteries are used, it would be better to replace the fixed amount of reaction control by a variable component which can be operated from the panel. This adds a complication to the receiver, but is well worth while with the weaker stations.

B.B.C. Engineering Training Department

THE chief responsibility of the Engineering Training Department is that of training engineers and technical assistants in the theoretical and practical aspects of B.B.C. technique and equipment for the sound and television services. It does not attempt to give basic training in electrical engineering in so far as this is available in the universities, technical colleges, and other existing institutions, but is concerned with the application of basic principles to the equipment and methods used in the B.B.C. Students are encouraged to undertake courses of study on their own initiative so that their standard of attainment in mathematics and physics will enable them to make fullest use of the courses provided by the training department.

During the war, the B.B.C. found itself faced with a serious loss of trained staff to the Fighting Services, and in 1942 the engineering division started a scheme of intensive training of engineers from other branches of electrical engineering. When this source was exhausted the training of youths aged 16 and of women operators aged from 21 to 30 was instituted. The training section responsible for this work was then a part of the Operations and Maintenance Department.

There was a central school in London and a number of smaller schools at certain B.B.C. centres in the provinces. At the central school, one month's preliminary training was given in the laws of electricity, acoustics and radio propagation, but in the provinces the students spent two months in lectures and operational work on the apparatus which they were eventually to handle. Training was given on transmission, control room and recording apparatus, and about 2,500 students were passed through during the war years. In addition to these schools, at a number of the larger stations and regional centres, instructors were appointed to bring the youths and women recruits up to a standard suitable for them to profit from the instruction given at the school. In 1945 the present head was appointed and the section was elevated to the status of a department.

It was realised that separate schools and station instructors were uneconomical and could not provide the proper facilities needed for full-scale training. Following the appointment of Dr. K. R. Sturley, M.I.E.E., to the staff of the Engineering Division of the B.B.C. in 1945, it was decided to centralise the whole department and this was done at Wood Norton Hall, Evesham, in March, 1946. The total number of students who have passed through the Wood Norton School is 1,100 and during the past five years considerable developments have taken place in training for the sound and television services. Formerly there was only one official television instructor, but it was soon realised that this was quite inadequate for coping with the demands for trained television staff, and the whole department is now engaged on television teaching as well as sound. Since the correct presentation of principles and facts is a most important aspect of training, it was natural to make the writing of technical instructions and manuals on new equipment the responsibility of the training department, a section of which is entirely devoted to this work.

Types of Training Courses

The main activity of the department has centred on two types of staff, the new recruit, who enters as a technical assistant, and the engineer. The engineer is generally, though not always, a former technical assistant with some years of experience in Corporation work. The technical assistant operates the apparatus under supervision; the engineer may be concerned with supervision of technical assistants and the maintenance of apparatus, or with development, design, research or engineering administration. An important development has been that of refresher courses for senior staff and these have concentrated on the presentation of new developments and techniques. Training has also been given to non-engineering staff known as programme operators, who are responsible for the technical control and balance of the programme output from the studio. On the engineering side there are five types of courses: Initial Entry, Promotion, Refresher, Conversion, and Workshop.

Calibrating an Ohmmeter

A Simple Idea for More Accurate Calibration of Home-made Meters

By D. CAVE

MOST readers will have undertaken at some time, no doubt, the construction of a simple ohmmeter, using the circuit shown in Fig. 1. M is a moving-coil meter of usually 1 mA full-scale deflection; R1 is a variable resistance of about 500 to 1,000 ohms, its value depending on the voltage of the battery to be used; R2 is a limiter resistance to prevent the meter being seriously overloaded when adjusting R1; and finally B is the battery required to supply the current for making the measurement.

In use the first step is to close the terminals T by clipping their leads together, and adjust R1 until the meter pointer moves full-scale deflection. Under these conditions the value Rt of the total resistance in the circuit (R2+ the meter resistance + the amount of R1 in use) is calculated by dividing the battery voltage by the full-scale meter current. Thus if B is a 1½ volt cell and M is a 1 mA meter, then the total resistance in the circuit will be 1,500 ohms. This may be arranged by having R2 about 1,200 ohms and R1 500 ohms.

The next step is to insert the resistance whose value is to be measured between the meter leads as shown at Rx in Fig. 2. The total resistance Rt in the circuit is now greater than it was before, and in consequence the current is reduced and the meter pointer reads less than full-scale deflection. The position it reads depends, of course, on the value of Rx.

Now the meter scale is marked in mA or decimals of 1 mA and we wish to know what each position of the scale corresponds to in ohms. A common method adopted by amateurs to calibrate the instrument is to insert at the position Rx various resistances of known value and to mark the meter scale with their values at the positions which the pointer indicates. This is a laborious method and requires a fairly large stock of resistors; furthermore the accuracy of the calibration will depend on the accuracy of the resistances used.

Here is an easier and more accurate method based upon the use of Ohm's Law.

The Method

Let Im be the meter current at full-scale deflection; E the battery voltage; and Rt the total resistance; all in the circuit of Fig. 1. Let Ix be the current; and Rx the value of the resistance to be measured; both in Fig. 2.

Then by Ohm's Law, $E = Im\,Rt$ for Fig. 1.

$E = Ix\,(Rt + Rx)$ for Fig. 2.

Therefore, $Ix\,(Rt + Rx) = Im\,Rt$

$IxRt + IxRx = ImRt$

$Ix\,Rx = Rt\,(Im - Ix)$

$$Rx = \frac{Rt\,(Im - Ix)}{Ix}$$

This equation enables us to calculate the unknown resistance Rx if we know the total resistance in the circuit of Fig. 1, and if we read the current shown by the meter pointer.

Rt is calculated as shown above from the voltage of the battery and the full-scale current of the meter. Therefore the resistance indicated at any point on the meter scale is simply the fraction $\frac{Im - Ix}{Ix}$ of the resistance Rt.

The procedure then is as follows. First calculate Rt. Next take any position on the meter scale and note the remainder of the scale from that position to full-scale deflection. Divide this remainder of the scale by the chosen position and multiply the answer by the value of Rt.

Thus, suppose the meter has a full-scale deflection of 1 mA, uses a 1½ volt cell and we wish to know the resistance at the position marked .1 mA. The remainder of the scale to full deflection is 1 mA − .1 mA = .9 mA. Divide .9 mA by .1 mA = 9 and multiply by Rt. In this case, as shown above, Rt is 1,500 ohms. So the resistance value at the point .1 mA would be 9 × 1,500 which equals 13,500 ohms.

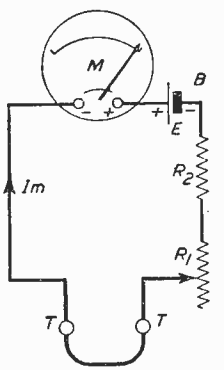


Fig. 1.—The usual arrangement for calibration.

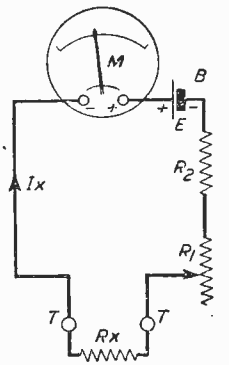


Fig. 2.—The method suggested by Mr. Cave in this article.

One further example should make the calculation quite clear. Suppose you are using a 5 mA meter and a 9-volt grid-bias battery. Then Rt = 9 volts divided by 5 mA = 1,800 ohms. The resistance at the point marked, say, 3 mA on the scale is found as follows. The remainder of the scale to full scale is 5 mA − 3 mA = 2 mA. Divide 2 mA by 3 mA = two-thirds, and multiply by 1,800. The answer is 1,200 ohms.

All desired points of the scale may be calculated in this manner and marked in ohms.

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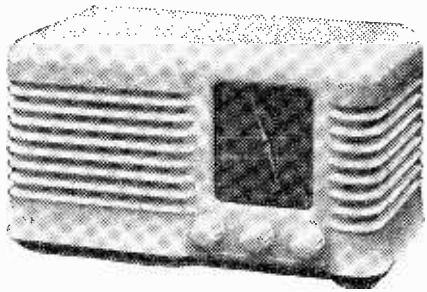

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Designing Your Own Receiver—8

Advice and Guidance for the Beginner

By STANLEY BRASIER

Crackle Finish

EVEN the much-coveted "crackle" finish can be carried out at home if the right type of enamel can be acquired. Black is the most successful colour to work with and is usually sold under the name of "synthetic" enamel. It is largely a matter of good fortune whether such enamels respond to the "crackle" treatment, but is always worth a trial on an odd piece of metal. After applying the enamel in the normal way it is usual to allow some time to elapse before applying heat. This time will vary according to the enamel used, but, in general, it should be left until just *before* the "tacky" period sets in. Great heat is not required to produce the crackle effect, and usually the lowest position on the thermostat of the domestic oven will be suitable. When the effect has been produced the metal must be allowed to cool and left so that the enamel may harden. If one is interested in this type of finish a little experiment is well worth while.

A good effect can be produced on metal or wooden cases by covering them with rexine or leather-cloth. Especially is this so when dealing with portable receivers or portable test equipment where a hard-wearing surface is required.

Plastics

Coming now to panels, it is often necessary to "face" the front of a piece of ex-Government equipment which one has stripped in order to make use of the complete case. Alternatively, one may wish to create a special effect for a "drawing-room" set. In this respect the plastic materials should not be forgotten. Notable amongst these is the material which goes under the trade name of "Perspex," and is available in varying thicknesses and a range of colours, including black and white. For special effects panels in shades of stone, amber and cream are particularly attractive. For workshop use black is serviceable, although white is useful for meter and instrument panels, and shows up panel markings extremely well.

Meter Case

Perspex, however, is very brittle and liable to fracture unless great care is exercised in cutting, drilling, etc., but another material in this group called acetate does not suffer from this disadvantage and, in fact, is very pliable yet strong. It also is available in a range of colours, including black and white, and its thickness is usually ranged in terms of millimetres. Acetate is extremely easy to cut, saw, file, etc., and may be bent simply to any shape. In addition to this, its solvent, namely, acetone, is used in a very simple technique to effect joins in the material which are almost as strong as the material itself. In fact, there is no limit to the variety of fitments, dial escutcheons, etc., that can be made in acetate, because the material can so easily be worked, jointed and polished.

Quite often good micro-amp. movements are contained in special ex-Government aircraft equipment, but are not practicable unless housed in a suitable case. Black acetate is entirely suitable in such instances, and an illustration of a convenient and very simple method of construction is shown in Fig. 11. Material 2 or 3 millimetres thick is used for all parts except C, which is cut from 3/16in. or ¼in. Perspex, and is the part upon which the meter scale is eventually fixed. Part D is a cylinder formed to receive the meter movement. It is constructed from a piece of acetate whose length is equal to the circumference, the width being that of its depth. The material is heated *gradually* over a bunsen burner or domestic gas ring, thus making it extremely pliable. In this state it is formed round a cylindrical tin or jar of suitable size—repeating the heat treatment if necessary. When formed the material is held under running water while still on its former, and when cool will retain its formed shape. The free edges are joined by applying acetone liberally with an imitation camel-hair brush. Part E is a disc cut to the outside diameter of D, which is placed in position over it, and the inside joint is "wiped" round with acetone. The hole in part C should be of a size to allow part D a good, tight fit. As this joint consists of Perspex to acetate, the best adhesive will be Perspex cement. The reason for using Perspex for part C is to provide strength for the whole case, but if ¼in. acetate is available it will be quite suitable.

