BEGINNER'S GUIDE TO RADIO—By F. J. CAMM

1/-

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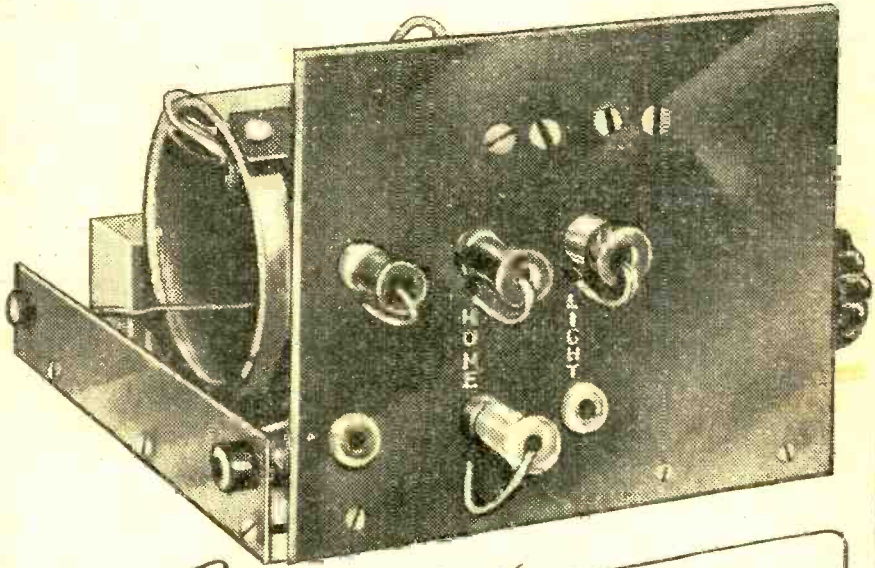
EDITOR:
F.J.CAMM

PRACTICAL WIRELESS



A Crystal Diode TUNING UNIT

IN THIS ISSUE :

A SIMPLE INTERVAL TIMER
HUM IN A.C./D.C. RECEIVERS
SOME ASPECTS OF D.C. AMPLIFIERS
THE PROBLEM OF FIDELITY
SHORT WAVE SECTION
THE REPRODUCTION OF DISC RECORDING

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It's blooming marvellous—the rise in efficiency that results from the use of OSMOR " Q " Range Coils. No wonder our customers are enthusiastic ! They tell us these " mighty marvels in miniature " are super-selective and sensitive to a degree they never dreamed possible. And we guarantee them—they're the outcome of patient scientific research plus the highest technical ability. Note these " plus " points that spell superior performance :

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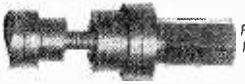

Prov. Pat.

Type	Hole Sizes	Price
1	1in. x 1¼in.	19/6
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3	¾in. x 1½in.	22/6
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Keep those small components—resistors, condensers, etc., neatly stored and yet visible by using an

OSMOR "JAR-RACK"

(If you're a generous husband you'll buy one or two for your wife's larder, too—she will appreciate somewhere to store her preserves.) Holds any 1 lb. jam jars with or without lids. Easily removed, cannot fall out. Just the thing for the tidy " HAM " or Radio Dealer.
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Post and packing, 1/- (either type).
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the first time you hear your own voice ! Have fun and find endless pleasure in using an **inexpensive TAPE RECORDER** you can build yourself. We can supply all the parts to make a really efficient one, utilising your gramophone turntable (which can still be used for its normal purpose). Send 2/6 for easy-to-follow blueprints and instructions, or ask for details.

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Practical Wireless

EVERY MONTH
VOL. XXIX, No. 563, SEPTEMBER, 1953

Editor F. J. CAMM

21st YEAR OF ISSUE

COMMENTS OF THE MONTH

By THE EDITOR

NEXT MONTH—Greatly Enlarged 21st Birthday and Radio Show Number

Free 3s. 6d. Blueprint of F. J. Camm's Coronet Four in Every Issue !

WITH next month's greatly-enlarged issue we celebrate the 21st year of continuous publication. The coming of age of a successful periodical is an event worthy of celebration. It is a time when we reflect upon the past, but mainly we regard it as an augury for the future. It is, of course, pleasant to reflect upon the achievements of the past, but it should not be an occasion when one should relax and rely upon past victories. The past is over. It may enrich the memory, but it will not provide the motivating force which is necessary to propel and to navigate a successful periodical through the stormy waters of the publishing ocean.

The attainment of our 21st birthday will inspire us to even greater efforts to encourage the fascinating hobby of radio.

Next month there will be features in plenty to remind readers of the past 21 years and of the achievements which stand to the credit of this journal. It is a source of great satisfaction to us to know that we still carry with us thousands of readers who can claim to have read every issue from the first, which first saw the light of day on September 24th, 1932. Our thanks to the many hundreds of them who have written wishing us many happy returns of the right sort !

Apart from those features there will be a complete report of the Radio Show, our usual articles and regular features. The size of the issue has been greatly enlarged to accommodate them.

FREE BLUEPRINT

WITH every issue there will also be included A FREE 3s. 6d. BLUEPRINT of the first receiver I have sponsored since the war—the CORONET FOUR. I launch it with confidence. It has been designed to incorporate the latest circuitry, for quality and for cheapness of construction. It incorporates components of the lastest type, readily available. It is my belief that it will be built in its thousands.

Readers do not need to be reminded that this receiver is designed round a P.W. circuit guaranteed to perform in the manner claimed. The CORONET FOUR will be *the* receiver of 1953. Look out for it on our stand at the Radio Show.

The whole of the issue will be included within a special two-colour cover printed on art paper. In every way it will be a souvenir issue which readers, I am sure, will preserve. We are, of course, printing many thousands of extra copies, but trade orders at the moment of going to press are so high that it would be unwise to rely upon the chance copy being available at your newsagent. It is necessary to *order next month's issue now.*

"P.W." AT THE RADIO SHOW

THE Radio Show takes place from September 2nd to the 12th and next month's issue will, of course, contain a full report of the exhibits. Readers are cordially invited to visit our stand No. 87 on the ground floor, where they will be able to examine our full range of technical books, periodicals and blueprints and examine the latest 16in. television receiver sponsored by our companion journal *Practical Television* under working conditions. Our staff will be in attendance throughout the show to answer technical questions.

SMALL FIRMS AND THE SHOW

ALTHOUGH, as we stated last month, the R.I.C. have made special arrangements to let stands at a specially reduced price to firms catering for constructors and experimenters, and which cannnot afford the higher prices which large firms have to pay to exhibit at Earls Court, and we have offered assistance to them, at the moment of going to press the response has been disappointing.

INDEXES FOR VOL. 28

A REMINDER to readers that indexes for Vol. 28 are now available and can be obtained from our Publishing Department for 1s. 1d. each. Those readers who wish to have their copies bound will be glad to know that we have made special arrangements with a book-binding firm for this to be done.—F. J. C.

ROUND the WORLD of WIRELESS

British Radio in Photographs

BRITISH Radio Leads the World is the title of a booklet which has been sent overseas by the Radio Industry Council (of Great Britain), enclosing an invitation to the National Radio Show at Earls Court, London, from September 1st (special invitation day) to 12th. The booklet consists almost entirely of photographs, 62 in all, telling the story of British achievements in every branch of radio, television and electronics. The captions are in English, French and Spanish. A gay front cover design consists of a union flag lying against a background of sea and sky. The booklet is not on sale to the public.

Broadcast to Feature "Elettra II"

RECORDINGS made by the BBC on board the Marconi marine radio research and demonstration yacht *Elettra II* in the Channel were broadcast in a special feature programme in the French service of the BBC on July 13th.

During the two-way crossing, Monsieur Jean Bacon, of the BBC, who devised the programme, described the various items of marine radio equipment on board the *Elettra II*, and the mobile recording unit recorded radio-telephone conversations with Boulogne Radio and the French fishing vessel, *Saints Pierre et Paul*. Thick fog on the return journey, with visibility down to 30yds., gave Monsieur Bacon an opportunity of seeing for himself how radar helps the navigator under such weather conditions.

Joy Nichols, radio star of "Take It From Here," together with her husband, Canadian Wally Peterson, and their daughter, Roberta, left her Hendon home recently to visit her mother in Sydney, whom she has not seen since coming to England seven years ago. She hopes to return to British radio next year.

New British Standard

THE recently published B.S.1988 : 1953 ("Memorandum on the Measurement of Frequency Variation in Sound Recording and Reproduction"), draws attention to the lack of uniformity, in this country and elsewhere, in the practice of and the terminology associated with the measurement of undesired frequency variation in sound recording and reproduction. The memorandum gives recommended terms and definitions, and general recommendations are made upon the criteria to be taken in measuring undesired frequency variation in sound recording and reproduction.

Copies may be obtained from the British Standards Institution, Sales Branch, 24, Victoria Street, London, S.W.1.

Evening Classes

CLASSES in two radio subjects will be held at Brentford Evening Institute next winter. One is radio servicing, with some practical work, covering the theory of receiver operation from first principles before dealing with fault-finding and repairs. The other is preparation for the radio amateur's examination of the City and Guilds Institute. The course includes all necessary theory from first principles.

The two series of lectures will be given by Mr. J. R. Hamilton, Assoc.Brit.I.R.E. The servicing course will be held on Tuesday evenings from 7 to 9, commencing September 22nd. The amateur's course will be on Wednesday evenings, commencing September 23rd. Enrolment week is September 14th to 18th inclusive.

Help on Everest

MEMBERS of the Everest expedition paid tribute to British radio batteries when they returned to London in July.

Interviewed at London Airport, Mr. George Band said, "The radio batteries supplied to us by the Vidor company performed even better than I had dreamed possible. Trouble at very high altitudes would have been understandable, but even at 24,000ft. they gave excellent results."

Col. Hunt, leader of the expedition, said that it had never been intended to take the radio equipment to the summit. The main role of radio was to facilitate the building up of stores and in this role it proved invaluable.

Radio Telephone Network

IN order to improve and extend their communications system the Posts and Telegraphs Department of Nigeria has ordered equipment for a large network of V.H.F. multichannel wireless stations. This network will link the telephone systems of many towns and will provide more channels on existing overhead wire routes. The order has been placed, through Crown Agents for the Colonies, with Marconi's

Wireless Telegraph Co., Ltd., who have already installed part of the scheme.

It will be possible, when the scheme is completed, to telephone from Lagos to many places which have never had telephone communication with the coast before. Surveys are still in progress in Nigeria by Marconi engineers in order to ensure that the development of the telecommunication system of the Nigerian communication network will provide the maximum facilities and flexibility for traffic handling in the future.

Broadcast Receiving Licences

THE following statement shows the approximate number of sound receiving licences issued during the year ended May, 1953. The grand total of sound and television licences was 12,945,828.

Region	Number
London Postal ...	1,728,457
Home Counties ...	1,461,820
Midland	1,319,044
North-eastern ...	1,734,433
North-western ...	1,348,767
South-western ...	1,034,778
Wales and Border ...	671,332
Total England and Wales	9,298,631
Scotland	1,115,353
Northern Ireland ...	215,244
Grand Total	10,629,228

Prize for Inventor

"TOUTE LA RADIO," the French radio and television magazine, has given 50,000 francs to Siegfried Klein, inventor of the Ionophone, as first Grand Prize for Invention.

The Ionophone, an inertialess loudspeaker, is to be made in factories all over Europe.

New System of F. M.

IT is announced that Dr. Edwin H. Armstrong, the pioneer of frequency modulation has perfected a new system which permits of up to three programmes being broadcast on a single carrier. It is stated that the cost of modifying an existing F. M. transmitter for "multiplexing," as it is called, is trifling, but special receivers would be needed although the number of extra components required would not be excessive. Experimental transmissions have been carried out for over 12 months from the experimental Armstrong station KE2XCC on 93.1 M/cs. It is claimed that listeners to the transmissions with ordinary F. M. receivers were unaware that "multiplex" was being used.

Robot Announcer

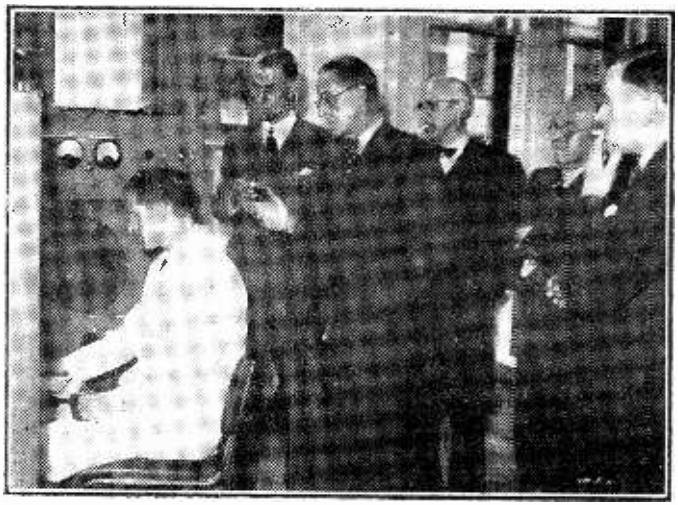
AMERICAN radio station KEAR at San Mateo, California, plans to go on the air without an announcer from 6 p.m. to midnight. Instead, KEAR will use a new long-playing tape playback device developed by Ampex Electric Corporation of Redwood City, California. Spot announcements and commercials are recorded on one tape, music on another. The announcements are cut in automatically, thus permitting KEAR to operate with only an engineer on duty.

The KEAR plan is to prerecord all of its night musical selections during the daytime while other programming goes out in regular fashion. All introductions to the music, station breaks and commercial announcement will be recorded in the daytime by two announcers. The Ampex system through a sub-audible tone then controls the stopping of the music playback and the starting of the voice recordings as required through the evening.

Marine Appointment

THE appointment is announced of Mr. W. A. Penkman as manager of the Service Division of The Marconi International Marine Communication Co., Ltd.

Like the majority of executive officials of the company, Mr. Penkman has served at sea on the operating staff, having gained the Postmaster-General's First Class Certificate shortly after joining the Liverpool depot staff in 1918. He remained on the seagoing radio staff, serving with the Marine Co. and the Radio Communication Co. until 1926, when he returned to shore duties.



Mr. V. Pringle, fourth from right, of the Mullard Valve Service Department, shows representatives from the Scottish radio industry round the new valve service depot and explains test procedure. From left to right: Mr. D. Hunter, President, S.R.R.A.; Mr. V. Pringle; Mr. R. W. Cresswell, President, R.I.C., Scotland; Mr. J. Robertson, National Chairman, R.W.F.; Mr. W. Mitchell, Vice-President, R.I.C., Scotland.

In 1951, he was appointed deputy manager of the Service Division and now assumes full control of the Division's activities.

North Greenland Expedition

EVER READY have supplied a quantity of their standard rubber torches, bulbs and a store of U.2 lighting batteries to the North Greenland Exploration expedition, also 144 flag cell batteries to operate some of the scientific equipment the party have taken with them. Rubber torches are essential in Greenland through the dark winters.

A SIMPLE INTERVAL TIMER

A USEFUL ACCESSORY WITH MANY APPLICATIONS

By E. Booth, B.Sc.(Eng.)

THE necessity often arises, in the home and workshop, for a process to be timed with a fair degree of accuracy. This is often achieved by clockwork-actuated mechanisms, but these are expensive if purchased ready-made, and are difficult to construct with the facilities normally available to the amateur. However, timing can quite easily be carried out electronically, and this article describes such a device which is cheap and easy to construct and with which, provided care is taken with the construction, an accuracy of plus or minus 5 per cent. is easily obtained with times of up to 30 minutes' duration.

Two applications of the circuit have been tried with complete success, but, of course, many others are possible. The first need was for a timer for use in the kitchen. This had four switched positions, giving times of three, five, seven and 10 minutes, these being the durations needed for timing a pressure cooker. The relay contacts were arranged to sound a bell and simultaneously light a pilot lamp on the front of the cabinet housing the timing device—this being mounted on the kitchen wall in a convenient position. This meant that, once the timing switch had been closed, other matters could be attended to until the specified time had elapsed, and the bell rang to attract attention. Any desired method of giving the alarm may be used since, when the timer has operated, a pair of relay contacts close and these may equally well operate a bell, buzzer, lamp or other device to suit the constructor's own particular needs.

Secondly, some method was needed in the dark-room for accurately timing photographic processes. There the durations of times needed were shorter, of the order of seconds rather than minutes. Break, instead of make, contacts were fitted to the relay, and these directly operated the lamp in either the enlarger or printing box, making the process automatic after it had once been started. This facilitated batch production of prints, and ensured constancy in the results obtained. A potentiometer will be found more suitable as a means of varying the timing resistor than will a switched arrangement of fixed resistors for this short-duration timer : a scale can be marked on the front of the chassis, and can easily be calibrated by experiment. Also, the value of the potentiometer will depend upon the maximum duration needed.

The Circuit

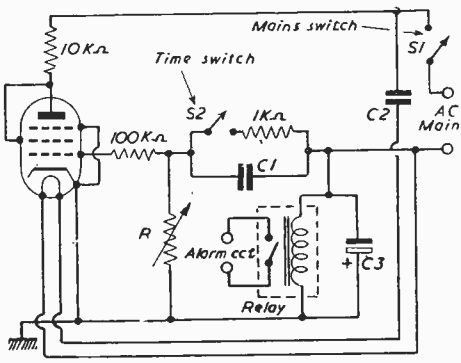
It will be seen that the circuit used is extremely simple, its cheapness lying in the fact that no mains transformer or rectifier is needed—a smoothed H.T. line is not necessary and a series condenser is used for the heater supply to the single valve. Thus, A.C. mains may be connected across the input terminals and the device will function. The valve can be almost any indirectly-heated triode or pentode—if the latter is used it should be triode connected as shown, with suppressor taken to cathode and screen to anode. C_1 and C_2 must be paper condensers, but C_3 can be an electrolytic. It should be noted, however, that the latter must be of a reasonably high voltage working (say, 250 v.) in spite of its being in the cathode circuit of the valve. With regard to the relay, this can be a standard P.O. type but must have a high impedance : 10KΩ is shown in the circuit, and one of even higher resistance could be used. However, difficulty will be experienced if a lower value is tried, as the pull-in current will be so high. 5 mA should operate the relay if reliable results are to be obtained.

Earthing, both to chassis and mains earth, should be carried out only at the point shown (i.e., the cathode of the valve) to minimise leakage effects. All other points should be left floating and not brought to chassis. The high-impedance point at the junction of R, C_1 and the 100KΩ resistor should receive special attention from the point of view of leakage to earth, especially if long time intervals are contemplated. For this reason, if R is to be switched to vary the time interval, the resistors should be wired to the tags of a rotary wave-change switch which should be of the ceramic wafer type, and not made of paxolin or similar substance. C_1 should be a paper condenser in good condition, i.e., it must not have an appreciable leakage resistance either between its terminals or to earth.

Calculations

Calculation of the values of C_1 and R for a given time interval tends to be involved, since other variables such as the mutual conductance of the valve have to be taken into account. To minimise the effect of leakage it is better to make C_1 as large as possible, thus keeping R down to at least several megohms for even the longest time interval. It is suggested that C_1 be made equal to 4 μF and that experimental values of R be tried to obtain the desired result. C_2, however, may be calculated quite easily. Since the resistive drop across the valve heater is small in comparison with the voltage to be dropped across the condenser, the former may be ignored and the calculation reduces itself to deciding a value of condenser to pass a certain current at the mains voltage to be used.

(*Concluded on page* 508)



Circuit of the timer.

A Crystal Diode Tuning Unit

A "QUALITY" R.F. UNIT FOR USE WITH A HI-FI AMPLIFIER

By R. H. Moore

THE article entitled "Crystal Diode Reception" in the September, 1951, issue of PRACTICAL WIRELESS induced the writer to design the receiver here described. Unlike the set in the former article, the function of this set is solely to provide quality reception of broadcast programmes for subsequent amplification in a Hi-Fi amplifier.

Advantage was taken of the experience obtained from the aforementioned article, and the diode circuit is designed to be of low impedance and provides for the application of a bias voltage from a 1½-volt battery to satisfy the working characteristics of the permanent crystal in use, whether of silicon or germanium.

As in the previous case, it was found that selectivity, without loss of signal strength or quality, was the fundamental problem and, with the indifferent aerial available in suburban London conditions, it was therefore essential to obtain maximum magnification in the coil and tuning arrangements. This was procured in the following manner:

(a) Coil Former

The number of components being relatively few and, therefore, space not being a material factor, the idea of a small-diameter coil-former was discarded in favour of a 2½ins.-diameter paxolin former.

(b) Resistance and Self-capacity

These were kept to a minimum by using Litz wire and spacing the turns; by dispensing with a long-wave coil involving wave-change switching; by separation of aerial and earth sockets; and by shortening all leads and sockets. For the same reason, close screening of the coil was avoided—an aluminium case for the whole receiver being sufficient to obviate interference from the amplifier.

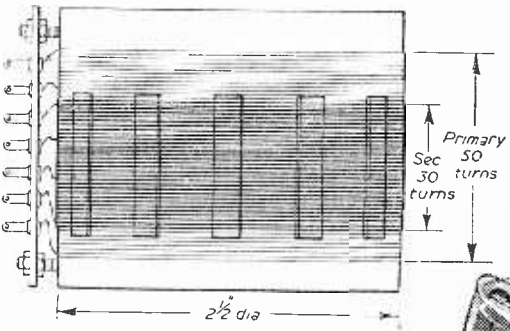


Fig. 3.—Coil construction details.

(c) Tuning

Tuning is effected by tappings on the aerial and secondary coils in conjunction with a .0005μF condenser used as a trimmer. The tapping points are quite critical for maximum signal strength, and experimenting with these is worth while; the condenser being set at half-capacity during the testing. The tappings are brought out by short leads to "sawn off" sockets on the face of the panel and programme choice is made by inserting plugs.

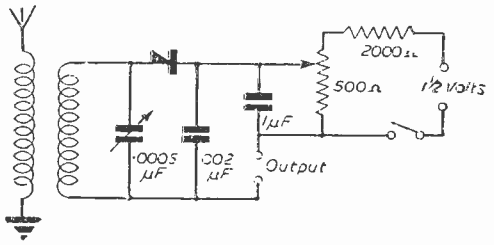


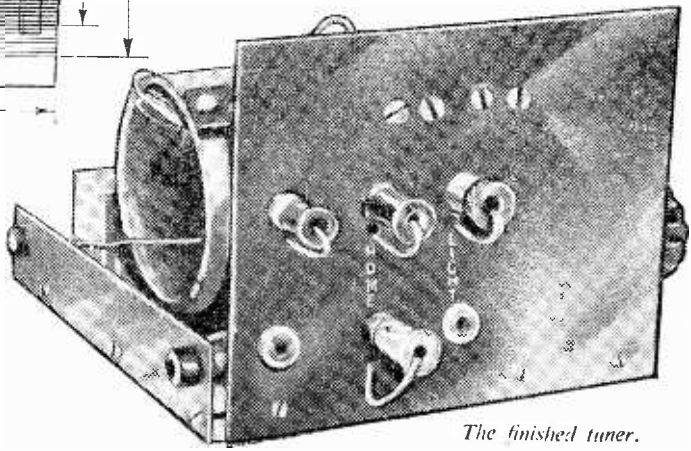
Fig. 1.—Theoretical circuit.

Circuit

The essential circuit is shown in Fig. 1 and the method of tapping the coil in Fig. 2.

Coil Construction

Details of the coil construction are as follows: 50 turns of Litz wire were wound on the former and anchored at either end, to form the aerial coil; the turns were spaced at approximately one diameter of the wire, and tappings taken at 10, 20 and 30 turns from the aerial end. Depending on the aerial in use and other local conditions, the number of turns may probably be reduced to 45.



The finished tuner.

Spacers consisting of 1½in. lengths of matchwood pipe spills were affixed over the primary with acetate, and the secondary, consisting of 30 turns, similarly anchored and space-wound. This was tapped at 5, 10 and 20 turns from the top end.

The ends of the coils and the tapping loops were soldered to short lengths of flex, the latter being knotted before being passed through strips of thin ebonite affixed by spacers along the length of the coil, which is placed as close to the panel as possible so that leads may be kept short. The making of this coil may seem laborious and needful of care, but this is well repaid in securing the higher "Q" factor that is necessary where H.F. amplification is not employed.

Performance

It will probably be found that

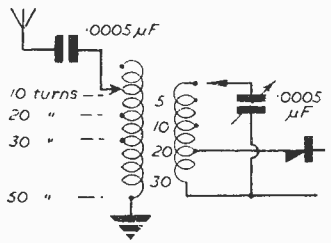
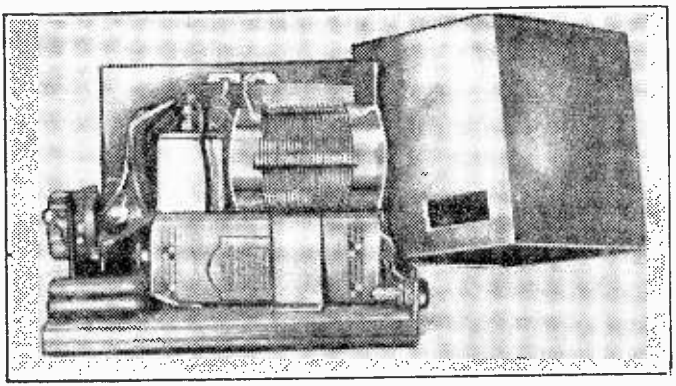


Fig. 2.—Tuning arrangements.

the best tapping point for the diode crystal is 20 turns "down" to obtain maximum signal strength without unbalancing the impedance of the diode circuit. The crystal may overload on the Home Service, but reduction of the bias voltage by means of the potentiometer should provide sufficient volume control. Again, depending on locality, it may be found that adequate selectivity is obtained without the use of the pre-set condenser in the aerial lead. By careful choice of tappings, interference by the Home Service was quite eliminated from Light Programme reception, while adequate spread of the tuning was preserved.