B is a narrow strip of acetate bent by the heating and cooling method to form a frame, the outside dimensions of which are similar to that of A, so that when B is stuck to A a "lid" is formed which should fit snugly *over* part C. Little fillets of acetate

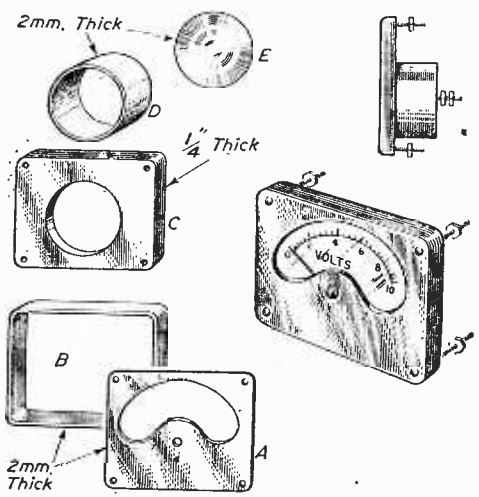


Fig. 11.—Component parts and finished meter case constructed from black acetate.

are stuck inside the lid to prevent it going right down and so that the bottom edges of B are flush with the under-surface of C. Holes are drilled at the corners of the cover in line with *tapped* holes in C, so that long 6BA bolts may pass right through and also provide fixing of the finished meter to a panel.

The front edges of the meter case are rounded with a file and sandpaper and, if facilities are available, the cover may be polished on a buffing machine. This treatment gives a really beautiful lasting finish *indistinguishable from the commercial product*. Alternatively, it will be found that a good finish can be obtained by merely "painting" the surface with acetone, especially if care has been taken to avoid scratching the surface.

From this specimen description it will be appreciated that many items can be constructed at low cost, such as universal meter boxes, sloping deck instrument cases, etc., and the method has the advantage that the items may be designed to suit one's own ideas and accommodations. Fig. 12 shows some useful designs, constructed from acetate. The case of working with this material cannot be too highly stressed and in the matter of joins it is only necessary to lay the two parts together and hold them so whilst applying acetone liberally. It will be noted that this action produces a highly-polished surface with complete absence of "surplus" which is usually associated with jointing when an ordinary adhesive is used.

An article may be handled within about 15 minutes of jointing but for maximum strength it is necessary to leave it for some hours.

Inserts

Threaded metal inserts provide a very neat method of fixing in certain cases and these may easily be provided for in acetate or, for that matter, in Perspex, too. To do this a nut of the required size is serrated around its outer edge. The material is then drilled with a hole to the size of the diameter of the nut (disregarding the points formed by the hexagon). The nut is heated slightly and then pressed flush into the hole and, when cool, smoothed off.

Meter Scales

The scales of ex-Government meters are usually marked in terms that are useless or not convenient to the radio amateur and if an attempt is made to add printed numerals by hand the result almost invariably mars the appearance. In such cases the following method ensures an effect equal to commercial standards.

The scale plate of the instrument is carefully removed and used as a template to cut another from very thin white Perspex, acetate or ivorine. Two tiny holes are then drilled in the original plate at the extreme ends of the scale arc, so that with a fine pencil these two points may be plotted on the new plate. Then by trial and error the curvature of the arc is determined and dividers are set to this radius. The dividers should be of the semi-locking spring type and the end of one leg is filed or ground to a tiny chisel edge. With the scale pinned down to a board the dividers are used to cut a reasonably deep but narrow channel in the material, thus forming the scale arc. Next, cobbler's black "heelball" is run into the channel by means of a hot pen-knife. The surplus is carefully trimmed off with a warm knife and finally rubbed with a duster, using hard finger pressure. The result will be a perfectly engraved jet-black line.

Transfers

The above method is far too tedious to apply to the marking of scale divisions and subdivisions, so use is made of transfers. It may not be generally known that letter transfers are available in alphabetical sets and figures in sets of 0 to 9. Some manufacturers include extra 0's and 1's which are useful where notation of radio panels is concerned. These transfers are available in various sizes down to

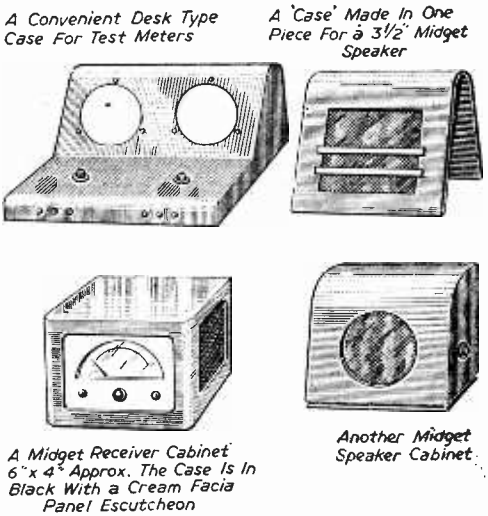


Fig. 12.—A selection of cases constructed from acetate.

1/16in. letters and figures, which size is ideally suited to the marking of superscripture and numerals on meter scales. Divisions are put in by using the 1's, care being taken that their angles are such that they will lie in line with the instrument pointer.

Tuning scales of instruments requiring individual calibration, such as oscillators, are always a problem but such difficulties are solved by the adoption of the above method. It is necessarily tedious, but it *does* ensure a professional effect, as opposed to one that is an eyesore for as long as the instrument is used.

The larger letters and figures, ⅛in. and 3/16in., are useful for the scales and markings of panel controls and will adhere to surfaces of polished aluminium, cellulose, plastics, paper, etc. Some manufacturers make transfers in white for black surfaces but even if these are unobtainable it is easy to fix individual marked scale plates in white. Incidentally, an easy method of "engraving" a circle on a plastic panel is as follows. When the control has been mounted select a knob that has a solid under-surface and, after drilling a small hole, insert a short pin (part of a thin nail will do). The pin should be a good tight fit and its free end filed to a chisel edge. The knob is then put on the spindle and swung to and fro until the required engraving is cut in the

panel. The channel is then filled with heelball as previously explained, and the calibration points or switch positions put in with transfer l's. A panel so marked complete with wording is well worth the effort and, indeed, imparts additional value to the finished instrument which is certainly advantageous when it is eventually disposed of.

Before leaving the subject of plastics it will probably be helpful to point out that many firms advertise plastic offcuts or scrap. These are often of sufficient size to be extremely useful in radio work and are, of course, much cheaper. A very simple method of obtaining meter scales or tuning scales to one's own requirement is by means of photographic reproduction. For instance, one may acquire a nice 4in. meter of useful basic range, but where the scale is marked in terms useless to the purpose one had in mind. Very often the wanted scale may be on, say, a 2in. meter in one's possession. So all that is required is to remove the wanted 2in. scale, photograph it on miniature film and then enlarge up to the required size. Often a scale may be borrowed for this purpose and the possibilities are unlimited. It is unlikely that the average amateur will be in a position to carry out this type of work himself, but any professional photographer will undertake it for a small sum. When taking such work, the scale must be accompanied by the measurement to which enlargement is wanted, and this is best taken in millimetres as a point-to-point divider measurement between extreme ends of the scale. Note that on many meters there are two scale arcs and it is important that no confusion arises out of these measurements, because unless the new scale is *exactly* the same length as the one fitted, the basic current range of the instrument is likely to be affected.

The photograph is best printed on matt white paper and the scale and superscripture only should appear on an otherwise plain white background with an ample surround. In other words, the outline of the actual *plate* is not wanted, because the face of the new meter may be more "open" than was the other, consequently showing more in proportion of the dial. In the same way it is possible for the photographer to "blank out" some of the superscripture not required. For the new scale may be wanted to read volts, whereas the one photographed reads milliamps, but the new wording may be applied by means of transfers.

The surround of the photograph, as received, will be larger than required and some means of locating it in the correct position is required. This is best achieved by drilling two tiny holes—one at each end of the arc—in the scale plate of the meter to which the new scale is to be fixed. Then, by placing this under the new scale and holding both up to the light, localisation is accomplished and the new scale plate trimmed to shape. It may be stuck, either to the old plate or to a new one made from some non-magnetic metal, by means of photographic adhesive.

In conclusion, it is hoped that this series of articles has shown the young amateur how to extract the utmost efficiency from his receivers, and proved that the constructional side of radio can give more satisfaction when the artistic is combined with the practical.

New Daventry Transmitter

APRIL 8, 1951, marked the opening of the new high-power transmitter and mast radiator at Daventry for the Third Programme on the present wavelength of 464 metres (647 kc/s). Originally this programme was broadcast from Droitwich, but last year it was transferred to a temporary 60-kilowatt transmitter at Daventry at the time when the Copenhagen Wavelength Plan came into force. Shortly afterwards the installation of the permanent transmitter at Daventry was begun and now that this is complete the service has been transferred to it.

With a power of 150 kilowatts the new transmitter is not only more than twice as powerful as its predecessor but has also been provided with a more efficient aerial, specifically designed to give as large a fading-free service area as possible. It is expected that the average radius of the service area will be about 100 miles—indeed, towards the north and east it will be rather more than this—and that the number of listeners able to receive the Third Programme will be increased to about 70 per cent. of the population.

Daventry has the longest history of any B.B.C. transmitting station. Just over 25 years ago (in 1925) the B.B.C.'s first high-power transmitter for long-wave broadcasting—Daventry 5XX—was installed there, to be followed two years later by the high-power medium-wave transmitter 5GB. In 1932 the station was re-christened the Daventry Empire Station, following the installation of the transmitters for broadcasting to the Empire on short waves. By 1937 the number of short-wave transmitters had increased to six, with a further increase to 11 by 1940, making Daventry at that time the B.B.C.'s most powerful short-wave broadcasting station. Meanwhile the long- and medium-wave services had been transferred to new and more powerful transmitters at Droitwich.

The new Third Programme transmitter, which has been designed and manufactured by Marconi's Wireless Telegraph Co., Ltd., is in the building that originally housed the 5XX transmitter. It consists of two identical transmitter units which can work in parallel, each complete in itself and each capable of an unmodulated carrier output power of 100 killowatts. Thus the transmitter is capable of a power output of 200 kilowatts, but to conform with the Copenhagen Wavelength Plan the actual power used will be limited to 150 kilowatts. The two units are arranged in line with a cubicle between them for combining the individual outputs. All the valves, including those in the output stage, are air-cooled—a new departure for a B.B.C. transmitter of this power and one that makes for easier maintenance and also lends itself well to remote control. Another feature of the transmitter is that all the valve filaments are supplied with alternating current, so that there is no rotating machinery, other than the air blowers, associated with it. A third feature, and one of particular interest, is that the transmitter is designed so that it will ultimately be possible to operate it from a remote point—from another building at Daventry or from Broadcasting House, London, for example — by means of signals sent over a single telephone channel

A Summer A

A Compact Three-valve Rec

By F.

THIS receiver is the result of a good deal of experiment which was conducted with a view to obtaining a really serviceable circuit, yet one not unnecessarily complicated. Pentodes are used for R.F. and detector stages, with a tetrode for output. Due to the use of reaction, this combination was found to be in no way inferior to the popular four-valve superhet circuit as regards range and volume, though it does require an extra control knob.

The frame aerial is situated in a shallow lid, the set being of the small "suitcase" type, and tests showed that signal pick-up was greater with this arrangement than when the frame windings have to be in close proximity to chassis, speaker, and other components. The use of a medium-wave frame with long-wave loading coil was tried, but this was abandoned because it provided much lower volume, on long waves, than the frame aerial wound for both wavebands.

The receiver was built in a bakelite case offered as surplus by a stores whose advertisements have appeared in these pages, but an indication of dimensions have been given so that a suitable case can be constructed. A Drydex Drymax Type 501, or G.E.C. Type BB501, H.T. battery (67½ volts) is used, with any 1½ volt dry battery for filament supply.