Signal strength of the medium-wave stations is clear and of adequate volume for feeding to the amplifier and providing the latter is of good design, quite high quality reception is possible. If the amplifier does not provide for an input transformer,



A plan view of the tuner.

one may be incorporated across the output of the crystal set to provide a low-impedance match for the rectified current.

From audible results of the more high-powered foreigners, it is not doubted that BBC programme reception will be satisfactory in all favourably situated parts of this country.

A SIMPLE INTERVAL TIMER

(*Continued from page* 506)

For example, suppose the valve has a heater rated at 6.3 v., 0.3 A. and the mains supply is 230 v., 50 c/s.

Then, since :

$$X_c = \frac{E}{I}, \text{ then } X_c = \frac{230}{0.3}\Omega = 766\Omega$$

But $X_c = \frac{10^6}{2\pi fC}$ if C is expressed in microfarads

i.e., $C = \frac{10^6}{2\pi f X_c} = \frac{10^6}{2\pi \times 50 \cdot 766} = 4.16\ \mu F$.

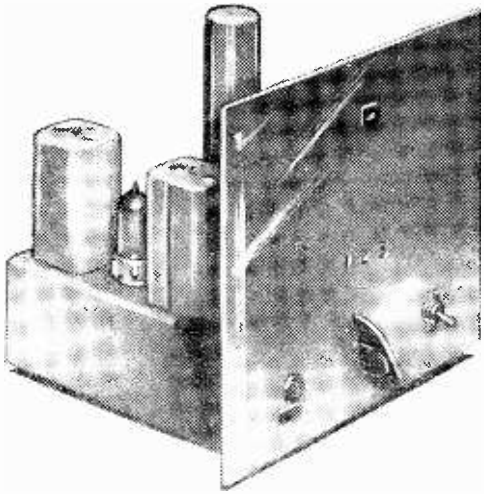
Since 4.15 μF would be plenty accurate enough, especially allowing for the wide tolerance on the condensers which would normally be used, this could be built up from 4 μF, 0.1 μF and 0.05 μF wired in parallel. They should be of sufficient working voltage to cope with the mains voltage present.

Operation

The operation is as follows: shortly before the timer is needed, the mains are switched on to allow it to warm up, the "time" switch being closed. When it is wished to start timing, switch R to the appropriate range (or adjust the potentiometer if one is being used) and open the "time" switch. The D.C. voltage will then gradually start to build up across C_1, the current through the relay will increase, and eventually its contacts will close, operating whatever external circuits have been connected To reset, close the "time" switch and the device is ready for use again.

Construction

Constructional details may, of course, be adapted to suit individual needs, but some ideas are given here for guidance. In the kitchen (and in the dark-room, too) table space is usually at a premium, and a flat chassis fixed to the wall is preferable to the normal horizontal type. The relay and valve, however, are better mounted vertically, and for that reason these two items are fitted on the shelf partway up the box. The overall size may have to be varied to accommodate the paper condensers as these tend to be physically bulky. It should also be noted that the "time" switch is apparently turned round in the opposite sense to that in which the front panel is marked, i.e., when at "off" as marked, the switch is actually closed. In the original the chassis was cut from tinplate, finished externally with black lacquer, the characters on the front being painted in white with a small brush afterwards. The two flanges at the top and bottom were bent outwards and drilled as shown, wood screws being put through these into a wooden board previously fixed to the wall.



Universal Radio Feeder UNIT

AN AC/DC VERSION OF THE UNIT DESCRIBED IN OUR JUNE ISSUE

IN many parts of the country there are D.C. mains, and in these areas it is desirable to have a radio feeder unit that can be used on either A.C. or D.C. mains. It was with this in mind that a modified version of the radio feeder unit was made. The main change in the types of valves was quite a simple matter: the Mullard types UCH42 and UAF42 are identical in electronic characteristics, but differ in the point of heater supplies. Whereas the "E" series of radio valves operate at a constant voltage of 6.3, the "U" series operate at a constant current of 100 mA. and are used in series. For further details on these Mullard types we would refer the readers to their very excellent publication for the radio amateur, *The Amateur's Guide to Valve Selection.*

There is one change in valve type, and that is the rectifier. Whereas in the A.C. version a double-diode rectifier valve was used, a single diode is used here, instead of the EZ40 or EZ41, the type UY41.

Container

It is also not advisable to use a steel case for the instrument as there is a very great danger of shock. It is better to use a wooden one, with the unit mounted in such a way that no live parts can be touched. In this latter respect it is impossible to use the normal type of direct or capacity output, as under certain conditions the hum level was found to be excessive, intolerable in fact. With this point in mind a considerable amount of experimenting was carried out, and the best type of output was found to be a cathode follower feeding a parafeed transformer. This is a little extra expense, but it is worth it, as complete isolation is given to the output and there is no chance of a dangerous shock. There are many valves that can be strapped as a triode and used, and a table has been drawn up for the reader to make the choice. The one found to be the best in the laboratory was the type UL41, but as this draws a rather large current it is advisable to modify the smoothing to handle a higher current. On the other hand, the UF42 is very good, but it gives a slightly higher output impedance. The fact that it is a variable-mu type is of little consequence, as the valve when operated as a cathode follower operates with 100 per cent. negative feedback. The extra circuit is shown in Fig. 1.

The power supply to the heaters has to be worked out, and with the "U" series of valves is very simple. One just adds up the heater voltages of all the valves to be used; subtracts this from the mains voltage; multiplies the answer by 10, and that is the value of resistance required. Several firms make a suitable dropper of the vitreous type. These resistors can be obtained to an accuracy of about 5 per cent. and can be obtained in very high power ratings. They should be mounted in a position where there is plenty of ventilation so that the other components in the unit are not damaged by the excess heat.

Heater Wiring

The order of wiring the valves is quite important; the detector valve, the UAF42, should be at the chassis end of the chain, as this ensures that the hum modulation is kept to a minimum in the detector stage. The next in the chain is the UCH42, with the cathode follower valve third up from the chassis; the rectifier comes next, and the dropper comes last between the mains positive. (See Fig. 2 for the connections.) It will also be seen in this circuit that there is a resistor of 150 ohms between the cathode of the rectifier valve and the reservoir condenser;

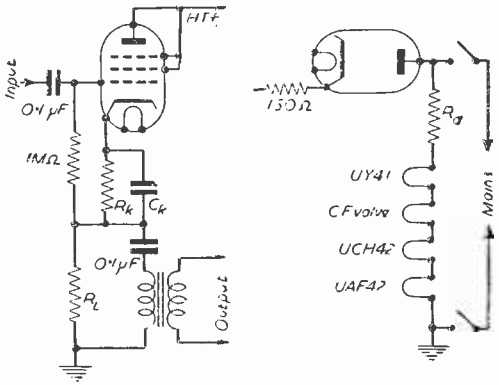


Fig. 1 (left).—The new output stage, and Fig. 2 (right) arrangement of the heater circuit.

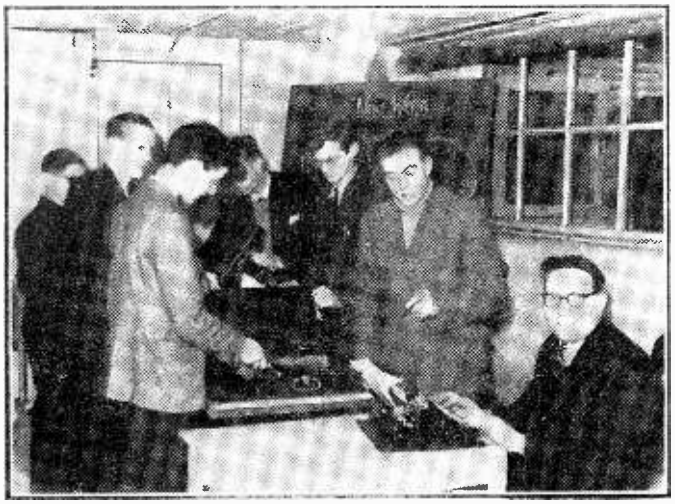
this is to prevent the current surge from the mains reaching an excessive value. There have been many good valves ruined in universal circuits by omitting the use of one of these surge limiting resistors, as the valves used for universal rectification are of a so very low impedance it is quite possible for them to blow if there is no extra resistance to limit the charging surge into the reservoir condenser.

Output Transformer

The output transformer can be almost any type at a ratio of one to one : a step-up one can be used, and by far the best type available will be found on the ex-W.D. market in the form of line transformers. These quite often have eight tags, and the case can be earthed separately. The connections are simple—join the centre tags of both sides so that two pairs of winding are joined in series, and then treat as if it were a normal transformer. Some of the larger types have an exceptional frequency coverage of from about 15 cycles to over 20 kc/s and can often be bought for a shilling or two. Care must be taken to obtain the correct ratio transformer.

TABLE

	Rk	Rl	C	Ia	Vh	Zo
UF41	330	10K.	50	10	12.6	600
UF42	750	10K.	25	12	21	120
UAF42	310	10K.	50	6.5	12.6	500
UBF80	300	10K.	50	6.5	17	400
UBC41	1,000	10K.	20	1.5	14	700
UBL21	140	1,400	100	55	55	120
UL41	150	1,500	100	55	45	100



Members of the Derby and District Amateur Radio Society busily employed printing their session magazine.

CLUB NEWS

CHESTER & DISTRICT AMATEUR RADIO SOCIETY

Hon. Sec. : N. Richardson, BBS19678, 23, St. Mary's Road, Doyleston, Nr. Chester.

NEW faces welcome to Tuesday's meeting when something of interest is always on.

DERBY AND DISTRICT AMATEUR RADIO SOCIETY

Hon. Sec. : F. C. Ward (G2CVV), 5, Uplands Avenue, Littleover, Derby.

THE Mid-Term meeting of the society will be on August 26th in Room No. 4,119, Green Lane, Derby, commencing at 7.15, when Mr. T. Darn (G3FGY) will demonstrate his home-constructed tape recorder. The weekly meetings will commence with the re-opening of the college on September 23rd, 1953.

BIRMINGHAM & DISTRICT SHORT WAVE SOCIETY

Hon. Sec. : F. C. Cook, 67, Regent Road, Handsworth, Birmingham, 21.

THE club's activities continue at a high level, and the next month's meeting will include a mock auction.

Further programmes in hand include talks by members and also a forum.

All visitors will be cordially welcomed at the Society's meeting place, "The Colmore Inn," Church Street, Birmingham, the second Monday in each month.

LIVERPOOL & DISTRICT SHORT WAVE CLUB

Hon. Sec. : Arthur D. H. Looney, 81, Alstonfield Road, Knotty Ash, Liverpool, 14.

THE club recently paid a visit to the Holme Moss Television Transmitter, with the kind permission of the BBC, tribute must be paid to the two engineers who gave up their time to conduct the party round and in the very excellent way that the details of this great undertaking were explained. All who paid this visit had a very enjoyable time and it will be remembered as one of the club's outstanding visits. A number of teams took part in a D.F. Contest, the winner being G3CK assisted by Mr. L. Roberts of the Wirral Club, using a converted 18 set. Second team home was G3IQO, assisted by Mr. S. Cotter. G3HII one of the club members who has just left for B.A.O.R. in the R.A.F., has been given the Call DL2US, would appreciate any reports from G Land. A welcome is extended to any service personnel stationed in the Merseyside area to come along on club nights—Tuesday at 8 p.m., St. Barnabas Hall, Penny Lane, Liverpool, 15.

NOTTINGHAM SHORT WAVE CLUB

Hon. Sec. : N. D. Littlewood, 129, Standhill Road, Nottingham.

ON June 8th, at a general meeting, the officers for the coming year were elected A series of technical lectures by G5QZ leading up to and above the Radio Amateur's Examination standard, occupy about one hour every Monday at 7.15. There is also half an hour's morse practice every Thursday, run by G3IQM. As the community centre has extensive grounds, it is hoped to be able to experiment with various types of aerials in alldirections. Visits to places of interest, are to be arranged, possibly in conjunction with other local bodies.

THE WEST LANCASHIRE RADIO SOCIETY

Hon. Sec. : T. Searle, 11, Sefton Drive, Thornton, Liverpool, 23.

THE above club is now meeting at its original headquarters again :—

Above Gordon's Sweet Shop,
St. John's Road,
Waterloo, Liverpool, 22.

Commencing September, there will be a monthly series of films and film strips, lectures, etc., and morse and technical classes, Meetings weekly, Tuesday evenings at 8 p.m.

RAVENSBOURNE AMATEUR RADIO CLUB

Hon. Sec. : Mr. W. Wilshaw, 4, Station Road, Bromley, Kent.

THE club meets every Wednesday evening at 8 p.m., at Durham Hill School, Downham. The club transmitter G3HEV has now QSO'd 125 stations on four bands A1/3 in 12 countries. Morse practice is given. Equipment includes : 6V6-CO-6V6 PA ; 6AC7-6AC7-TT11 PA ; Edystone 640RX, Denco RX, class D wavemeter and 200ft. marconi aerial.

New members welcomed. It is also proposed to visit places of interest in the radio sphere.