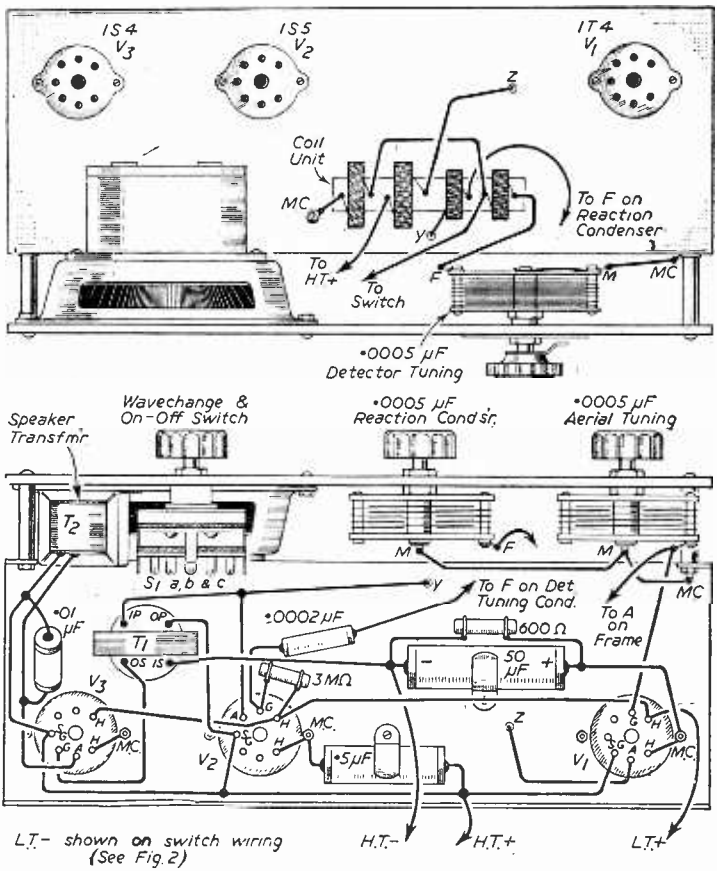


Fig. 1.—Above and below chassis wiring.

Further Circuit Details

A gang condenser is not used for tuning frame-aerial and coil because it is difficult to make two windings so dissimilar in type gang correctly, so that loss of volume may result when a gang condenser is used. The detector tuning condenser is most important, and the dial can be marked to indicate where stations are received. The small aerial tuning knob is simply turned for maximum volume, and this arrangement *does* permit of best results without difficulty.

The rotary switch has three positions—1, "Off." 2, "Medium Waves." 3, "Long Waves." It is wired as shown in Fig. 6. This type of switch is easily obtainable, and the contact tags which are not required are disregarded.

Automatic bias is obtained by the voltage drop across the 600 ohm resistor, and it must not be overlooked that the 50 µF condenser must be wired in the correct polarity, following the markings on it and Fig. 3.

Panel and Chassis

The panel is cut from 3-ply to the dimensions shown in Fig. 2. This fits flush in the

COMPONENT LIS

Three .0005 µF solid dielectric varia
.0002, .01 and .5 µF fixed conde
electrolytic bias condenser.
600 ohm and 3 megohm ½-watt resis
Dual-range H.F. coil with primary
Switch as specified.
1 : 3 mu-metal ex-Service or si
transformer.
Three small knobs ; larger knob
Three B7G valveholders. 1T4, 1S5
3½in. speaker with midget battery
former.

l-dry Portable

'er with Self-contained Aerial

) RAYER

case, leaving ample space at the back for batteries. The chassis is 6½in. by 2¼in., and is made from 20 s.w.g. aluminium or similar material. It is secured to the panel by long bolts with lock nuts or sleeves so that the front edge of the chassis is about ⅛in. or so from the panel. (This is necessary because the edge of the speaker projects below the

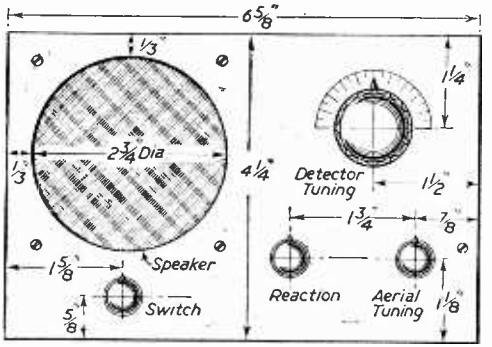


Fig. 2.—Panel details.

chassis.) The three ⅝in. diameter holes necessary for the valveholders are cut, the variable condensers and speaker mounted on the panel, then panel and chassis bolted together.

All wiring is shown in Fig. 1, and points marked MC are connected to the metal chassis by being secured under convenient nuts. Solid insulated wire of about 20 s.w.g. is used throughout,

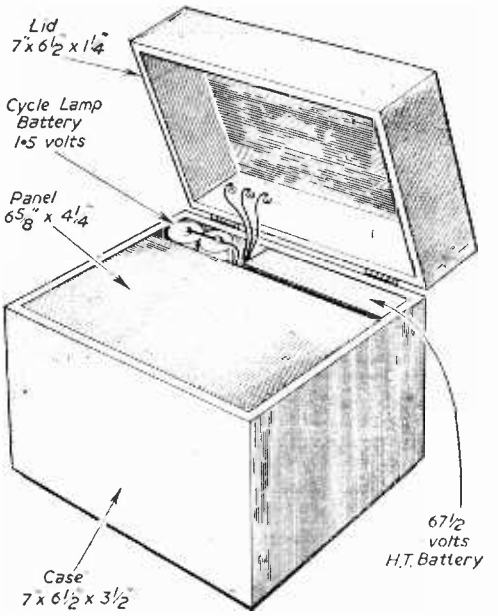


Fig. 4.—General measurements of the case.

except for the battery leads, and three leads which go to the frame aerial. These are of insulated flex. The two larger fixed condensers require to be made fast by metal clips bolted to the chassis. Joints or bare leads should not be allowed to touch the unused tags on the valveholders, as these provide alternative connections to the electrodes, and a short could be caused. The socket connections are different for each valve type, except for filaments, which are brought out to the pins forming number one and number seven of the semicircle.

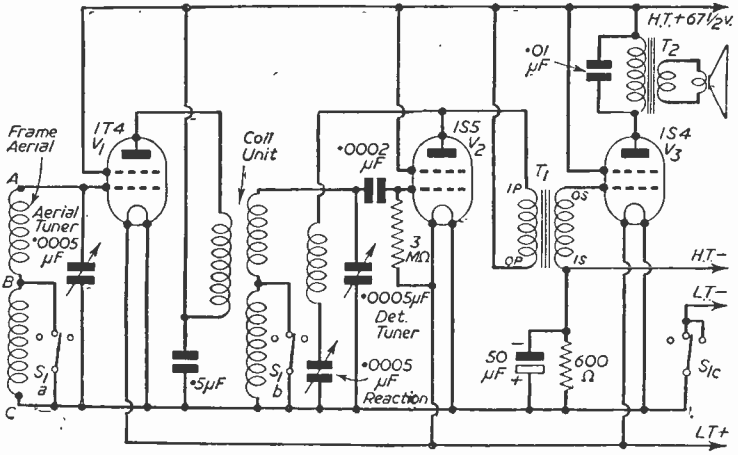


Fig. 3.—Theoretical circuit.

The Frame Aerial

This is wound as illustrated in Fig. 5, enamelled wire being used. The smaller section has turns side by side, but the turns in the larger section will need to be in a pile. The ex-manufacturer's containing case mentioned has a shaped bakelite former which fits in the lid, and the aerial is wound on this. Small bolts (6 or 8 B.A.) are used at points A, B and C. The end of the 34 s.w.g. wire is

condensers.
's. 50 µF
reaction.
ır coupling
pointer.
1S4 valves.
ıtode trans-

soldered to bolt C, the head covered with tape, and the 60 turns wound on. The end of this winding is then soldered at B, together with the beginning of the 23 turn winding, which is concluded at A. At least ¼in. free space should be left between the two aerial sections, and both sections must be wound in the same direction.

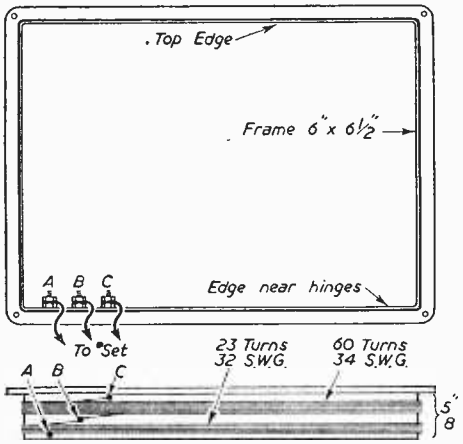


Fig. 5.—Frame aerial details.

Fitting and Operating

The frame aerial is inserted in the lid and attached by long, thin screws at the corners. The receiver fits flush at the front of the case, and the three flex leads should be attached to their respective points on the frame. A convenient type of H.T. battery has been quoted. For L.T. any 1.5 volt battery can be used. A twin-cell cycle lamp battery, with cells connected in parallel, will be found to have a long period of life.

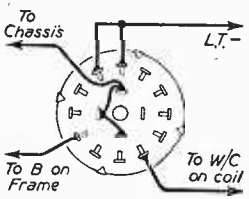


Fig. 6.—Details of wiring of the combined on/off and wavechange switch.

Both tuning knobs are turned approximately together, and adjusted for maximum volume. Reaction is used to build up the signals obtained from the weaker stations. The frame aerial is directive in the usual way, so that the receiver may need turning for maximum volume from any particular station. Local stations, however, should be received at ample volume without attention to this point.

B.B.C. Festival Plans

AS we go to press, details have been released of the plans made for the Festival period on the Light, Home and Third programmes. In general these will cater for the normal public—not the visitor. Some programmes have already been specially written, whilst others are to be prepared to a given formula. On the Light Programme, for instance, there will be special dance-music programmes augmented by artists each week, and specialised programmes in these series such as "Tuneful Twenties," cabarets, etc. On the Home Programme, a fortnightly series of "Music Hall" programmes will be built round Kenneth Horne and Richard Murdoch, and this programme will alternate with a Festival Parade programme featuring Ben Lyon and Bebe Daniels. Guest artists will complete these programmes.

Outside Broadcasts

Many elaborate outside broadcasts have been provisionally arranged, starting from the opening ceremony, and highlights of these will be a helicopter flight from London to Birmingham and an Ambassador flight from London to Paris. Visits will be paid to the Port of London, Royal Observatory, Tower of London, British Museum, etc.

Although they are going to Australia, those incomparable script-writers, Muir and Norden, have been asked to produce something special, and their script will have to be left with the B.B.C., and at the time of writing no details are available as to the form the programme will take.

Some of the musical feasts are:

Menuhin, Philharmonia Orchestra, Kubelik (Royal Albert Hall), on May 9th.
R.P.O., Stokowski (Royal Albert Hall), on May 16th.
Hallé Orchestra, Barbirolli (Royal Festival Hall), on May 25th.
B.B.C. S.O., Beecham (studio), on May 27th.
B.B.C. S.O., Sargent, Berlioz Mass, on June 5th.
L.P.O., de Sabata (Royal Festival Hall), on June 13th.
B.B.C. S.O., Beecham, Arrau (studio), on June 20th.
L.S.O., Sargent, at Norwich, on June 27th.
R.P.O., Beecham, opening concert at Colston Hall, on July 9th.
L.S.O., Sargent, at Cheltenham, on July 11th.
Boyd-Neel Orchestra, Bach B minor Mass (studio), on July 18th.

A weekly Cathedral Music series will come from: York Minster; Durham; Westminster Abbey; Worcester; Canterbury; King's, Cambridge; St. Paul's; St. George's, Windsor; Purcell Concert, Westminster Abbey.

Control in Unit Construction

A Useful Relay-operated Installation

By T. H. ROBINSON, B.Sc.

THE recent article by Mr. W. J. Delaney in the February issue on the return to popularity of unit construction, has prompted the writer to offer these notes on a method of control devised for his own use.

The disadvantage of power being continuously consumed by muted units when not in use is obvious,

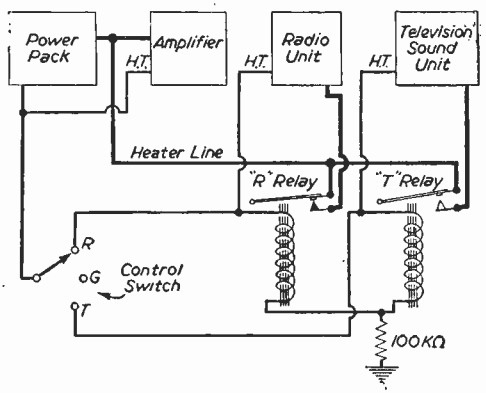


Fig. 1.—General arrangement of the switching circuits.

as apart from waste, the life of such components as valves will of necessity be shortened.

Power Switching

The main difficulty in switching power pack outputs to different units is the comparatively heavy current in the valve heater circuits, which precludes the use of ordinary wafer switches. Suitable ganged switches are both cumbersome and rare.

The system to be described controls the "sound" side of a combined television-radiogram, and is shown broadly in Fig. 1. A separate power supply is provided for the vision units.

A mains switch controls the sound power pack which feeds H.T. and heater current directly to the second unit, the amplifier.

H.T. positive from the power pack is connected also to the moving contact in a 3-way wafer switch and thence to the radio-feeder, the television sound unit, or the third contact which is blank and represents the gramophone position.

Contacts 1 and 2 are also connected to the coils of two 25,000-ohm relays wired in series with a 100,000-ohm ¼-watt resistance to earth, which is the common H.T. negative return. These relays are easily obtained on the surplus market, and work very satisfactorily under the above conditions, where with an H.T. voltage of 275 the current is just over 2 mA.

The heater supply from the power pack is also led directly to the amplifier, and also to one of the heavy-duty "make" contacts on each relay, which when closed completes the circuit to the appropriate unit. An earth return is provided.

Signal Switching

The sliding contact on a second bank in the control wafer switch is connected by means of a screened co-axial cable to the amplifier input via a common volume control. The three stud contacts of the switch are taken, also in screened cable, to the outputs from the appropriate units: radio, television or gramophone pick-up.

Tell-tale Light

The relays used have various contacts including some which break on closing, and an added embellishment—not shown in Fig. 1 for clarity—is illustrated in Fig. 2.

A single warning light is wired in the heater line from the power pack, in series with a "break" contact in both relays. When the control is set to Gram., the light remains on; when turned to Radio or Tele., the light goes out.

In addition to the useful advice that all is well with the control system, there is something rather satisfying in the behaviour of this light. With the control set to "R," for example, upon switching on the set from cold the lamp at first lights up, then when the power pack warms up in about 15 seconds the relay is heard to click, the warning light goes out, and the dial lights come on instead. When switched to "T," no distracting lights appear.

There is a further quite accidental feature worthy of note. Purely for convenience in making connections, a couple of 2 μF. Mansbridge condensers were used in place of junction boxes on the H.T. lines between control switch and relays, as shown in Fig. 2. With the set warmed up, upon switching from "R" or "T" to "G," an interval of just over a second elapses before the relay opens and the warning light appears. This is due to the charge in the Mansbridge condenser supplying both unit and relay.

This time lag can be a useful indication as to the condition of decoupling condensers, etc., in the units, and some time ago its absence when changing

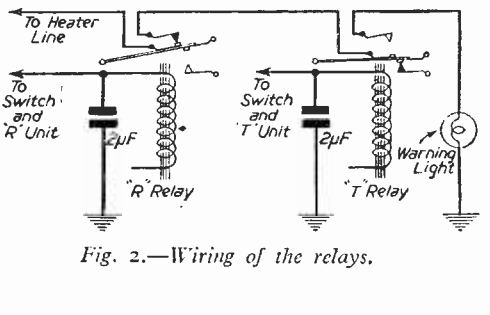


Fig. 2.—Wiring of the relays.

from "R" to "G" led to investigations in the radio-feeder and the discovery of a leaking electrolytic condenser in process of breaking down.

High-tension Regulation

It might be thought that by reducing H.T. current consumption by switching off units, the voltage would rise and threaten a large number of condensers. The heaviest load, however, is the amplifier which is in operation continuously, and with a power pack of reasonably good regulation, the voltage variation will not be significant.

Constructional Points

In the writer's apparatus the control switch is mounted in a small earthed metal box to avoid hum pick-up, with the signal leads brought in by co-axial cable; the screening being securely soldered to the box at points of entry. These leads terminate at the units with co-axial plugs and sockets.

Power leads from the relays join up with wires from the units at Mansbridge condensers acting as junction boxes, the nuts on the condensers being replaced by round terminal heads.

Earth connections are made from brass terminals on the chassis of each unit to copper braid tacked around the inside of the cabinet.

Each unit can, therefore, be speedily released for removal.

Reliability

In conclusion, it may be stated that the system as described has been in operation without a hitch for over two years, and it is hoped that it may be of interest to any reader contemplating the construction of a combined instrument on the unit principle.

Short-Wave Topics

File for Future Reference

THEORETICAL diagrams, official manuals and bench-wiring diagrams are well worth the outlay for filing, in case of future need. They may not always be available. Owing to the changing fancies of the amateur, an HRO or AR88 may come your way at some future date and at a reasonable price.

The R1155

One of the most popular and most widely used of ex-Service receivers is the R1155. In the first place there were large quantities available, and in recent years the price asked may be considered as most reasonable.

Do not, however, imagine that all models of a particular receiver including the 1155 are alike so far as performance is concerned.

Some variation is to be expected. Unless one has to hand a model which has recently been realigned and is known to be up to standard in every respect, there exists a certain element of doubt.

The general opinion among amateurs is that the noise level of the R1155 is rather high. There are a few simple ways in which this can be improved. In discussing these it should be remembered that we have in mind the 1155 as it stands, unmodified, and for use with headphones.

Replace the latter, if of the magnetic type, with a pair of the HS33 moving-coil type. In addition, add an audio filter and a tone control. Instead of the combined volume control use separate units. Try the effect of using the built-in filter and external audio filter together, when noise level on the amateur bands is high.

These are refinements which can be added with but little trouble. As a loudspeaker receiver with a 6V6 output stage the 1155 will hold its own as a world-wide short-wave broadcast receiver and provide more volume than can be reasonably used in the average living-room. It is capable of overloading a 10in. MC speaker on American and other transmissions.

On the score of reliability with personal experience as a guide it is reliability itself.

The 1224A Receiver

This popular ex-Service receiver is used in considerable numbers. The pity is that it does not cover from 13 metres up to the 160 metres band. A regular reader some time ago experienced difficulty in adding an additional range. This was due to the fact that he had been misled as to the frequency of the I.F. transformers. These are not 465 kc/s. Please note that the correct I.F. is 470 kc/s. and this may save similar trouble being experienced by those who wish to carry out like modification.

The R1120 Receiver

In a previous paragraph I mentioned the R1139. The R1120 is another version of the former. Both models are to hand. Future plans cover certain experiments using the R1120 as a basis in addition to other work. What the final results will prove remains to be seen. If worth while, a separate article will be devoted to them.

Time nowadays is the limiting factor and no definite date can be given. Letters received from readers indicate that there exists an urge to experiment. Short-wave receiver construction is on the increase, as distinct from specialised listening with the aid of commercially-produced receivers.

Of Interest to Licensed Amateurs

There appears to be some doubt so far as ex-Service transmitters and transmitter-receivers are concerned as to which types can be used for amateur transmission by licensed amateurs. The writer, for instance, was informed by another amateur that it was forbidden to use the TR9 transmitter-receiver.

This is incorrect. In reply to an inquiry addressed to the Chief Engineer of the G.P.O. I am informed that provided that the apparatus referred to meets the requirements of the conditions of the amateur licence, a summary of which was enclosed, it can be used.

Readers who are prospective licensed amateurs and are in doubt should write for a summary of the Amateur Transmitting Licence, and if the use of ex-Service equipment is contemplated, give full details. This will avoid disappointment, also the chance of being misled.

A. W. MANN.

Detectors for F.M.

Circuit Arrangements for Use in Receivers for Frequency Modulated Transmissions

By THE EXPERIMENTERS

INFORMATION which has recently been given in the Press, of the B.B.C. F.M. station at Wrotham, gave indications that an extension of this method of broadcasting is being considered. Many radio enthusiasts in the south are already receiving these experimental broadcasts, and others may be expected to build receivers if F.M. transmissions are put out in their areas. One of the chief fundamental differences between A.M. and F.M. receiving technique is the method of detection of the R.F. signal which is employed. The remainder of an F.M. receiver is fairly readily understood, but to an experimenter coming fresh from A.M. reception the detector (or discriminator as it is usually known in F.M. receivers) may appear puzzling. This article will describe the conventional standard F.M. discriminator and also a new type of detector which has recently been introduced in the U.S.A.

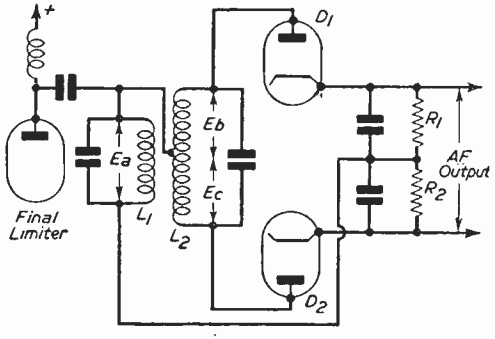


Fig. 1.—F.M. discriminator schematic.

F.M. Discriminator

Fig. 1 shows a conventional F.M. discriminator stage. It will be seen to consist of two diode rectifiers connected so that the D.C. potentials across their respective load resistors are subtractive. These voltages (across R1 and R2) are proportional to the A.C. voltages applied to the diodes. L1 and L2 form an interstage coupling transformer tuned to the carrier frequency. The R.F. voltage Ea across the primary of this transformer induces a voltage (Eb + Ec) across the secondary which is fed to the diodes as shown. Hence the effective R.F. voltage on the anode of diode D1 is (Ea + Eb). The addition is vectorial as shown in Fig. 2. Fig. 2a shows the case when the frequency of the voltage applied from the limiter is equal to the resonant frequency of the discriminator tuned circuit. The voltages Eb and Ec induced in the two halves of the discriminator coil are each 90 deg. out of phase with the voltage in the primary and hence the resultant voltages E1 and E2 fed to the diodes are also equal. The rectified voltages will therefore be equal and since the output connections of the diodes are opposed no voltage will appear at the audio output terminals.

When the R.F. input frequency increases during a half cycle of modulation the phase relationship between Ea, Eb and Ec will change to some condition such as that shown in Fig. 2b, from which it will be seen that E2, the vector sum of the voltages applied to diode D2, exceeds E1, the vector sum of the voltages applied to diode D1, and hence a higher rectified voltage will be developed across R2 than across R1. This difference in voltage will appear as a negative voltage in the discriminator output. Fig. 2c shows the condition when the input frequency decreases to less than the resonant frequency of the discriminator tuned circuit. This condition produces a positive voltage in the discriminator output. The important points to remember are that the output voltage is proportional to the *difference* in the voltages applied to the two diodes, and this difference is in its turn proportional to the frequency swing of the input signal.

A serious disadvantage of this type of F.M. discriminator is that it also responds to A.M. Considering Fig. 2c again, A.M. present in the input signal would result in the voltage applied to the discriminator being increased or decreased in amplitude. An increase in voltage, for instance, would increase all the vectors in the diagram proportionately. The effect would be as though the whole diagram were enlarged photographically. Thus while the phase relationships would remain the same, E1 would increase more than E2. Thus A.M. signals would be rectified and passed on to the audio amplifier, so causing distortion in the output. In order to eliminate the effect of A.M., discriminators of this type are usually preceded by limiter stages which remove most of the A.M. It will be remarked, however, that inherently the F.M. discriminator described is not capable of rejecting A.M. signals, except twice per cycle at the instants when the input frequency is exactly equal to the resonant frequency of the discriminator tuned circuit.

It will be observed that although the effect of an increase in signal amplitude was to increase the difference in the voltages E1 and E2 the ratio of E1 to E2 remained constant. Hence it is apparent

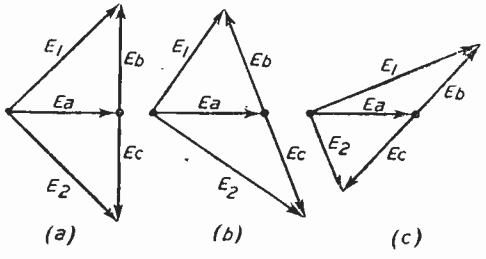


Fig. 2.—Vector diagram.

that an F.M. detector which would respond only to changes in this ratio would be unaffected by A.M. Such an F.M. detector, known as a ratio detector, will now be described.