The Beginner's Guide to RADIO

The Fifth in a Series of Articles for Those New to Radio. This Month the Purposes of Decoupling and Tone Control are Explained

By F. J. CAMM

THE relationship of voltage, current and resistance forms the basis of Ohm's Law which is dealt with more fully later. In the meantime due to this difference across the resistance, it will be seen from the position of the two resistances in Fig. 23 given last month that at the lower end (nearest the L.T.— connection) the voltage will be more positive than at the upper end where it joins H.T.—. Therefore, the point to which the first grid circuit is connected (the L.F. transformer secondary) is at a lower negative voltage than the point to which the end of the volume control is connected. With the current flowing from the valves in question the top end (H.T.— end) of the two resistances will be about 7.5 volts negative and the junction about 3 volts negative.

Last month I mentioned the term *decoupling* and it is necessary now to explain what the term means and why it is necessary to employ decoupling between the input and output circuits of a source of *stage gain*, such as is provided by a thermionic valve. In brief it can be said that decoupling is employed to prevent oscillation and distortion. Decoupling is carried out by means of resistances, chokes and condensers. Sometimes the term *stopper* is employed, as in connection with the resistance inserted in the grid lead of a detector valve to reduce high-frequency potentials on the grid of the valve and the consequent build-up of parasitic (unwanted) oscillations. The resistance-capacity combination for decoupling anode or grid supply circuits so as to obviate oscillation in amplifying valves is a well-known decoupling arrangement.

In Fig. 25 the components and wiring necessary to decouple and add tone control to our three-valve receiver are shown solid and the circuit before decoupling by dotted lines. The actual components are shown in perspective in Fig. 26. It will be seen that the first two stages have been decoupled.

In a straight three-valve set, the H.T. sides of each of the components in the anode circuit are joined together either directly or through the intervening cells of the H.T. battery, with the result that the major part of the battery voltage is between the anode

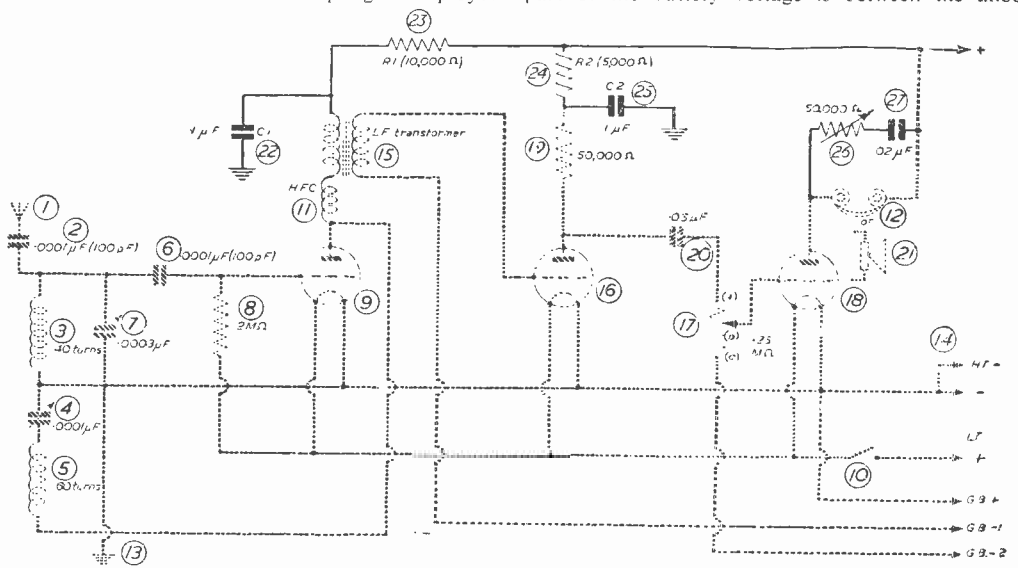


Fig. 25.—The three-valve circuit shown by Fig. 20 (August issue) with decoupling resistances and condensers and tone control added.

leads and earth. This portion of the high-tension battery may have a considerable high-frequency resistance which, being common to all three valves, redistributes such stray currents as are flowing in each anode circuit to the other anode circuits, thus causing instability, motor-boating or violent oscillation.

In order to stop this trouble, it is necessary to give other than battery current a direct path to H.T.−, and to separate the anodes from each other by a resistance, or choke and a condenser. In general practice the choke is seldom used, as it is useful only when a very heavy high-tension current is passing. It is, however, generally used in the output stage to choke-feed the loudspeaker and direct the speech current through the loudspeaker winding to earth.

In all sets the decoupling of the detector valve is probably the most important. Here, it is necessary to make certain that the values are adequate. Unfortunately, if too high a resistance is used, the H.T. value will be lowered, which is undesirable below a certain point. In order to ensure that decoupling is efficient, the resistance in ohms when multiplied by the capacity of the condenser in microfarads should not be less than 40,000. It would appear that the simpler way would be to use 40,000 ohms with 1 μF., but such a value of resistance may reduce the high-tension voltage. The amount of voltage lost over the resistance is simple to calculate, it merely being necessary to multiply the resistance by the number of milliamps. passing and take off three noughts. For example, if the anode resistance were only 30,000 ohms and the current 3 milliamps., multiply these two together and the result is 90,000; take off three noughts and it will be seen that the loss of voltage would be 90. (See Ohm's Law, on a later page.) Decide first of all what voltage it is desired to apply to the detector stage and subtract this from the H.T. battery voltage, which will leave the amount that may be sacrificed in the interests of decoupling. If 80 volts is required on the detector and the battery voltage is 120, then 40 volts can be spared. Now, reference to the valve curve or the use of a milliammeter will show what current the valve is taking. Suppose it is taking 3 milliamps.; it is now desired to find what resistance will drop 40 volts when 3 milliamps. is flowing. This is arrived at by dividing the milliamps. into the voltage, when the answer will be the number of thousands of ohms required. Divide the 3 milliamps. into the 40 volts; this goes approximately 13 times and as the answer is in thousands of ohms the resistance will be 13,000 ohms. The nearest value obtainable will be 15,000 ohms, which will have to be associated with a 4 μF. condenser in order to reach the 40,000 indicated.

In a first L.F. stage the valve can usually be lowered to 30,000.

The values chosen for the circuit shown by Fig. 25 are suitable for most practical purposes, however.

Adding Tone Control

The receiver is now at a stage where it is good enough for ordinary purposes; it will make a satisfactory domestic receiver. Those, however, with an ear for quality may care to add the refinement of tone control. It is not absolutely necessary, of course, in a receiver of this type, although with mains receivers and others capable of high output it becomes desirable In this receiver a variable resistor, similar to that used for part 17 (volume control) is used, but it has a lower value and it is used together with a fixed condenser. These two parts are Nos. 26 and 27 in Fig. 25 and they are shown in perspective in Fig. 26. Some of the modern output valves give over-emphasis to the higher notes or frequencies so that the tone sounds too shrill. As a result we need tone control to provide a high note cut-off to balance the reproduction. But as certain types of broadcast music need more cut-off, for example, than speech, the control is made variable, so that it may be adjusted according to the item being received.

Many modern receivers are provided with a tone control across the first L.F. stage. This usually takes the form of a condenser and resistance arrangement, joined between the anode of the L.F. valve and earth. Suitable values will depend upon the valve and the R.C. components and, again, up to .05 μF and up to 100,000 ohms are generally suitable.

In the main, this form of tone control affects only the high notes (brilliance); but in commercial receivers provision is made for control of the lower frequencies, or bass notes, the high notes and, in addition, a fixed tone corrector is employed. The bass control consists of a fixed condenser and a condenser in series between the anode of the last stage but one and earth, and shunted across these two components is a variable resistor. The brilliance of the reproduction is effected by a fixed condenser and resistor across the grid circuit of the output valve and it is, of course, variable.

The fixed tone corrector is a fixed condenser and resistor coupled between the grid and anode of the output valve. In addition to these arrangements chokes and other components are sometimes employed in special circuits.

That is as far as we can take the present circuit and, if correctly built and adjusted, it should give as a simple receiver very good results.

Ohm's Law

The reader, up to this stage, has been engaged on the practical application of the principles of radio. It is necessary, now that he has apparatus with which to check theory, to deal with first principles. The very basis of all radio design is Ohm's Law.

Ohm's Law is named after Dr. G. S. Ohm (1787-1854) who discovered the relationship existing in all circuits between resistance, voltage and current. Symbols are used to designate these three terms. Throughout the world I is used to designate current, E for voltage and R for resistance. He discovered that the relationship could be reduced to a very simple

formula from which, knowing two of the values, such as current and resistance, it is possible to estimate the voltage.

The formula is $I = \frac{E}{R}$ .....(1)

This really means that current is always equal to voltage divided by resistance. From this formula we can evolve two others by simple algebraic evaluation. Obviously :

$E = I \times R$ .....(2)

or expressed in words, voltage equals current multiplied by resistance. Similarly :

$R = \frac{E}{I}$ .....(3)

or, expressed in words, resistance equals voltage over current.

In making calculations employing this formula, it is necessary that the three terms shall be in the units of their respective measurements, namely, I in *amperes*, E in *volts*, and R in *ohms*. The formula as given only applies, however, to *direct current*. It does not apply to circuits employing *alternating current*. The latter is a current whose direction

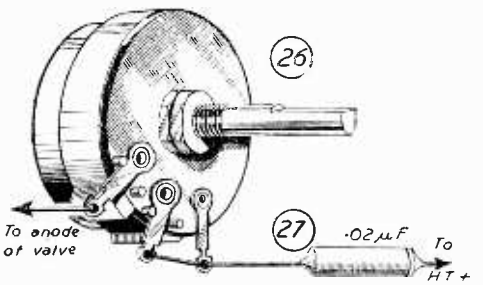


Fig. 26.—The variable resistor and condenser necessary for adding tone control.

surges first in one direction and then in another at a regular frequency. Thus, we refer to alternating current as being at so many cycles per second—usually 50 c.p.s. This means that there are 50 alternations per second and a circuit employing such current means that *impedance* must be taken into consideration. The sign employed for impedance is Z.

For the moment, however, we will confine our attention to the simple Ohm's Law. Now the unit of resistance is the *ohm*, the unit of current is the *ampere*, and the unit of pressure is the *volt*. The ohm is the resistance offered by a column of mercury at the temperature of melting ice, 14.452 grammes in mass and of uniform cross-section and with a length of 106.3 cms. When an electrical pressure of one volt is required to force a current of one ampere through a circuit, the circuit is said to have a resistance of one ohm.

For very small resistance measurements the microhm (one-millionth of an ohm) is used.

The ampere (originated by André Marie Ampere, 1775-1836) is the current which will flow through a resistance of 1 ohm under a pressure of 1 volt. With small currents, such as that taken from a H.T. battery in wireless circuits, the *milliampere* is the unit used. This is equal to one-thousandth of an ampere. Even smaller currents are measured in *microamperes* (one-millionth of an ampere).

The volt is the unit of *electromotive force* (EMF) or *pressure*, or *potential*. It is that pressure which produces a current of one ampere when applied to a conductor the resistance of which is 1 ohm. Smaller units are the *millivolt* (one-thousandth of a volt) and the *kilovolt* (KV) which equals one-thousand volts.

For measuring the amount of current flowing in a circuit an instrument known as an *ammeter* is used, for measuring voltage a *voltmeter* and for resistance an *ohmmeter*. Later on I shall show how to take current and voltage readings throughout the circuit to make sure that the set is functioning as designed. It is most important to ensure that the correct anode and filament voltages are applied to the valve and that the correct current is passing.

In the meantime, the reader should familiarise himself with the application of Ohm's Law by studying the following examples.

If there is a resistance of 125 ohms between two points in a circuit, the voltage being 250, what current is passing ?

Applying formula (1) :

$$I \text{ (current)} = \frac{250}{125} \text{ or 2 amps.}$$

There is a resistance of 125 ohms when a current of 2 amperes is passing. What is the voltage ?

Applying formula (2) :

E (voltage) = 2 125 = 250 volts.

When a current of 2 amperes is passing under a pressure of 250 volts, what is the resistance ?

Here I = 2 and E = 250 and, substituting these figures in formula (3) :

$$R = \frac{250}{2} \text{ or 125 ohms.}$$

A 10-volt battery has an internal resistance of 2 ohms, and it is connected to a resistance of 3 ohms. Find the current flowing. Here R will equal 3 + 2 = 5 ohms, and applying formula (1) :

$$I = \frac{10}{5} = 2 \text{ amperes.}$$

If two or more resistances are joined *in series*, that is to say one after the other, the total resistance will be equal to the sum of the individual resistances. If they are joined in *parallel*, that is to say if all the left-hand connections are joined together and all the right-hand connections are similarly joined, the total resistance will be such that $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ . . . etc., according to the number of resistances. In complicated circuits resistances are sometimes connected in *series-parallel* and calculations in such a case are very complicated and are governed by Kirchhoff's Laws, which will be dealt with much later in this series.

Thus, if resistances of 5 ohms, 3 ohms and 2 ohms are connected in series, the total resistance will be 10 ohms.

If they were joined up in parallel, the resulting total resistance R would be :

$$\frac{1}{R} = \frac{1}{5} + \frac{1}{3} + \frac{1}{2}$$

$$= \frac{6 + 10 + 15}{30} = \frac{31}{30}$$

i.e., $R = \frac{31}{30}$ of an ohm.