Ratio Detector

A simplified schematic of the circuit is given in Fig. 3. It will be seen that the input circuit is the same as for the discriminator. Diode D1, diode D2 and R3 form a series circuit fed by the A.C. voltage across L2. Since the diodes are in series they will be conductive during the same half cycle, and the rectified current through R3 will cause a negative

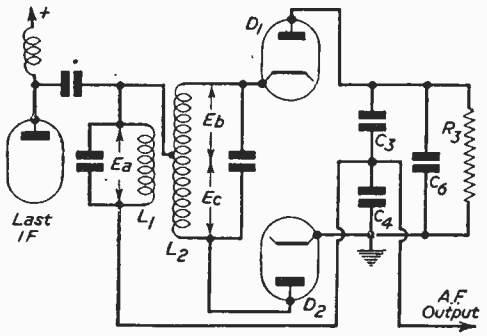


Fig. 3.—Ratio detector schematic.

potential to appear at the anode of diode D1. The time constant of R3, C6 is usually of the order of 0.2 second so that this negative potential will remain constant even at the lowest audio frequencies to be reproduced. C3 will be charged by the rectified current through diode D1 to a voltage represented by E1, Fig. 2c, and C4 to a voltage represented by E2. These voltages are additive, since the diodes are in series, and are equal in sum to the constant potential across R3. The ratio of these voltages will vary at A.F., and the potential of the junction of C3 and C4 will vary with the modulation voltage when an F.M. signal is applied to the input of the detector. Hence the rectified audio signal is extracted at this point and fed to the A.F. amplifier. Amplitude modulation is rejected by such a detector by virtue of the large time constant of R3 and C6. The constant voltage across C6 acts as a stabilizing voltage.

The time constant of R3, C6 is not too high however to prevent mean changes in carrier level from appearing as changes in voltage across R3. Thus the voltage across R3 is proportional to the mean value of the received signal strength and may be used as an A.V.C. voltage.

Since the ratio detector is not affected by A.M. signals it is unnecessary to use limiter stages and consequently the number of tubes in the receiver for the same output can be reduced. Also since it is

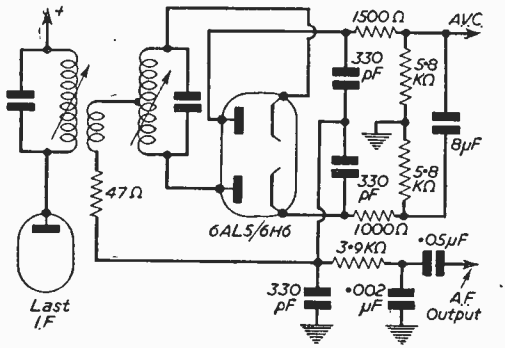


Fig. 4.—Typical ratio detector circuit.

not necessary to work at a minimum carrier level in order to saturate the limiter stages for noise attenuation it is possible to detect much weaker carriers.

Practical Arrangement

A practical ratio detector circuit as used in a present-day F.M. receiver is shown in Fig. 4. It will be noticed that the two diodes have been combined in a single valve, which may be of the type 6AL5 or 6H6.

In order to improve the overall sensitivity a form of impedance matching is used between the high impedance of the driver pentode and the relatively low impedance reflected by the diodes.

Jet Aircraft Radio at the Festival

A REPLICA of the cockpit of the "Comet"—the world's first jet airliner—showing its complete Marconi wireless communication and navigational aid equipment, will be exhibited in the Transport Pavilion, at the South Bank Exhibition of the Festival of Britain.

This Pavilion houses not only exhibits of great historical value, showing the development of transport and communications, but also some of the most up-to-date equipment.

The "Comet" equipment consists of two high-power high-frequency transmitters, two high- and medium-frequency high-discrimination receivers, and two automatic direction finders. Voltage regulators for this installation are also of Marconi design and manufacture.

The "Comet" is also fitted with Marconi "suppressed" aerials; aerials which do not protrude above the skin of the aircraft but which are built into the structure as an integral part of aerodynamic design.

One of the greatest aeronautical advances of today is embodied in this new technique which also embraces the loop aerials associated with the automatic direction finder.

All that is necessary to navigate accurately with the automatic direction finder is for one member of a crew to tune the receiver to any transmitting station. Bearings of that station can then be read off, continuously and instantaneously, by members of the crew. Repeater bearing indicators and receiver control boxes can be installed and repeated at any crew position.

Visitors to the Festival will thus be able to see a vital part of one of the world's greatest aircraft.

Modifying the Telesonic Receiver

A Special Army Unit which Forms the Basis of a Useful Amplifier

By A. COMFORT

THE telesonic receivers which have been available at surplus stores during the last year are small, versatile battery amplifiers, containing four Hivac midget triodes. They were intended as wireless telephones picking up radiated audio directly through the coil wound on the case, or through a plug-in pick-up coil. Similar instruments are used by television floor-managers to maintain contact with the producer unhampered by trailing leads.

Several amateurs have successfully modified these amplifiers as deaf-aids, midget receivers or gramophone amplifiers—a recent press photograph showed one serving as a bicycle radio, although cycling in headphones is not an advisable practice. The output valve (Hivac XP) has a recommended anode voltage of 45, but will operate successfully at about 70 volts, and will drive a sizeable 3-ohm speaker, the transformer primary being plugged into the phone jack in place of the high-resistance headset.

Circuit

The basic circuit of the unmodified amplifier is shown in Fig. 1. The signal is conveyed to the grid of V1 through a transformer. The gain control operates between the anode of this stage and the grid of the next. V1 is mounted in a special non-microphonic valveholder and screened from the remainder of the receiver by a metal partition—the chassis is connected to L.T. positive.

Modifications

Several types of modification are clearly possible. If the set is to be used as a personal receiver, one can either use V1 as the detector, followed by three L.F. stages, or as an R.F. amplifier drawing its signal from a suitable frame aerial, with V2 as detector. The first course has the advantage that it involves very little meddling with the existing circuit, which is very compact and cannot be reached without dismantling the chassis. Some experimenters may prefer to keep the amplifier intact, so that it can be used for a variety of purposes. If this is to be done, the addition of a single tuned circuit of high Q on the grid side of V1 is easy, and involves no irrevocable change in the rest of the instrument. There is room at the side of the L.T. battery for tuning or tuning and reaction condensers of the bakelite dielectric type. To do this, remove the pick-up wire and the front of the case, take the chassis out by unscrewing the knurled knob, remove the fixing-screws and unsolder the transformer. This makes room for the tuning coil. A lead is attached to the anode pin of the socket of V1 to provide feedback, the grid lead is located, and the gridleak and condenser mounted on the panel behind the valve. The anode is decoupled for R.F. to ground through 20 KΩ and about 100 pF. If it is desired to increase the coupling condenser Cx, extra capacity can conveniently be added between the anode end of the reaction coil and the tagboard separating V1 and V2, where the leads to the gain control are brought out under a locking strip of paxolin. The gain control itself and the on-off switch incorporated in it are left untouched, but the jack marked "coil pickup" is replaced by an aerial socket, after disconnecting the lead to the feed-through point which originally carried one end of the case-wound coil. The modified circuit is shown in Fig. 2. A Denco green series coil has a "Q" high enough to provide clean separation of Home, Light and European services in the London area. A preset condenser for reaction can be used instead of a larger variable if preferred.

Tone Control

If midget H.T. batteries are used, a midget speaker can be accommodated in the battery compartment, though a 5in. or larger speaker will give both better tone and greater volume—with smaller speakers, a condenser of about .02 μF across the primary of the output transformer serves as a top cut should the tone be shrill.

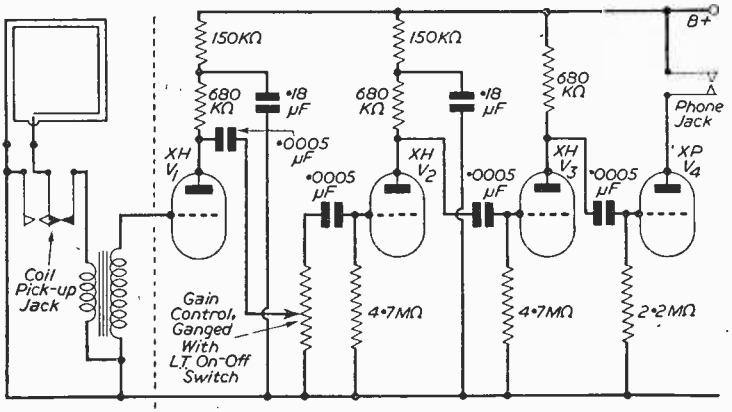


Fig. 1.—Circuit of the Telesonic receiver before modification.

Portable

Modified in this way, and with a 4ft. rod aerial, the instrument makes a receiver which can be carried about while in use, although, with the

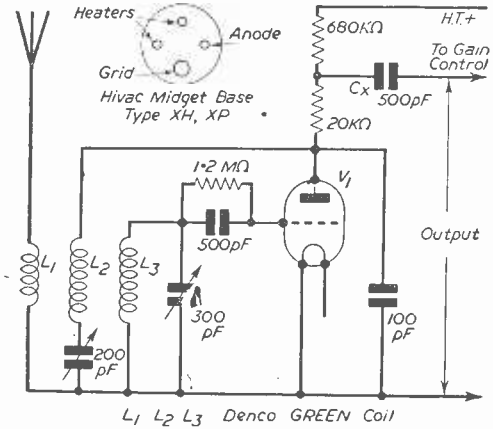


Fig. 2.—Detail's of the first stage.

coupling shown, tuning and volume will vary with aerial constants and body capacity. An efficient earth greatly improves performance. Other amateurs may care to try other coils outside the broadcast band. If a really light and compact receiver is wanted, it is better to strip the existing instrument and rebuild it with separate valveholders on a

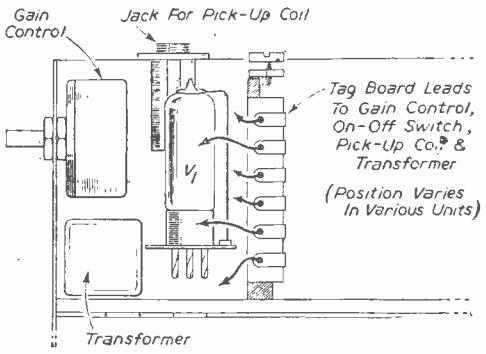


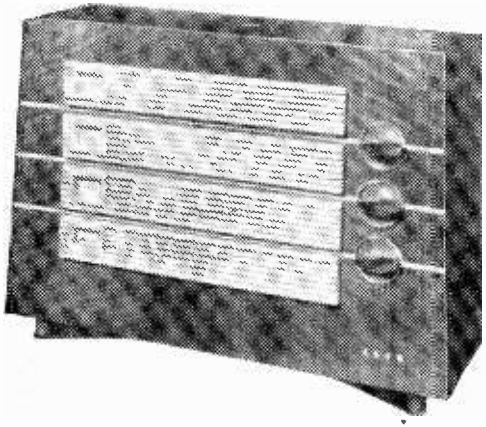
Fig. 3.—Layout—1st stage of intact unit.

small aluminium chassis, housed in a wooden case or within the cabinet of a small extension speaker, converting it into an independent receiver. At prices in the neighbourhood of 35s., the unit provides a good experimenter's bargain.

TRADE NOTES

Ekco "Festival" Model Receiver

A NEW Ekco receiver which has been accepted in its prototype form as an exhibit in the Festival of Britain is shown below. This is a pre-tuned four-station receiver designed for quality reproduction, but with an extension of the wave-range coverage giving a better choice of stations in certain parts of the country. The receiver has a built-in aerial and is provided with pick-up sockets. Designed for A.C. mains operation only, the price is £17 5s. 2d., plus purchase tax.