(To be continued)

HUM IN A.C./D.C. RECEIVERS

CAUSES AND CURES OF A COMMON TROUBLE

By W. Nimmons

THE question of hum in A.C./D.C. receivers is fraught with all kinds of practical difficulties. Common practice is to be generous with smoothing arrangements, and 32 μF is not too much for the smoothing condensers. Even so, there crop up cases where the amount of hum is objectionable.

There are certain standard remedies for hum, and it is not proposed to enter into them here. But there is one cause which is seldom mentioned, and which is particularly objectionable because it increases when a station is tuned in. The hum seems to come particularly from D.C. mains, and is made up of commutator ripple at the generators.

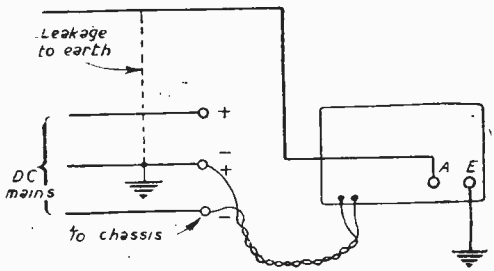


Fig. 1.—Illustrating the effect of aerial leakage.

The cause referred to is very simple. It is nothing more or less than a leaky aerial condenser. With this class of circuit, however, such a simple cause can have far-reaching complications.

Not that the faulty aerial condenser can cause trouble in every case. This tends to make the trouble more mysterious. It is quite possible for the receiver to function perfectly in a neighbour's house, and to go back to the hum when in our own—or, of course, vice versa.

It all depends upon which pole of the mains is earthed. Even then, the trouble will not be apparent unless the insulation of the aerial itself is below par. To make matters worse, the hum may come and go, depending upon the weather conditions, for rain naturally causes a lowering of the insulation resistance of the aerial in certain circumstances. An indoor aerial naturally is not affected by this.

If the mains in the user's premises happen to be so connected that the negative pole is earthed, then the trouble will not be apparent. But if the positive pole is earthed then the fault is liable to make itself apparent if the other conditions have been fulfilled.

An Analogy

It is not easy to explain why this should be so. But the mains make use of the 3-wire system of distribution, in which the centre wire is always earthed; one of the outers is positive and the other is negative with respect to the earthed central wire. It is easy to see that the positive outer wire will, in some cases, go to supply the anodes of the valves; it is less easy to understand that the earthed central wire, which is negative in this case, can also be the positive (supplying the anodes of the valves) when the outer negative wire is used. But if we imagine two accumulators connected together in series, it is easy to see that the centre terminals can be either positive or negative with respect to either of the outer terminals. It is when the central wire is positive that the trouble with a leaky aerial condenser is possible.

As is well known, when this is the case the chassis of the receiver cannot be earthed. Any attempt to do so will blow the fuses, because the chassis, being connected to the negative main, will cause a dead short across the mains if it is connected to earth (the positive main also being earthed). It is this combination of circumstances which, as we will see in a moment, is responsible for the hum.

The aerial, by reason of the leaky aerial condenser, is in direct contact with the chassis via the coils. If the insulation of the aerial was perfect this would not matter, but since there is a leak to earth through the aerial itself this means that the aerial is in effect acting as a pick-up, transferring the ripple to the grid of the first valve. Fig. 1 is an attempt to show how this happens. It will be seen that the aerial is in contact with the positive pole of the supply. Incidentally, any sparks seen, however minute, when connecting up the aerial to the receiver, should be treated with the utmost suspicion. A voltmeter connected between the aerial and the aerial terminal of the receiver will also give a reading in certain circumstances.

In practice there is a continual hum in the receiver, which increases when a signal is tuned in. This is particularly annoying as in bad cases it may completely drown a weak station. The cure is to replace the leaky condenser with a sound one; but a temporary cure may be made by simply connecting a .001 μF mica condenser in series with the aerial. The aerial insulation should also be seen to as soon as possible.

Some Aspects of D.C. Amplifiers

AN ARTICLE DEALING WITH THE D.C. AND THE RESISTANCE-CAPACITY COUPLED-AMPLIFIER. TYPICAL CIRCUITS ARE GIVEN

By James S. Kendall

LATELY there has been quite an amount of comment on the subject of D.C. amplifiers. Whether D.C. means "direct current" or "direct coupled" I do not know, as there are many people who will argue that it is either, but as far as this article is concerned it will be taken as meaning an amplifier which will amplify from zero frequency by the incorporation of direct coupling between valves.

First, what are the points of this type of circuit? The obvious is that as there are no condensers phase shift is reduced to zero, therefore, anything that is fed in is amplified and fed out with exactly the same phase relationship, but amplified. This sounds ideal, but what may it be used for? Amplifiers for audio work require a transformer to match the speaker so that trouble starts here. Then again, who can hear the very low notes, say below 30 cycles? Here, there are many who will say "Why not use a capacitor speaker as it can be fed from a resistance capacity circuit?" The answer is that the capacity upsets the phase position of the high notes!

Secondly, it is claimed that the cutting out of the coupling condensers reduces the cost of the amplifier. This is, in many cases, a fallacy, as in order to stop the amplifier "hunting" (a slow form of motor-boating) the power supply has to be stabilised. The writer several years ago made an amplifier to amplify in the range ½ to 10 cycles per second, and the amplifier had one double valve and the power unit had three besides the rectifier. This unit was guarded against the effect of any mains variation, which is another headache with the D.C. amplifier.

Since the frequency range is so good in the lower region, it is the ideal circuit for low-frequency work with a 'scope. A circuit was published a few years ago in these pages which used two double valves (6SL7GT) to obtain a voltage gain of 3,000 with a push-pull output. The output swing was only 150 volts, whilst the H.T. voltage required was 450, and a stabiliser valve had to be used to read the first valve. This circuit was a little expensive as regards valves. It used one section of a 6SL7GT as an anode load, and an EF50 as a voltage stabiliser in a halving circuit. Otherwise, it was simple and free from condensers. The point, however, was that, although mains fluctuation had been reduced in effect by the use of a valve as an anode load, the extra capacity introduced by so doing reduced the high-frequency response so that it was little use above 20,000 cycles per second. The introduction of another stage of amplification would have greatly increased the complexity of the circuit and lowered still further the top frequency response.

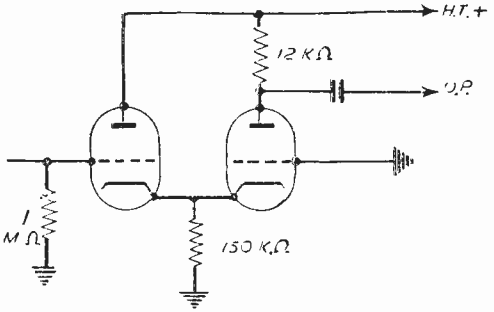


Fig. 1.—A novel circuit with a grounded grid section.

Examples

With high-frequency amplification the impedance of any condensers in the circuits is so very small that it can be neglected, as can the minute amount of phase shift that is introduced. For instance, the Mullard ECC81 can be used in a resistance-capacity circuit to give a band width of from 15 cycles to 15 Mc/s at a voltage gain of about 20, or a band width of from 30 cycles to 7.5 Mc/s at a gain of 400 for two valves. Such a response is impossible with a D.C. amplifier. The circuit is to a very large amount dependent on very short leads for its high-frequency response. The circuit is given in Fig. 1. One section of the valve is used as a cathode follower amplifier, whilst the second is used as a grounded grid amplifier. The first section acts as an impedance matching device, whilst the second acts as an amplifier in which the Miller effect is reduced to a minimum. One stage of this circuit can be used as a D.C. amplifier provided that the output is taken direct to the deflector plate of the cathode-ray tube. The proviso is that the voltage on each of the two deflector plates is the same, and this can be done simply by the use of a resistance network between H.T. and chassis. The capacity of the plates of the tube reduces the frequency response at the top end

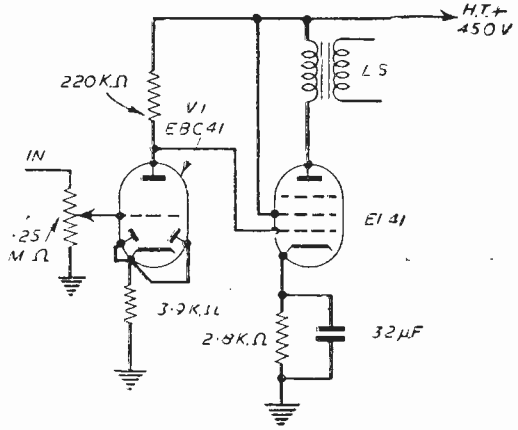


Fig. 2.—A single-ended output stage.

of the scale. For instance, the capacity of the Mullard DG7/5 is so high that it will reduce the response to just under 4 Mc/s. If the circuit were resistance capacity coupled to a cathode follower circuit the lower register would be reduced and the top increased to just under 15 Mc/s. That is, I think, a point for resistance capacity.

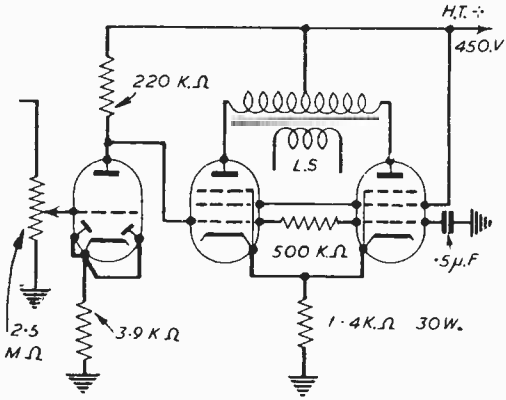


Fig. 3.—A push-pull stage is used here.

Specimen Circuits

For those who would like to try one of these D.C. audio amplifiers Figs. 2 and 3 give two circuits that have been developed in Kendall and Mousley's laboratory. The valves used were Mullard, and the transformers made by Elstone, as these have a good low-frequency response.

The circuit in Fig. 2 is a single-ended unit, the power output being fairly low as the voltage on the anode of the output valve is only 210 volts with a H.T. line voltage of 450. The cathode voltage of the output valve is about 240 volts above chassis, and this should be remembered when the cathode electrolytic is being chosen. A 32 μF condenser or higher should be used, and the working voltage should be at least 250. The wattage rating of the cathode resistor must also be high enough to handle the power of 40 mA. at 240 volts—one of 15 W. rating would be suitable.

The other circuit is a push-pull version and requires twice the drive voltage. It is based on the well-known "Schultz" phase split circuit. These circuits both use the same valves, the first one EBC41 and one EL41, whilst the second uses an extra EL41. The output transformer recommended for both is the Elstone MR7, so that the first circuit can be tried, and if found satisfactory a push-pull version can be built at a later date at a little extra cost. Perhaps, if these circuits were tried against the conventional type of amplifier, the difference could be noted. We have demonstrated the circuits before students who have claimed to have had a good musical ear and no one has so far been able to detect any difference above 250 cycles, but at low frequencies there is certainly a noticeable difference.

Condenser Checking

DETAILS OF A SIMPLE METHOD OF TESTING PAPER, CERAMIC AND MICA CAPACITORS FOR THE USUAL FAULTS

By C. H. Banthorpe

WHEN a capacitor becomes faulty it will be either short-circuited, leaky, open-circuited, or its capacity has changed. These faults may be intermittent.

The writer has found that when testing a radio or television receiver it is easy to check for the first three of these faults using only a voltmeter and the receiver itself. To check for a short-circuit the capacitor should be connected in series with the voltmeter between H.T. + and H.T.– (Fig. 1). If there is any deflection on the meter after the initial surge the capacitor is short-circuited or very leaky. Really small leaks may be detected by connecting the voltmeter to the cathode of the D.D.T. or output valve of the sound receiver and joining the capacitor between grid and H.T.+ (Fig. 2). If the meter reading is higher while the capacitor is connected, then the capacitor is leaky. Leaks of 1,000 MΩ are quite clearly indicated by this means. Very small leaks between windings of transformers, squegging, intervalve, etc., and between tags on tag strips can be detected in the same way.

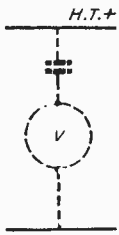
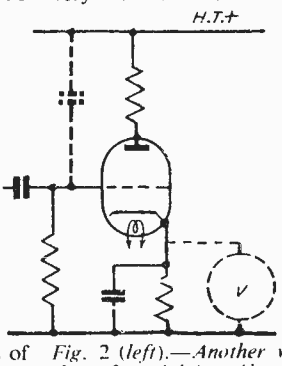


Fig. 1.—Checking for short-circuit.

The method has the added advantage that leaks are detected under H.T. conditions, which is not so if a usual bridge is used for the purpose. To check for an open circuit the suspected capacitor should be connected across a circuit where, if normal, it will have a marked effect, such as between grid, or anode, and earth of the sound output valve, when the top frequencies will be reduced quite noticeably (Fig. 3). The effect is still more apparent between grid or anode and earth of a video stage of a television receiver, the picture becoming very smeared, or unrecognisable. R.F. or I.F. circuits may also be used for the purpose when checking capacitors of up to 50 μF. With a little practice it is possible to check a suspected capacitor very quickly and, in particular, the test for very high-resistance leaks has been found very useful in field and bench testing.



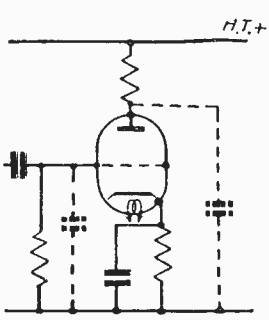


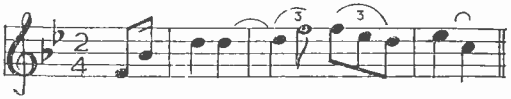
Fig. 2 (left).—Another way of checking a condenser. Fig. 3 (right).—Alternative positions at which condensers may be checked.

Identifying Musical Interval Signals—3

A SUMMARY OF SOME OF THE MORE POPULAR MUSICAL INTERVAL AND IDENTIFICATION SIGNALS USED BY FOREIGN TRANSMITTERS. A SPECIAL ARTICLE FOR THE LONG-DISTANCE LISTENER

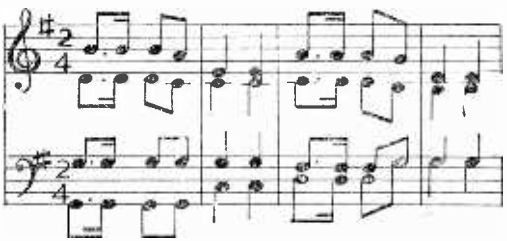
(*Continued from page* 486 *August issue*)

ALSO from Greece may be heard the main motif from the march "Greece Never Dies" played on trumpets at a very slow tempo. This interval signal is relayed from the Central Forces Radio Station at Athens and will probably best be heard in England on 80.36 metres. The following is approximately the air:



Greenland

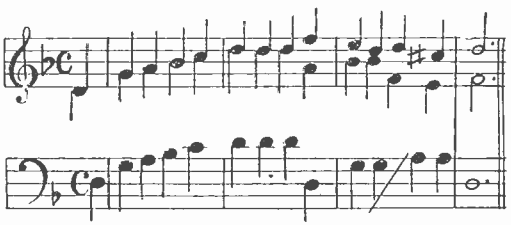
From the Godthaab Radio station strains from a Greenland melody "Sonja Kaligpok" which sounds



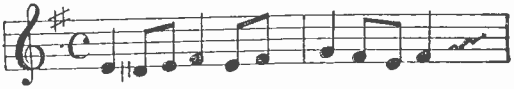
like this may be heard. It might be pointed out at this stage, however, that the interval signals which are given in these notes are those which are listed and not necessarily those which are heard in this country. As with all medium and short-wave stations, no definite guarantee as to range or audibility can be given. It may, for instance, be possible to receive loud and clear signals from a 1 kW station situated two or three hundred miles away, whilst a few hours later a 50 kW station less than 100 miles away may be inaudible.

Holland

From Holland there are two interval signals, the first



which is a part of the tune "O Nederland, let up u saeck, de tigt en stont is daer." This will be heard on the Hilversum frequency. Radio Nederland Wereldomroep radiates on many frequencies in many languages, including Afrikaans, Arabic, Indonesian, and on all frequencies part of an old Dutch folk-song ("Merk toch hoe sterck") will be heard played on a carillon or celeste. It goes like this:

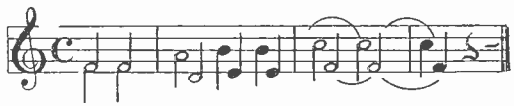


Hungary

There is only one melody likely to be heard from Hungary, and although broadcasts are made in a number of languages identification is rendered simpler as an English announcement is made from time to time. The interval signal which may be heard is as follows:

Iceland

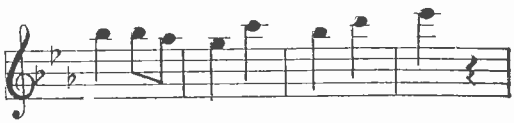
On the short-wave broadcasts from Reykjavik the following melody is usually heard as the commencement of broadcasts, although it appears to be repeated at odd times:



Some criticisms have been made concerning the notation used in some of these musical examples and it should be explained that they may not in every case agree with the standard English form. They are, of course, intended as a guide for those who are musically inclined and are, in fact, only of use to those who can translate the written music into melody or play it on some instrument so as to be able to recognise it. In the above example, for instance, musicians will readily observe that as it is in common time the second bar would in English notation be written with the first two minims on the same upright and the B and E of the next two groups would also be in the form of two-note chords, thus giving the correct four beats to the bar.

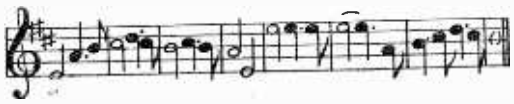
Luxembourg

The home service broadcast by Luxembourg is radiated on several wavelengths and in several languages a Luxembourg popular song played on a piano being its main identifying feature. The air is as follows:



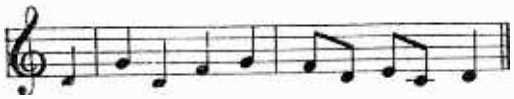
Monaco

From the small state of Monaco an extract from "L'Hymne Monegasque" is heard before and after every transmission. This is the air—

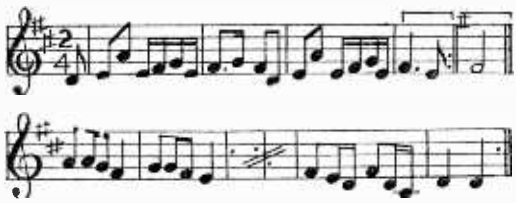


Norway

There are numerous broadcasts from Norway on medium and short waves and usually these are fairly easily identified by the constant repetition of the word "Norsk" or "Norga" in the announcements. A very simple interval signal is employed as follows:



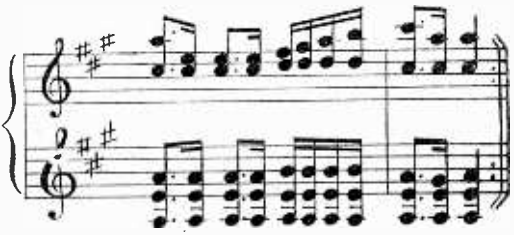
Services to foreign countries are given also on many different frequencies and all those which are directed to Norwegians living outside of Norway are introduced by a little Norwegian folk melody which goes like this:



At the beginning and end of these programmes a choir will be heard singing Norwegian music. There should be little doubt, therefore, when receiving these Norwegian transmissions.

Poland

Broadcasts in German, Russian, French, Spanish and several other languages are given on various frequencies from Warsaw, and relay stations are heard in many languages. There should be little difficulty in identifying any Polish station when the interval signal is located, as it consists of the first movement of the famous Chopin Polonaise in A flat major, which goes like this:



This signal is radiated by what is known as Warsaw No. 2 station, Warsaw No. 1 using the following melody:

(To be continued.)

G.P.O. Interference Analysis

A RÉSUMÉ OF THE YEAR'S TROUBLES FROM THE SOUND RADIO POINT OF VIEW

THE G.P.O. recently issued a detailed analysis of the radio and television complaints received and investigated in the 12 months ended January 16th, 1953. The following is the table which will most interest the readers of this magazine as it deals only with sound radio. It will be noted that one item is "Unknown; not observed by P.O. Staff." This refers to those complaints in which either the interference was so transitory that it had ceased before the P.O. engineer arrived to investigate, or it was so intermittent that it was not possible for a visit by the P.O. to coincide with the interference; no useful steps could therefore be taken by the authorities.

The G.P.O. point out that, apart from the causes usually under the control of the listener, such as inefficient aerial/earth systems, faulty equipment and faulty electric wiring, the most prominent cause of complaint on the sound side was radiation from time-base circuits of television receivers of the flyback E.H.T. type—a matter which is receiving the attention of the radio industry.

The most frequent causes of interference to reception of sound broadcasting expressed numerically and as a percentage of cases closed.

Unknown; not observed by P.O. staff	10,528	22.4
Inefficient aerial/earth systems ...	8,140	17.3
Radiation from T/V receiver time-base ccts.	5,697	12.1
Faulty receivers	5,284	11.2
Faulty wiring of buildings	2,408	5.1
Sewing machine motors	1,641	3.5
Fluorescent tubes	1,599	3.4
Refrigerators	1,110	2.4
Drills	996	2.1
Motors miscellaneous	946	2.0
Bedwarmers	800	1.7
Vacuum cleaners	647	1.4
Overhead power lines...	539	1.2
Radio transmitters	524	1.2
Hair-dryers	471	1.0
Smoothing irons	436	.9
Neon sign tubes	362	.8
External cross modulation	305	.6
Sodium lamps, street lighting ...	282	.6
Fan motors	252	.5
Calculating machines	238	.5
Generators	192	.4
Dental motors	150	.3
Lamp flashers	148	.3
Washing machines	144	.3

On your Wavelength

by THERMION

Pictorial Service

MY paragraph inviting readers to state whether they would prefer pictorial wiring diagrams as well as circuits has brought a most interesting crop of letters from readers who still are unable to follow the usual theoretical circuit diagram. Some of these readers state that there are articles that are too technical and welcome the new series for the beginner written by the Editor. The volume of letters asking for pictorial diagrams has been so great that I have passed them along to the appropriate quarter with my own recommendation that, in future, articles which lend themselves to this form of illustration should have that style of diagram.

Personally, I have always found such diagrams more difficult to follow than the circuit. As far as the usual wiring diagram is concerned I use it only as a templet for the location of the components, preferring to complete the wiring from the theoretical diagram. But then, I have been building sets almost from the commencement of the hobby and it is probable, therefore, that I have presumed that readers' skill has progressed with mine. It is a common error. One can forget that every year newcomers enter the field who are anxious to learn. On the other hand, I do know that some readers have criticised P.W. because its articles are not sufficiently technical. I have heard this criticism at the end of my lectures. It is part of my duty to report these comments back to headquarters where they are always given sympathetic consideration.

Mr. S. R. Davies, of Colindale, N.W.9, is quite forthright about the matter. In a lengthy letter in which he proceeds to eviscerate me, he backs up the comments of Mr. White, of Swindon, whose letter I recently quoted. He disagrees with my statement that we do cater for the amateur. He says that he will defy any novice to understand any of our articles ! If that was strictly true this journal would rapidly go out of existence. He bases his statement on the fact that " he knows because he has tried." Well, we must admit failure in his case if, after his seven years of readership, he still cannot understand a circuit diagram, and he threatens to give up the hobby !

I therefore invite further correspondence from beginners on this subject. This journal exists to serve and to give the majority of readers what they require. Its ever-growing circulation has never caused us on the staff to lapse into complacency. Judging from the number of letters received, the new series for the beginner should help readers like Mr. Davies and Mr. White. As in a school there must always, I suppose, be scholars who are good at history but are clots at mathematics and vice versa. We all tend to underestimate the fellow who is not up to our standard in a particular subject, unmindful of the fact that we might be equally dumb in a subject in which he excels. I readily admit that. You may rest assured that if beginners exist in large enough quantities a proportion of the pages of this journal in ratio to the circulation would be devoted to their special interests. One can only judge by letters from readers as to the quality of technical knowledge they possess, and design articles up to that standard. It is, in spite of all this, reasonable to assume that the average beginner taking up radio for the first time understands more about radio when he starts than his counterpart of thirty years ago. The knowledge of a regular reader should increase issue by issue, but the new readers must not be neglected. If *you* are one of these will you write to me and express your views, addressing the envelope to me with the word " Beginner " in the top left-hand corner of the envelope ? I want to analyse a cross section of this part of our readership.

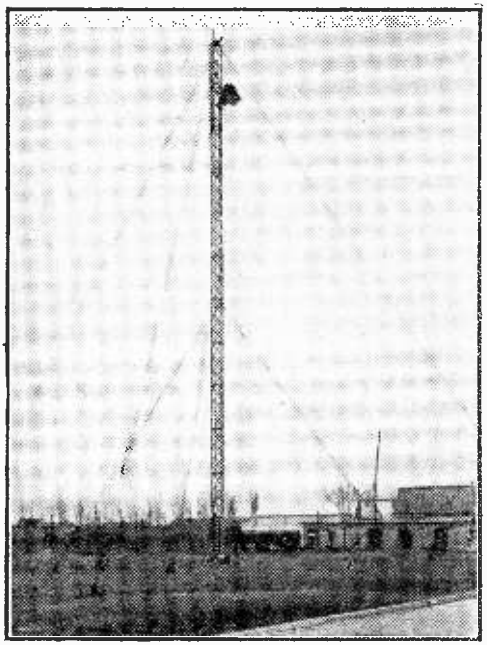
Sponsored Programmes

THE very ample report of the Beveridge Committee on broadcasting, in which it expresses a recommendation that the BBC monopoly on sound broadcasting should continue, but that its monopoly on TV should be broken, seems to me to have been a three years' waste of time. The Government, having committed itself to sponsored TV programmes to the extent of publishing a White Paper on the subject, is apparently having second thoughts on the matter and does not propose to make a statement on the subject until the autumn. It is scandalous that after a very thorough investigation into the pros and cons of Government-sponsored monopolies by the Beveridge Committee, the Government should now listen to the bleatings of the Church, all of whose views were adequately presented before it and rejected. Dr. Garbett, Archbishop of York, who admits that he has never watched a television programme, adopts an Inge-like attitude on the matter. He thinks that sponsored programmes will exert an evil influence. It has not done so in America. It is my belief that there is no sincerity behind this Church opposition. The Church is more concerned with the declining church-going population than it is with the ethics of TV advertising.