The "Festival" 4-station pre-tuned Ekco receiver.

H.M.V. Record-player

CERTAIN recent H.M.V. receivers are provided with sockets for use with a record-player, and a special unit has been produced which is highly suitable for the purpose. This is a fully automatic

H.M.V. Record-player.

unit handling up to eight 10in. or 12in. records (not mixed), and is fitted with the latest H.M.V. light-weight pick-up. This has a unique mounting and gives a wide frequency response with low needle-point pressure, thus giving minimum record and needle wear. There is a Normal/Extended range switch to ensure best possible results from all types of records, and a switch enables the automatic mechanism to be cut out for manual operation of single records. Price £16 2s. 4d., plus purchase tax.

For the Transmitter

A π-Section Matching Network

An Arrangement for Feeding R.F. Power from Low- or Medium-power Transmitter to a Radiating Aerial

By H. SASSON

THE question of correct coupling of a final amplifier to an aerial system is one that often gives the newcomer some trouble.

The construction and adjustment of a two-stage transmitter is a relatively straightforward matter, but that of a satisfactory impedance matching aerial coupler is not. The whole subject of aerials and transmission lines bewilders and mystifies the newcomer to amateur radio far more than it need do—at least until he has grasped the essential theory of impedance matching and subjects allied to R.F. transmission.

The circuit it is proposed to discuss is one that permits efficient matching to a variety of aerial systems fed with a single-line transmission line. It also acts as the resonant output tank circuit.

Whereas the best aerial available should naturally be used, the output circuit provides a means of feeding power into a random length of wire whose overall length is not necessarily, though preferably should be, a multiple of a half-wavelength at the transmitting frequency.

It is not proposed to enter into a mathematical treatment of the behaviour of filters in general and π-section matching networks in particular, as that would be beyond the scope of this article, which is intended to be primarily of a practical nature.

With a circuit of this nature it is advisable to incorporate the unit on the chassis of the transmitter proper in the interests of short "hot" anode leads, and the two condenser controls can well be brought out to the front panel.

The changing of coils can be achieved by using conventional plug-in coils, or else, as the more ambitious would prefer, a coil switching arrangement.

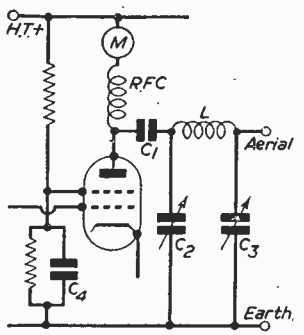
Coil inductance values are given for the 80, 40 and 20 meter amateur bands; if 1½in. diameter coil forms are not available, ones of a different diameter within reason may be used provided a correction is made to the number of turns to allow for the change in that dimension. An optimum coil has its length equal to its diameter, so it is best to avoid making long coils of small diameter, and, to a lesser degree, coils of large diameter consisting of very few turns.

Operation and Procedure for Adjusting the Matching Network

The transmitter should first be tuned up with no aerial connected to the output terminal. The anode current meter or dial lamp, whichever is fitted, should indicate a relatively high current consumption by the final amplifier. C_3 is set to about half of maximum capacity, and C_2 varied until the current meter or dial lamp registers a dip in current consumption. If no dip is observed, another setting of C_3 should be tried and the procedure repeated. When the dip is found, the aerial may be connected up and the tuning sequence gone through once again, but more carefully, as the dip will not be as pronounced as before; when the final amplifier is correctly loaded it should be only just noticeable. The point at which the loading is optimum may be found by trying several settings of C_3 and rotating C_2 through its range for each one. When nearing the critical point, C_3 should be adjusted in smaller steps till that point is reached.

In the case of certain aerials it may be necessary to short-circuit a few turns on L in order to obtain maximum loading, especially on 3.5 Mc/s with the 80 meter coil plugged in.

The final amplifier can be a 6L6, 6V6 or a similar receiving output pentode or beam tetrode if a lower power transmitting type valve is not available or desirable.



M = 100mA. meter or dial lamp.
C_1 = 0·001μF mica.
C_2 C_3 = 250 pF variable
C_4 = 0·01 μF paper.
L = See table.

Waveband	Wire Gauge	Turns	Coil Diam.	Coil Length
80	20 d.c.c.	32	1½"	close wound
40	20 enam.	20	1½"	1½"
20	18 enam.	10	1½"	1"

Circuit of the Aerial Matching Unit.

Programme Pointers

This Month MAURICE REEVE Deals with Some More Recent Programmes

THE two series of gramophone record programmes, "Desert Island Discs" (Weds.), and the more selective collections of famous people—usually on Tuesdays—make very agreeable interludes. The former programme is invariably presented with gaiety and wit, without any loss of brains or good taste. Whether the selections are high or low brow, the selector, and his genial and adaptable interviewer, Roy Plomley, can be counted on to tickle our palates and whet our appetites in a thoroughly well-worth half-hour. The other programme, too, is excellent, and subjects interviewed, such as Sir Thomas Beecham, are hosts in themselves. It runs to three quarters of an hour.

Drama

The dramatic presentations, recently, have been, in some cases, of outstanding interest. In order of merit, I would rank "Mrs. Dane's Defence" first, followed at close intervals by the "End of Things," "The Secret Agent," "My Dear Isabella," "David Garrick," and "Wagstaff's England."

"Mrs. Dane's Defence" was written by Henry Arthur Jones fifty years or more ago, and may be said to be a powerful tract on the then live subject of society's unreasonable cruelty towards women who had merely proved themselves daughters of Eve. Poor Mrs. Dane, after what we would call an affair or two of the type far too mild for most Hollywood productions, falls genuinely in love with a "good" young man. The suspicions of the lad's father, an eminent lawyer, are aroused by certain breaths of scandalmongering air which taint the cloisteral atmosphere of the old widower's home. He at once rises to the "defence of society"—his defence, in other words—and in the process finds Mrs. Dane guilty and completely "breaks her on the wheel." Naturally, the marriage does not take place. The significant point seemed to be the love of obvious regret in the old boy's voice when, completely triumphant, he realised what he had achieved. A moving play by a minor master. Excellent performances by Kynaston Reeves and Fay Compton.

"The End of Things" (La Fin des Temps), a radio drama by Gabriel Marcel, and first broadcast from France in 1950, was described in the *Radio Times* caption as "a play of a woman who, late in life, saw a vision of a world in torment and thought to come to its help." The world in question was largely her husband's, which she did much to destroy. With characteristic French logic and penetration, we see it fall piece by piece, each piece being considered more permanent than the last. The wife's love, the daughter's divorce, the occupation of France, etc. Catherine Lacey, Austin Trevor and the others contributed handsomely.

"The Secret Agent"

Joseph Conrad was one of our greatest novelists, and probably the greatest writer on the sea we or anyone ever produced. He could also go far afield for a plot and write a masterpiece. Consequently, Felix Felton's radio adaptation of "The Secret Agent" was looked forward to with considerable anticipation. It should not have disappointed many. The extraordinary and pathetic story of the little East-end shopkeeper's futile spy activities, and of his wife's hatred when her idiot brother gets blown up in Greenwich Park, has more than a resemblance to what is happening to-day, forty years after, in many parts of the world. Will it ever come to Greenwich?

Frank Hauser's production kept the story moving along well, and Joan Matheson, Francis de Wolff, Ray Jackson, Hamilton Dyce, Stephen Jack, Maurice Denham, Gladys Spencer, etc., played well.

"My dear Isabella," by Norman Ginsbury and Maurice Moiseiwitsch, was an interesting fantasy on the less pleasant effects of heredity. Vivien Travers is a descendant of Byron and, from her general behaviour and irresponsibility, is not unnaturally believed to have inherited a large quantity of what we may call "Byronism." In the end it turned out that she was not related after all, and that the Byronic complex was something else. The story gave rise to many amusing and interesting scenes and dialogue. But one, where Vivien, an aspiring pianist, plays Balakirew's fabulous "Islamey" to an American concert agent and gets booked for an American tour in consequence, was absurd and fatuous in the extreme. Joan Hart, who plays a large variety of parts, Gladys Young, Desmond Carrington, Geoffrey Keen, etc., contributed well.

"The Romance of David Garrick"

The article on David Garrick in my encyclopædia contains no mention of the very romantic episode which formed the plot of Constance Cox's and Donald Wolfit's "The Romance of David Garrick," adapted for radio by Cynthia Pughe. But the story of how the daughter of a very rich though self-made man fell in love and finally married "an actor," together with all the plots and stratagems for its prevention, made effective radio. Rosalind Iden and Mr. Wolfit starred and gave the play much distinction.

The last play I listened in to last month was Robert Greenwood's "Wagstaff's England," an unpretentious though pleasing play which may most briefly be described as setting out the "mystique" or the "quelque chose je ne sais pas" known as the English Way of Life. It starred the ubiquitous, irrepressible and much liked Wilfred Pickles. When I say that Mr. Pickles starts off in a play with the enormous handicap of being fettered to "Have a Go," so that the minute he opens his mouth we are taken right away from the job in hand, I do not mean that he is not very effective. Stuart Hibberd, Stewart McPherson or Arthur Streeter would suffer similar disability.

Symphony

Purcell's masterpiece, "King Arthur," made a welcome change at a B.B.C. Symphony Concert.

Our "Tchaikovsky-soaked" public only half-filled the Albert Hall. Few people can play the Emperor better than Moiseiwitsch, who, I see, was 61 the other day.

Argument

I thought that the interesting "Argument" series went a little too far when Randolph Churchill and Tom Driberg, M.P., "discussed" the American Admiral question. I did feel that such an issue should have been kept out of a public debate, especially as one of the contestants got so worked up over it. After all, it is all only entertainment, and we are entitled to burlesque or slang our own domestic issues as we see fit. But international personalities should be very carefully handled.

News from the Clubs

THE MIDLAND AMATEUR RADIO SOCIETY

Publicity Representative: B. H. T. Oliver (G3DJQ), Cleeve Lodge, Nether Whitacre, nr. Coleshill, Warwickshire.

AT the last regular meeting, a most interesting lecture with lantern slides was given by Dr. John Simmonds, of the Physical Research Dept. of Birmingham University, on the new synchrotron in the course of construction at the University. The machine and the principles on which it operates were explained in a manner that could be assimilated by even the less advanced members.

The Society meets at the Imperial Hotel on the third Tuesday each month at 6.45 p.m., and prospective members are always cordially welcomed.

BRIGHTON AND DISTRICT RADIO CLUB

Hon. Sec.: R. T. Parsons, 14, Carlyle Avenue, Brighton, 7.

PREPARATIONS for NFD are well under way. The club is hoping to form a section for those members interested in TV. It is intended that the section will deal with constructional and theoretical side of TV receivers.

Programme highlights for future events are further Mullard valve film strip lectures. Later there will be a general discussion on "Link" topics and on the proposed formation of the TV section.

SHEFFORD AND DISTRICT RADIO SOCIETY

3089519 S.A.C., R. Dulton Raby, Radar Link 'T' Division, R.E.U., R.A.F., Henlow, Beds.

RECENT activity at Shefford has included a demonstration by Mr. I. B. Howard (G2DUS) of his 2-metre rig. Mr. C. Pettifer (G3DPQ) gave a talk on methods of aerial coupling. A talk on oscilloscopes was given by Mr. P. Robinson. The subject of radar, including centimetre technique, is being covered in a series of lectures by Mr. R. D. Raby. Two visits have also been made to the Luton and District Radio Society which laid on a very interesting programme.

The club transmitter is now active on top band, and it is possible that a rig for 2 metres and 70 cms. may be in action soon. Mr. R. D. Raby, working with two friends, Mr. J. Coombes and Mr. G. B. Rogers, is hard at work on the development of gear for 13 cms. So far, results have been promising. Further reports on this rig will be forthcoming.

SOUTHEND AND DISTRICT RADIO SOCIETY

THERE has been an encouraging increase in attendance and interest in meetings of the Society lately. There is still a good programme ahead. Mr. Youngmark of Goodmans is definitely fixed for May 11th. Mr. Walters of Belling and Lee probably for May 25th, and Mr. Garnham of Mullards early in June. One of the Festival efforts, the amplification of "A Midsummer Night's Dream," has faded right out. The committee, however, are busy arranging other efforts, one of which may be the erection and manning of a station in Chalkwell Park in conjunction with other Societies.

WATFORD AND DISTRICT RADIO AND TELEVISION SOCIETY

Hon. Sec.: R. W. Bailey (G2QB), 32, Cassiobury Drive, Watford, Herts.

RECENT talks and demonstrations included a continuation of G2HAR's course in radio fundamentals, a demonstration of television gear by G8CK, G6GR, and G2YD. G3GIY gave a most interesting talk on frequency measurement. The usual junk sales have been held, and during May a transmitter demonstration, and exhibition of home-constructed gear will be held. Preparations for the Club's participation in the R.S.G.B. National Field Day are well in hand, and an interesting programme has been arranged for the summer months.

The club meets at 7.30 p.m. in the Cookery Nook Café, The Parade, Watford, on the first and third Tuesdays in each month.

STOKE-ON-TRENT RADIO SOCIETY

Hon. Sec.: K. H. Parkes (G3EHM), 159, Belgrave Road, Longton, Stoke-on-Trent.

THE Society held its annual general meeting on March 29th. New officers were elected. Indications show that the club is increasing in membership and the financial aspect is good.

The Society's transmitter, call sign G3GBU is active on the 3.5 Mc/s. band. Further demonstrations of sound, transmitting and television equipment will be given and all local enthusiasts are cordially invited.

COVENTRY AMATEUR RADIO SOCIETY.

Hon. Sec.: K. G. Lines, 142, Shorncliffe Road, Coventry.

RECENTLY members were privileged to hear a talk entitled "Mathematics—why," by T. R. Theakston, B.Sc. The lecturer covered the origin of units, proved impossibilities and even added a few conjuring tricks in the course of his most engaging talk. The thanks of members are due to Mr. Theakston for opening new vistas on a subject hitherto considered a "bind" by most of them.

The Society is to operate a portable station during R.S.G.B. Field Day, and the construction of the "rig" is to be undertaken by those members studying for their tickets. Operators will, of course, be provided by licensed members.

Forthcoming meetings to be held at the B.T.H. Social Centre, Holyhead Road, at 7.30 p.m. are as follows:

May 7th.—Field Day Discussion.
May 21st.—Members Open Night.

BIRMINGHAM AND DISTRICT SHORT-WAVE SOCIETY

Hon. Sec.: W. V. Shepard, 174, Gristhorpe Road, Selly Oak, Birmingham, 29.

DETAILS of meetings of this Society are as follows:

(1) On the second Monday of each month at the "Colmore Inn," Church Street (off Colmore Row), Birmingham, at 7.45 p.m.

(2) A series of talks on building a Superhet RX for the amateur bands has been arranged. Part I has been given; Part II will be given on June 11th.

(3) The May meeting will take the form of a Mock Auction in order to raise funds for the Society.

(4) Field Day, Sunday, June 17th, 1951. Location: Manor Park Recreation Ground, Stechford, Birmingham, 9 a.m. to 6 p.m. It is hoped to be on top band and 80 metres using the calls G2BON/P or G6KW/P.

THE DORKING AND DISTRICT RADIO SOCIETY

Secretary: J. Greenwell (G3AEZ), 7, Sondes Place Drive, Dorking.

VISITORS are invited to attend any of the Society's meetings which are held at headquarters, 5, London Road, Dorking, every Tuesday evening from 7.30 to 10.30 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

THE following meetings have been arranged:

London Section: Thursday, May 24th, School of Hygiene and Tropical Medicine, at 6.30 p.m.: "The Resistance Wire Strain Gauge in the Measurement of Physical Quantities" by J. L. Thompson, M.Brit.I.R.E.

Birmingham Section: Wednesday, May 24th, Joint Meeting of the West and South Midlands Sections. Details will be circulated to members later.

Liverpool (Merseyside Section): Friday, May 4th, Electricity Service Centre, Whitechapel, at 7 p.m.: Annual General Meeting, followed by a technical film, "Atomic Physics."

Newcastle-on-Tyne (N.E. Section): Wednesday, May 9th, Neville Hall, Institute of Mining and Mechanical Engineers, Westgate Road, at 6 p.m. Annual General Meeting, followed by a technical film.

SPEAKERS

5in. Goodmans P.M., 2/3 ohms...	13/6 ea.
6½in. Truvox P.M., 2/3 ohms ...	13/9 ea.
8in. Plessey P.M. Lightweight, 2/3 ohms	13/6 ea.
Invicta Speaker Cabinets with carrying handle. Size 17in. x 17in. x 6in. to take a 10in. Speaker Unit. Sprayed Brown	13/6 ea.

We can quote for a Speaker suitable for above on request.

METAL RECTIFIERS

L.T., 2 volt ½ amp.	5/- ea.
L.T., 12 volt ½ amp.	1/- ea.
H.T., 300 volt 80 mA.	4/9 ea.
H.T., 280 volt 60 mA.	4/6 ea.

VOLUME-CONTROLS

½, 1 and 1 and 2 meg. Morganite with switch	4/3 ea.
2k-ohms, 3k-ohms, 5k-ohms, 25k-ohms, less switch	1/6 ea.

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.0001, .0002, .0003, .0005, .001, .004, .003, .00027	4/- doz.
Buzzers for battery working, suitable for doors, etc.	1/6 ea.
Bell Push with warning light, numerous uses, ideal for offices	1/6 ea.

VALVES, GUARANTEED NEW AND BOXED

VU120, 4/- ; 7193, 2/- ; 215SG, 4/- ; VU111, 5/- ; SP41, 5/- ; SP61, 3/6 ; 2X2, 4/- ; CV6, 1/9 ; VR54, 5/- ; MS/PEN, 7/6 ; 7Q7, 7/- ; PEN220A, 4/- ; EF8, 7/6 ; EF36, 7/- ; EK32, 7/6 ; 6C6, 8/6 ; DLS10, 6/- ; VS68, 6/- ; E1148, 2/- ; VT61A, 2/- ; CV73, 5/- ; 2050, 6/9 ; 37, 4/9 ; 6G6G, 7/9.

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2 VOLT BATTERY SUPER-HET. 6-9 mcs. Chassis taken from the No. 18 Tx/Rx. Tested and ready for use. **30/-.**

New IN34 CRYSTAL DIODES, 5/6.

METERS. M/c 0-300v. 2in., 10/-. 0-40v. 7/6. 0-500 micro amp., 11/-.

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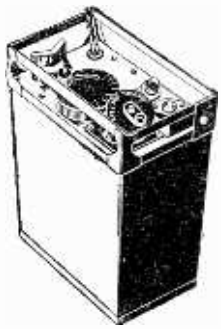

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The Editor does not necessarily agree with the opinions expressed by his correspondents. All letters must be accompanied by the name and address of the sender (not necessarily for publication).

Modern Superhet Tuning Unit

SIR,—I have made a careful check of the description of the Modern Superhet Tuning unit, and find that R26 is the treble control and R28 is the bass control. These two numbers have been transposed in the text. There are two slight corrections to the circuit diagram which I did not see when the proofs were in my hands.

The two corrections are:

1. The junction of C41 and C42 is shown looped over and isolated from the moving arm of R28. In fact these points should be joined together so that the moving arms of both tone control potentiometers connect to the output.

2. The oscillator section of the tuning condenser has been omitted. This is connected between point 4 of the coil pack and earth.

The reason for omitting a bypass condenser from the cathode circuit of V5 is explained on page 169 (April). This gives a measure of n.f.b. and improves the linearity of amplification. If, in any application, more gain is required than was the case in the circumstances for which the design was originally intended, a condenser can be fitted and there will be only slight deterioration in quality. It is always preferable, however, to have no more audio gain than absolutely necessary before the tone control stages.—R. HINDLE (Wallasey).

Type 18 I.F. Transformers

SIR,—During the modification of type 18 Rx. in the February issue of PRACTICAL WIRELESS I unfortunately unsoldered both I.F. transformer leads in error.

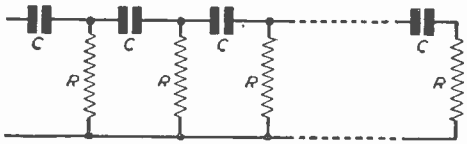
I now find there are no distinguishing marks for anode H.T. grid and earth, and I am in doubt regarding re-assembly.

I would appreciate, very much, any help readers may be able to give in this direction or how I may be able to test for right connections.—B. TAYLOR (Brierley Hill).

Bridges and Networks

SIR,—In his article on "Bridges and Networks," in the March issue, A. M. St. Clair says that the frequency at which a three section R.C. ladder will give 180 deg. phase shift can be arrived at without difficult mathematics by assuming 60 deg. shift per section. This assumption of 60 deg. per section is correct only if the section works into an infinite impedance or if the sections are made unequal. The first case is impossible unless each section is separated by a cathode follower and the second involves laborious calculation to obtain the various values of C and R for the different sections.

The normal circuit used has all the sections of the network similar. Thus all the Cs and all the Rs are equal. If the frequency of oscillation (180 deg. shift) is calculated according to Mr. St. Clair's method the frequency if given by $f_o = \frac{1}{2\pi\sqrt{3}RC}$



Circuit covering Mr. Oats' explanation.

However, if a rigorous solution of the network is made the frequency is given by $f_o = \frac{1}{2\pi\sqrt{6}RC}$

Thus any calculation based on Mr. St. Clair's data will result in frequencies $\sqrt{2}$ times those required.

It may be of interest to readers to note that if the circuit is changed so that we have shunt C and series R the frequency is given by $f_o = \frac{\sqrt{6}}{2\pi RC}$

and the attenuation in a three section filter at f_o is always 29 dB. By using four sections the attenuation can be reduced to 25 dB but then the frequencies are given by

(a) Shunt R series C $f_o = \frac{\sqrt{7}}{2\pi\sqrt{10}RC}$

(b) Shunt C series R $f_o = \frac{\sqrt{10}}{2\pi\sqrt{7}RC}$

Any of these formulæ can be obtained by solving the circuits involved by the use of complex algebra. I would also like to mention that these formulæ and attenuation figures are borne out in practice. —P. H. OATS (Rayleigh)

V.C.R.138

SIR,—I wonder if other readers would be interested in a fact which came to light when I used a V.C.R.138 in a home-built oscilloscope.

I had trouble with the focusing; the spot would

not focus unless the brilliance control was turned right down.

The fault lay with the tube connections which, according to the information I had, should have been as follows:

The V.C.R.138 is supposed to be the equivalent of Mullard ECR35, the base connections being, spigot uppermost and going clockwise round the base,

1,	2,	3,	4,	5,	6,	7,	8,	9,	10,	11,	12.
G	K	h	h	—	a^2	—	Y^2	X^2	a^1a^3	X^1	Y^1

I found however that a^1 appears to be connected to contact No. 5 and not No. 10, for when contacts 5 and 10 were strapped together the fault disappeared and the focusing became perfect at any brilliance setting.—C. J. LEAL (Welling).

Training Service Engineers

SIR,—An amusing aspect of Mr. G. H. Gunter's tale of woe—related at length in "Open to Discussion" (PRACTICAL WIRELESS, May, 1951)—is that whilst he claims long-standing knowledge of the radio art, and also very definite knowledge of the cause of the trouble with his radiogram, he paid out to the tune of £10 for repairs. Incidentally, I wonder what the comments of the various dealers concerned would be if they were obtainable?

I'm sorry a sinister motive has been ascribed to my method of marking invoices (where applicable) that "Cost has been increased due to inexpert attention." This "device," presumed by your correspondent to be designed to discourage the employment of free-lance servicemen, is merely honest statement of fact. It must surely be obvious that where a serviceman has to straighten out the efforts of a dabbler, as well as repair a set, more time is occupied, therefore the labour charge is increased.