I should have thought the Church would have welcomed the advent of this new method of spreading the Gospel in the quickest possible manner to the largest possible congregation—a congregation which could not be housed in any one church. Much better, as has been pointed out elsewhere, for one man to preach to the vast TV congregation than for thousands of parsons up and down the country to preach in the churches to those already converted. At least there would be unanimity of views in TV services instead of the diversity of interpretation under the present system of preaching the Gospel. The biblical exhortation is " go ye forth into all the world and preach the Gospel." What better method than by means of the all-pervading ether ? The Church opposed radio in its early days for the same reason, but now gladly takes advantage of it for its Sunday radio services. If sponsored TV is not permitted here sooner or later it will be provided for us from the continent. Much better to keep the money in the country.

Portable Test Masts in Aluminium

FINDING SITES FOR RELAY STATIONS



An aluminium test mast erected to half its full height of 200 ft. At the head of the mast the light-alloy erection pole can be seen.

THE system of wireless transmission at "very high" and "super high" frequencies is now being used on an increasing scale for television and telephone links. As the short waves are effectively interrupted by physical obstacles such as hills, or the curvature of the earth, the system requires a series of receiving and retransmitting stations within "visual" range of each other and hence at relatively frequent intervals along the line of transmission.

Establishment of a new line has to be preceded by tests to discover the best site for each relay station and the height of mast that will be needed, and for this work pairs of temporary test masts, carrrying transmitting and receiving equipment, are employed. Structurally, these test masts must be easily transportable to the sites over all types of country and capable of being quickly erected and dismantled by a small crew. A further essential is that the height of the directional transmitting and receiving aerials and reflectors on the masts should be readily adjustable.

A pair of 200ft. high test masts to meet these requirements has recently been built for Standard Telecommunication Laboratories, Ltd., by Painter Brothers, Ltd., Hereford, to the design of British Insulated Callender's Construction Company, Ltd. It will be seen from the illustration above that each mast is of lattice construction, triangular in cross-section, and is built up from a number of short, easily-handled lengths. It is guyed at several points.

The material chosen for the structure was the aluminium alloy Noral 51SWP, supplied by Northern Aluminium Company, Ltd. This alloy, which meets B.S. 1476 HE10, is of the aluminium-silicon-magnesium type now widely used for structural work, having a typical tensile proof stress of 18 tons/sq. in. and sufficient durability to enable it generally to be used without painting. In this case, the lightness of aluminium alloy was obviously attractive. The possibility of welded steel construction was investigated but ruled out on grounds of weight alone; it is generally safe to say that aluminium, with a density one-third that of steel, will in practice yield a structure of about half the weight of a steel one. Transportation to the site is simplified, and erection and dismantling greatly speeded up. Each length of mast, 8ft. 4in. long, weighs only 110lb. and is easily handled by two men aloft with the aid of a light-alloy erection pole.

Bolted construction was chosen for the mast, so as to enable the individual lengths to be further broken down to any degree necessary for shipment over long distances, for instance by sea. In general the bolts are of Noral 51SWP alloy like the members, but high-tensile steel is used for the bolts that connect each length to the next. Mild steel is used for various details at the butt joints and at guying points. All steel parts are galvanised to prevent atmospheric corrosion and to avoid any possibility of galvanic interaction with the aluminium.

A special section was designed for the main leg members, which assist in guiding the test equipment up and down the mast. The readiness with which complex, multi-purpose sections can be produced by extrusion is, of course, one of the advantages of aluminium as a structural material. A central Coburn track is also provided on one face of the mast. All diagonal bracing members are 1¼in. by 1¼in. by ¼in. equal angle, and short horizontal pieces are fitted as steps.

At the butt joints between the lengths of mast, the connections are made through welded steel fittings on each leg. The fittings embody ⅜in. steel plates, one shaped to fit inside the leg section and one outside. The aluminium web is thus trapped between them and held by six ½in. diameter light alloy bolts. To the edges of the steel plates is welded a lug drilled to take two ½in. diameter H.T.S. assembly bolts. Six bolts in all therefore have to be inserted and tightened for each length of mast. Guys are attached to welded steel lugs fastened to the outside of the legs by two ½in. diameter M.S. bolts. The bolts pass through a steel reinforcing plate shaped to fit inside the leg section.

One 200ft. mast, complete with steel head and base plates, wire ropes and fittings but excluding anchorage pickets, weighs just over one-and-a-half tons. With all materials on site and the pickets driven in, the whole structure can be erected by six men in an eight-hour day; where the full height is not required, erection time is reduced. The first two masts have proved themselves satisfactory in service and a further six are being built, though development work is still proceeding and may show the possibility of further improvement.

The Reproduction of Disc Recording

INTERESTING DETAILS AND CIRCUITS FOR THE GRAMOPHONE ENTHUSIAST

By J. B. and R. E. Gregory

A MEANS of recording sound in permanent form has existed for more than fifty years, but through this half-century three different processes have been developed. Improvements have been so rapid that the extremely high quality of the sound recordings now available necessitates extreme care in the manufacture and arrangement of the reproducing apparatus if faithful reproduction is to be obtained.

The three recording systems are styled mechanographic, magnetic and photographic. Each has certain advantages, so it cannot be said that one will eventually replace the others; the systems are really complementary rather than interchangeable. For the reproduction of music in the home the disc form of the mechanographic system has come into general use, mainly because a recording of this description is permanent—an essential consideration if recordings are to be sold and performing rights therefore involved. It is this form of recording that is to be considered.

The Reproducing Chain

(1) *The Disc and the Groove*

Until quite recently, all discs were made of some form of shellac: each manufacturer claimed that his patent recipe was superior to that of his competitors. The development of plastics has, however, given him a superior material, so modern discs are made of some variant of vinylite or lacquer.

Early discs varied in speed between about 65 and 85 revolutions a minute, but gradually 78 became accepted as standard, and references to "standard discs" will henceforth mean those which were recorded at that speed.

"Standard" and "Microgroove"

The microgroove recording plays at 78, 45 or 33⅓ r.p.m., and as there are two and a half times as many grooves to the inch playing times of 25 minutes are possible from a twelve-inch disc, compared with five minutes from a standard recording. The new record is superior to its predecessor in that the noise level is lower (around −50 db. compared with the signal as against −20 db.). In addition, the disc itself is "unbreakable." The new materials are, though, rather softer than shellac, and although higher frequencies can be recorded great care must be taken in the design of the reproducing needle and the pick-up head, or the higher frequencies will be obliterated after a few playings; for when the needle is tracking a note of frequency in the region of 12 kc/s the accelerations involved are very high and considerable force is exerted on the walls of the delicate groove. In passing, it is worthy of mention that a vinyl disc will not stand a sharp dig with a finger-nail when being withdrawn from its cover.

The greater proximity of one groove to another on a microgroove record results in a lower recording level, necessitating greater amplification when reproducing. Considerable difficulty may be experienced in obtaining sufficient output to load the average commercial wireless unless a crystal pick-up is employed, though the high sound quality possible from the new long-players causes them to deserve a better fate than mere "plugging in the back."

The Old and the New

Experiments with acoustic standard recordings and even electric recordings which were made before about 1935, led to the following conclusions. Modern apparatus in the shape of light-weight pick-ups and sapphire needles is of little practical value in trying to get the best out of these older recordings. Groove widths and depths were far too variable for the precision ground stylus to trace smoothly, particularly at the low downward pressures that are now normal. Since the higher frequencies are not on the record anyway, the best results are obtained (without any question) from a medium-weight moving-iron or crystal fitted with fibre needles. These needles will adapt their shape with amazing rapidity to suit the groove; thus their very weakness for high-fidelity work is their strength when tackling old favourites. The pick-up must, however, be of free movement, or the needle tip will tend to shatter altogether and will not then trace the groove at all.

Having said that, consideration will be confined henceforth to quality work (where reproduction can justifiably be compared with the original performance); it will be assumed that recordings themselves are of recent origin.

(2) *The Pick-up*

The duty of a pick-up is to follow the groove by means of a needle (or stylus) and to convert the waveform represented by the vibrations of the groove into an exactly similar electrical one, introducing no distortion in the process. At the same time it must be sufficiently light and free of movement to produce a minimum of wear both on the record and on its own stylus. In addition, the frequency of resonance should be outside the audible spectrum, which means above a frequency of 18 kc/s. Since transient vibration is likely to occur in degrees of freedom other than that required to trace the waveform of the groove, a certain amount of damping will be necessary to remove these vibrations.

Thus the factors concerned in the design of the ideal pick-up (against which any given type may be compared) are:

(i) The effective mass of the moving element must be small in order to reduce wear and to obtain a high resonant frequency.

(ii) The compliance of the needle or armature suspension must be adjusted in relation to the effective mass to ensure the correct frequency of resonance.

(iii) Sufficient damping must be applied to eliminate any spurious vibrations in degrees of freedom other than the degree required.

(iv) A high degree of stiffness is required between the stylus and the E.M.F. generating element, to avoid frequency distortion due to the stylus and this generating element not vibrating in an exactly similar manner.

As has been said, these properties would exist in the ideal pick-up head, but this ideal cannot be obtained in practice, for elements of extremely small mass and high stiffness cannot be obtained, and mass-production sets a limit of practicability on the accuracy of manufacture. Distortion in one form or another will therefore occur, and methods of dealing with such distortion must be examined.

Distortion

(i) Attenuation Distortion

Such distortion is due to variation in gain with frequency. The usual effect is a loss of gain at frequencies above about 7 kc/s and below about 200 c/s. The characteristic is very nearly flat between these two frequencies, falling, usually quite rapidly, outside them. When music is being reproduced this means poor quality in the stringed instruments owing to the loss of harmonics ; extremely poor quality in (or even complete absence of) the higher-frequency percussion instruments such as triangles ; and, in the lower frequency range, bad quality in, for example, organ music where the frequency range may extend down to 50 c/s. To correct this distortion, the circuit must contain a component which offers a greater impedance at certain frequencies than at others.

In some badly designed pick-ups, the resonant frequency may occur within the audible range, causing a high peak in the characteristic curve. This may be overcome by the introduction into the circuit of an inductance tuned so as to produce an opposite effect and so cancel out the peak.

(ii) Harmonic Distortion

This appears with the production of harmonics in the output which are not present on the record ; it is caused by a non-linearity in the reproducing system.

The effect may be produced by the stylus (particularly when it is fairly long and not very stiff) moving in a secondary mode of vibrations, so producing a harmonic of the note that is being tracked. Or, if the moving element is not accurately centred, movement to one side will produce a greater E.M.F. than movement to the other ; the effect is similar to that caused where, in a push-pull amplifier, one of the valves has a low emission so that both odd and even harmonics are generated.

This distortion is not unduly important provided the amplitude of the harmonic generated is small compared with the fundamental, as is usually the case. The effect is more important in the amplifier, where non-linearity in the valve characteristics may give rise to harmonics of considerable amplitude.

(iii) Intermodulation Distortion

This is almost certain to occur whenever harmonic distortion is set up, for both effects are produced in a somewhat similar manner. Intermodulation distortion consists in the production of combination frequency tones in the output by the non-linearity of a network, when two or more tones are applied at the input. For example, if frequencies f_1 and f_2 are applied at the input, there may arise frequencies $(f_1 \pm f_2)$ or $2(f_1 \pm f_2)$ at the output.

Quite often these combination tones are not harmonically related to any of the inputs, and so they produce a very discordant noise. When, as is frequently the case, the combination tones are either too quiet to hear or fall outside the audible range of frequencies, the effect may be disregarded ; however, when a full orchestra is playing, a great many of these tones may be produced, and they appear as an indefinable background noise, which clears as soon as the sound becomes less complex or when the sound level falls off.

(iv) Amplitude Distortion

This arises when there is a lack of consistency in the ratio between the output and input voltages for different amplitude values of input. This effect may occur when the method of suspending the stylus is not perfect. It is not serious as the only result is a loss of volume, which is usually not very noticeable.

(v) Other Distortion Effects

There are a few other effects which should strictly be dealt with under the previous distortion headings, but which can be best investigated separately in view of the manner in which they arise.

The Pinch Effect

This rather picturesque (though apt) title is given to an effect arising from the difference in shape between the recording and reproducing styli. That used for recording is more or less flat with pointed ends ; this is to obtain a clean cut and smooth grooves. The stylus used for reproduction, however, is circular in section. This is shown pictorially in Fig. 1.