Mr. Gunter also states, "the radio service business is a racket." It certainly is when practised by the "dabbler," who probably has a full-time job in some other trade and does not this bring us back to your "Editorial" of September-October, 1950, which inspired this correspondence?—A. HARRISON (Regd. R.T.R.A.) (West Hartlepool).

Modifications to RX18

SIR,—May I take this opportunity to thank Mr. Key for the circuit diagram and the two articles on the modifications to the WS18 receiver published in the last two issues of this magazine.

I feel that such articles are of great help to amateurs and especially to those who took to radio rather "late," and I hope that others, too, would welcome such articles and in turn express, through the columns of this magazine, their views and results of their experiments on similar lines.

In this connection I wish to state that I have been working one of those excellent little 18 MK. III sets for the last 15 months and am still working it with good results. The set is being worked off a battery-eliminator giving about 140v. H.T. and using an outdoor aerial of the inverted L type. Though the volume is quite sufficient for 'phone reception, using low impedance 'phones, addition of grid-bias has no appreciable effects.

From the descriptions given in the article it appears that the WS18 and the 18 MK. III are similar in all respects. Therefore, I shall be thankful if any reader could let me know through the columns of one of the succeeding issues of this magazine as to whether the recommended modifications would apply to the 18 MK. III as well.—S. PATHMANATHAN (Ceylon).

A Puzzling Fault

SIR,—I occasionally see readers' queries in PRACTICAL WIRELESS about faults in circuits, and I am sending this servicing puzzle, as some of your readers might like to try their hand at solving it, especially as it seemed to defy Ohm's Law!

Receiver: A.C./D.C. superhet, 4 valves (3+ rect.).

Trouble: The set went "dead" one day after warming up and starting to play.

Test: All valves heated normally, but no H.T. H.T. line, filters, etc., all good. Rectifier valve showed connecting strap to cathode inside envelope parted. New rectifier fitted, performance normal. But occasionally, sometimes on heating up, sometimes after playing for long periods, programme partially or completely disappeared, and greatly increased circuit passed through heater chain with consequent gross overheating of all valves. In the brief interval before switching off, an A.C. voltmeter across the heater series voltage dropper showed noticeable *decrease* in current. Voltage dropper tested and found completely satisfactory. No wiring faults, shorts between wires, or from wires to chassis.

And the cause of the trouble?

There was an intermittent cathode-heater short in the new rectifier, thus considerable rectified current, limited only by H.T. series resistor, was diverted from the H.T. line and passed to chassis via the heater chain, causing the overheating, with a decreased demand via the dropper resistor. The H.T. resistor was subsequently found to be hot, though not damaged, and the fuse held out. The original rectifier must have developed the same fault, and the increased heat fused the cathode strap, but, of course, then with an isolated cathode no test could be made. Simple and common maybe, but probably puzzling!—S. A. R. GUEST (Isles of Scilly).

P.A. for the Amateur

SIR,—With reference to the article "P.A. for the Amateur," in the May, 1951, issue, I feel that the statement, "if D.C. supply is used the amplifier will not function unless polarity is correct, *automatically rendering chassis safe*," is rather dangerous.

In the likely event of a three-wire feeder system being in use the domestic mains may have either the negative or positive earthed, and in the latter case the amplifier chassis will be negative to earth by the supply voltage and definitely "live."

It should, therefore, be made entirely inaccessible to avoid the possibility of dangerous shocks.—S. M. SUGDEN (Lancs.).

Impressions on the Wax

Review of the Latest Gramophone Records

FROM the remarkable opera "Salome," written by Richard Strauss to a libretto after the poem by Oscar Wilde, Sir Thomas Beecham, conducting the Royal Philharmonic Orchestra, has recorded the orchestral climax the "Dance of the Seven Veils" on *H.M.V. DB*21149. More particularly than in any other Strauss opera, the orchestra is the principal character throughout, given the chief responsibility for presenting the whole drama in its gripping intensity.

For the first time in about twenty years the distinguished American conductor Leopold Stokowski is visiting Great Britain to undertake a tour with the Royal Philharmonic Orchestra. Sir Thomas Beecham recently paid him the compliment of saying that Stokowski excels at producing the finest orchestral sound imaginable. The latest additions to the Stokowski repertoire are "Les Sylphides," by Chopin, on *H.M.V. DB*21255, in which he conducts his own symphony orchestra, and "Siegfried," Act II, by Wagner, on *H.M.V. DB*21238, in which he conducts the Hollywood Bowl Symphony Orchestra.

Even in these days of technical achievements in the world of recording, "Façade Suites 1 and 2," by Walton, played by the Philharmonia Orchestra, conducted by Constant Lambert, stands out as a fine piece of work. The drums, triangle, castanets, indeed any and every instrument, even playing softly, is heard in perfect relation to the others and in depth. For a quick conception of this interesting recording listen to side five, "Noche Espanola" and "Old Sir Faulk." It is recorded on *Columbia DX*1734-6.

"Jubilee" and "On the Mall," on *Columbia DB*2835, is a new record made specially by the Military Band of the Black Watch (Royal Highland Regiment), under the direction of Bandmaster Laurence H. Hicks, in connection with its impending tour of Australia and New Zealand.

In order to focus attention on new releases linking up with London stage successes, the Melachrino Orchestra, conducted by George Melachrino, have recorded a selection from "Gay's the Word" on *H.M.V. C*4079. It introduces "Bees are Buzzin'," "If Only He'd Looked My Way," "A Matter of Minutes." "Finder Please Return," "Gaiety Glad," "On Such a Night as This," and "Vitality." Another recording of this nature is a selection from Emile Littler's "Dear Miss Phoebe," played by Tom Jenkins and his Palm Court Orchestra, on *H.M.V. B*10047.

Vocal

The death of Ivor Novello saddened the world, and as a tribute to a great musician, composer and actor, and complying with public demand, "Ivor Novello Vocal Gems" (*H.M.V. C*4080, introducing a number of famous singers) have been reissued. These records feature Peter Graves singing "Every Little Girl" "And her Mother Came too"; Olive Gilbert singing "Thoughts of You." "Rose of England," "Bless You", and "We'll Gather Lilacs"; Webster Booth singing "Love is my Reason," "My Life Belongs to You," "Shine through my Dreams," and "France Will Rise Again" as a duet with Helen Hill; Helen Hill singing "Waltz of My Heart," "I Can Give You the Starlight" and "Glamorous Night"; and finally the orchestra, conducted by Harry Acres, play "Keep the Home Fires Burning" and "April's Lady."

Records by Gigli are always eagerly sought after and for his latest recording he has chosen "Sona Chitarra" ("Play the Guitar") and "Paese Che Neatena," on *H.M.V. DA*1917.

Variety

That popular singing and whistling star Ronnie Ronalde has chosen "The Song of the Thrush," in which his whistling is heard to good effect, and "I Leave my Heart in an English Garden," which is one of the hit-songs of the moment.

That gifted artist Bill Kerr, who struck a lovely line in telling people they looked on their last legs, that the theatre circle would probably collapse shortly, and so on, applies his philosophy admirably in his recording of "Sing Me a Happy Song" and "The Death of Willie," on *H.M.V. B*10056.

A young English singer, Larry Day, has gained fame in record circles because of the repeated broadcasts of "Music by the Angels" (*H.M.V. B*10036), in which he is the soloist. Make sure to hear his second record, "As Long as the River Flows On" and "I Still Feel the Same About You," on *H.M.V. B*10046.

Sam Browne and his All-star Singers make a welcome reappearance with "Songs from the Hit Parade," on *H.M.V. B*10053, and "Tennessee Waltz" and "I Haven't Been Home in Three Whole Nights," on *H.M.V. B*10049, is foolery by Spike Jones and his City Slickers at its best.

Dance Music

Freddy Randall with his band makes his début on *Parlophone R*3382 with "Since My Best Girl Turned Me Down" and "That's a-Plenty," and Humphrey Lyttelton and his Band are heard to advantage with "Trog's Blues" and "Gatemouth Blues" on *Parlophone R*3379. Trog is Wally Fawkes, part author of the former blues. *Daily Mail* readers will be familiar with Trog's cartoons.

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PRACTICAL WIRELESS, JUNE, 1951

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No. 38 "WALKIE TALKIE" TRANS-RECEIVERS. Complete with Throat Mike, 'Phones, Aerial Rods and Junc. Box. Freq. Range: 7.4 to 9 mc/s. Brand new and guaranteed, £4/19/6. Carr. 2/6.

RECEIVER R.1355 as specified for "Inexpensive Television." Complete with 8 valves VR65, and 1 ea. 5U4G, VU120, VR92, and a copy of "Inexpensive TV." ONLY 55/- (carriage, etc., 7/6).

EF50 (VR91) BRAND NEW RED SYLVANIAN. 10/- original boxes. British Types boxed 7/6. Unboxed British Types 5/-.

RECEIVER TYPE 21. The receiver portion of the W.S. 21 operating from 4.2-7.5 Mc/s. Double superhet from 18-30 Mc/s. Incorporating B.F.O. and crash limiter. Valve line-up 7-AR(12 (VP23) and 2-AR8 (HL23DD). Absolutely brand new, complete with circuit. Only 45/- complete. Vibrator power unit for above, brand new, 17/6 only.

Send stamp for current Component List. Probably the most comprehensive in the trade.

TYPE 25 R.F. UNIT. brand new, converted from new R.F.24. 19/6. (Carriage and packing 1/6.)

R.F. UNIT TYPE 24. For 26-30 mc/s. Preset, switched tuning, incorporating 3 valves SP61. Brand new, ONLY 16/6. This unit can now also be supplied modified to cover R.F. 26 frequency (for Midlands T.V.), brand new, at 25/-.

INDICATOR TYPE 6. These units are brand new, in excellent condition and are all fitted with a VCR97 CRT, the tube which many constructors have put to T.V. use. Valves include 4/VR9 (EF50), 3/VR54 (EB34), plus a host of potentiometers and H.V. condensers, etc. The complete unit is enclosed in a metal box 18 x 8½ x 7½in. Price only £3/19/6, post paid.

VIBRATOR POWER UNITS, 2 volt. As for Canadian 58 set. Completely smoothed, output 1.5v. L.T. and 90v. and 180v. H.T. at 35 m/a. Complete in grey metal box. Size 8" x 3¾" x 4½". 50/- only.

R.3084 RECEIVER. Incorporating 7 EF50, 2 EF54, 1 EC52, 1 VU39A 1 HVR2, 1 EA50, plus 30 mc/s. I.F. strip. Guaranteed absolutely brand new in maker's original packing case. 75/-. (Plus 10/- carriage and packing.) This receiver is ideal for conversion to vision receiver.

5CP1 C.R. TUBES. Brand New and Boxed. 25/- carriage paid.

METAL RECTIFIERS. S.T.C., 300 volts 75 m.a. 5/-; S.T.C., 24 volts 2½ amps., 17/6. G.E.C., 6 volts 1 amp., 4/-. Westinghouse, 12 volts 2 amp., 12/6. Pencil Type E.H.T., 600v. 1 m.a., 4/7; 1,000v., 1 m.a., 6/-. 2,400v. 3 m.a., 15/-; 350, 500v. 2 m.a., 7/6.

5M/A METER RECT. 5/- W.6 and WX6, 1/6.

FILAMENT TRANSFORMERS. All Inputs 200/50 A.C. 6.3v. 1.5 amp., 7/6; Ignanic 6.3v. 2½ amp., 10/-; 6v. or 12v. 3 amp., 15/-; 6.3v. 12 amp., 37/6.

MAINS TRANS. (PARMEKO). 250-0-250, 90 m.a. 6.3v. 3 amp., 5v. 2 amp. Input, 110/250, 20/-. Min. Mains Trans., 3½ high by 3 x 2½, fully shrouded, 250-0-250, 60 m.a., 6.3v. 3 amp., 5v. 2 amp., 21/-.