It will be seen that if the reproducing stylus fits the groove during the straight portions of the modulation, it will be too small to trace accurately the peaks of the groove ; indeed, in order to touch the groove at all it will have to move further down the triangular section of the groove. As the note is traced a vertical stylus movement will occur. True, this movement will be small ; but as it is at twice the signal frequency, considerable accelerations and forces will be involved.

Thus it may be seen that the stylus must have a low mechanical impedance to vertical as well as to horizontal movement. Since this up-and-down movement must not be transformed into sound, a pick-up must be devised wherein vertical movement of the stylus does not result in an induced E.M.F. It is claimed (with some justification) that the tongue-like protuberance on which the stylus of a modern crystal is mounted helps to overcome this pinch effect by permitting vertical movement of the stylus without

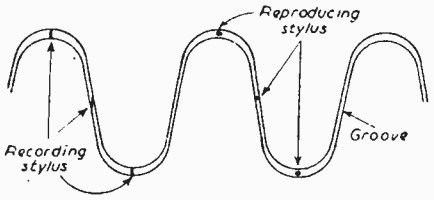


Fig. 1.—The pinch effect. Note the variable width of groove.

the necessity of raising the entire pick-up head and arm.

Radius Compensation

As the pick-up head moves toward the centre of the record the velocity with which the record passes under the stylus decreases, and as the recorded wavelength decreases it is increasingly difficult for the reproducing stylus to follow the groove. In addition the output of the reproducing head falls. This tends to produce a characteristic which falls as the frequency increases. The only method of curing this fault is to increase the recording level at high frequencies as the centre of the disc is approached. This, however, makes the curvature of the waveform more acute, thus increasing the distortion. A compromise must therefore be effected between frequency response and distortion ; the aim must be the minimisation of the listener's objection. Nothing practicable can be done in reproduction to overcome this difficulty.

Pick-ups in Practice

Various types of pick-up have been designed, all seeking to fulfil, as nearly as possible, the requirements of the ideal previously described. Most of them are magnetic in operation, although the crystal pick-up, whose principle of operation is electrostatic, is very popular. The relative performance of each type is not the only consideration : manufacturing costs are important where the commodity is to be marketed.

Types of Pick-up

(i) Moving Coil

This type of pick-up consists of a plastic former upon which is wound a coil of fine wire, usually of but some 50 turns in order to reduce the moving mass. A stylus is fixed into the former, which is so pivoted that it may rock about its axis, as shown in Fig. 2. A small but powerful magnetic circuit is placed round the coil so as to produce a horizontal field ; thus when the stylus is moved an E.M.F. is generated in the coil. Damping is provided either by rubber or by plastic on the pivoting mechanism ; alternatively, the whole coil may be immersed in petroleum jelly.

(ii) Moving Iron

This comprises a piece of iron carrying the stylus fixed at one end to a block of rubber ; the iron moves between a coil and the poles of a magnet. The coil is circular in shape, the armature passing first through its central hole and then through the gap between the magnetic poles. The change in flux in the armature as it vibrates sets up an alternating E.M.F. in the coil. As the coil is not required to move, it can have many turns, so giving a greater output than is possible with the moving coil. Damping is provided by the rubber suspension block.

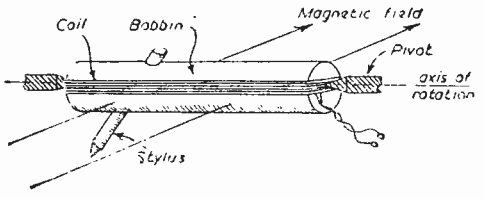


Fig. 2.—Moving coil pick-up.

The familiar XMS pick-up provides a clear example of this type of pick-up in its simplest form.

(iii) Crystal

This type is fundamentally different from the other two types in that its method of operation is electrostatic instead of magnetic.

When a mechanical force is applied to certain crystals it is found that they generate a potential in a direction perpendicular to that in which the force was applied. This potential is directly proportional to the applied force, and so the charge is proportional to the displacement. It will be seen that with suitable mounting the resultant E.M.F. will be proportional to the stylus displacement.

The arrangement is used in the ACOS Microcell, which is represented diagramatically in Fig. 4. The

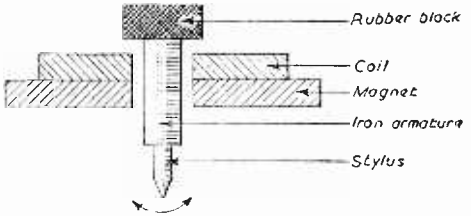


Fig. 3.—Moving iron pick-up.

crystal element is mounted in a plastic gel, which provides the necessary damping. The stylus is mounted on the end of a cantilever " tongue " ; as has been said, it is claimed that the vertical compliance so gained reduces wear and pinch effect.

Comparison of the Pick-up Types

If efficiency is defined as the ratio between electrical output and mechanical input, the crystal is, beyond question, the most efficient, for the efficiency of the magnetic units is around 5 : 100, while that of the crystal is greater than 60 : 100. Of the magnetic types, the moving iron has the higher output, its final limitation being the amount of flux the armature can carry. This cannot be raised beyond a certain point without introducing a risk of the armature clinging to one of the pole-pieces. The moving coil has no such limitation, and in theory its output could be increased by increasing the strength of the magnet ; however, no magnetic material is known which could raise the efficiency to a level comparable to that of the crystal.

The moving coil results in the least distortion, principally because the magnetic field does not alter the restoring force provided by the suspension, as it does in the moving iron. To overcome this defect in the latter case a wide air gap must be used, but this reduces the output.

(To be continued.)

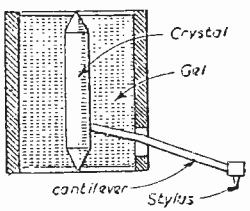


Fig. 4.—Crystal pick-up. Note cantilever mounting of stylus, which gives vertical compliance and therefore reduces pinch effect.

D.C. Supplies for

DETAILS OF A SIMPLE BATTER'

By T.

FOR most radio men, professional or amateur, battery receivers have much to recommend them and particularly so if they have one or two short-wave bands. Even for those of us who have been using mains operated receivers for years there is a feeling that we should like to get back to battery operated. The reason for this feeling is not hard to find and lies principally in the low noise level and generally quieter background of the battery receiver as compared to that of an A.C. operated instrument. Switch on a communication receiver, swing the tuning off signal and the gains up, and you will get an idea of what I mean!

Unfortunately, battery receivers have two great drawbacks: (a) the necessity to have batteries always on hand and, in the case of accumulators, always charged, and (b) the fact that they are not particularly easy to service.

To the enthusiast who has no mains supply and is entirely dependent on batteries little can be done to remedy the situation except, perhaps, to install a wind-driven dynamotor, such as those used on American command receivers, which will certainly free him from the bogies of H.T. battery replacement and accumulator charging, for a very moderate outlay. But for the man who has mains supplies available and uses a battery receiver from preference or occasionally services one for friends the position is very different and his difficulties can be overcome quite easily by constructing a battery eliminator to replace both L.T. and H.T. batteries. Such a unit (Fig. 1), is not difficult to construct and, provided the smoothing on the L.T. side is adequate, a receiver built specifically for short-wave reception or one of the many ex-Service battery receivers available, operated from the unit, will give a much superior performance to that of the average A.C. receiver in actual signal-getting qualities and at the same time the unit will always be available for testing any other receiver which may come along, such as those of friends.

The unit to be described, which fulfils this purpose admirably, utilises the minimum of components and many of these will be found in the junk box or can be obtained very cheaply from surplus dealers advertising in P.W. This particularly applies to the rectifiers and high capacity smoothing condensers for which, normally, there is not a very great demand.

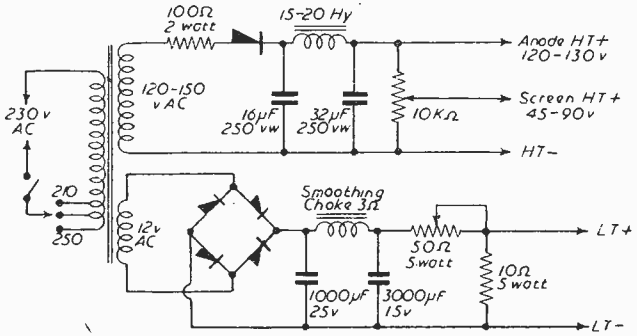


Fig. 1.—Theoretical circuit of the eliminator.

The eliminator is built on a chassis 8in. x 6in. x 2½in. deep of 16 gauge aluminium and the mains transformer, smoothing chokes and condensers are mounted on the top as shown in Fig. 2. All other components—principally resistors and rectifiers—are mounted beneath the chassis, and the two variable controls are brought out on one of the long sides of the chassis, close to the insulated supply leads with which they are associated. Fig. 3 gives a below chassis view showing the layout of these components.

L.T. Output

The only difficulty encountered in designing the unit was in determining the output voltage for the L.T. side, having regard at the same time for what components are readily available. Many personal receivers, both British and American, have series filaments operating off a 7.5 or 9 volt battery and, obviously, therefore if the eliminator is likely to be used on such receivers it must have a similar output voltage. On the other hand, thousands of British battery sets have paralleled filaments supplied from a 2 volt accumulator with a dropping resistor where 1.4 volt valves are used, as in modern types. The unit must, then, go down to this voltage too. For these reasons the output has been made variable between these limits by means of the control provided.

A similar situation obtains with the H.T. to some extent, for while the supply to the valve anodes can be the full output of the unit, which is between 120 and 130 volts, some control is advisable on the screen grid supply, which may call for anything between 45 and 90 volts, according to the particular make or type of receiver being tested. Moreover, unless steps are taken to ensure some stability, variation of the screen voltage will

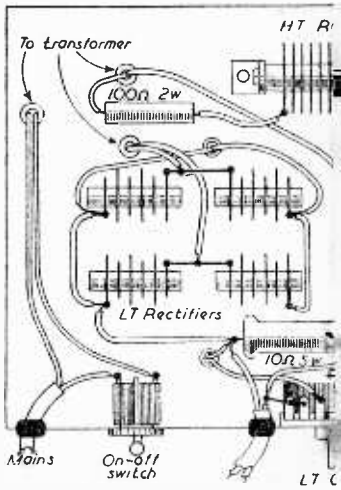


Fig. 3.—Wiring diagram o

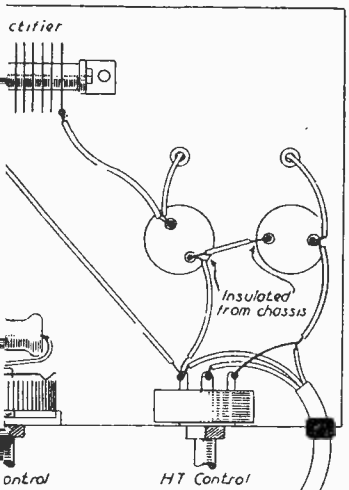
Battery Receivers

ELIMINATOR FOR H.T. AND L.T.

V. Dresser

also cause a variation in the anode supply. The variable screen voltage control incorporated in this unit will have negligible effect upon the anode supply and yet will control the screen voltage within the limits indicated.

As the power taken from the transformer is very small it need not be of massive dimensions and, indeed, many amateurs may already have one around which is suitable. All that is asked is that it is capable of supplying 120 volts—the figure is not a set one and 125, 130 or even 150 volts will serve equally well if such a transformer is on hand, and provided a fixed resistor is placed in the anode feed lead to reduce it to the required figure—at a maximum of perhaps 30 mA and 12 volts at one ampere. In regard to the L.T. it is unusual to find a transformer with a 12 volt winding, but this difficulty can be overcome quite easily by connecting two 6.3 volt windings in series or even, if nothing else is available, two 5, a 6.3 and a 5, or a 4 and a 5 volt winding. But in doing so care should be taken to see that the windings are truly in series and are not opposed, i.e., that the output voltage from the combined windings is 12.6, 11.3, 10 or 9 as the case may be. It is extremely easy to connect them in such a way that the output voltage is 6.3 – 6.3 = 0, and so on, and this would result in a badly overheated winding if not a ruined transformer. As the voltage from the rectifier may not be more than 9 or 10 volts, and at the maximum 12.6, and we require 9 at the output terminals, the smoothing choke must be of very low resistance. The writer wound 400 turns of 20 s.w.g. enamelled wire on an old transformer core which had a centre limb of 1in. x 1in. x 1.5in. and the completed choke had a resistance a little less than 3 ohms. A suitable alternative would be the type of choke used in car radios which has an even lower resistance.



f the underside of the unit.

The remainder of the components require little description. The variable control on the L.T. supply must be a wire-wound item capable of carrying at least five watts without overheating. This also applies to the load resistor, inserted to prevent an undue rise in voltage when the receiver load is removed.

When the various L.T. voltages required have been found by varying the control potentiometer some method of quickly identifying them should be used in order to prevent accidentally applying a higher voltage than that required and thereby burning out a set of valves. Spots of paint of different colours will do or a marked paper dial.

The rectifiers used are standard selenium assemblies rated at approximately 12 volts 1 ampere and purchased at a surplus store, and the H.T. smoothing choke is a standard 15 Henry component obtainable at any dealer's. The inductance is not critical and 10 or 20 Henry will serve equally well. Positive and

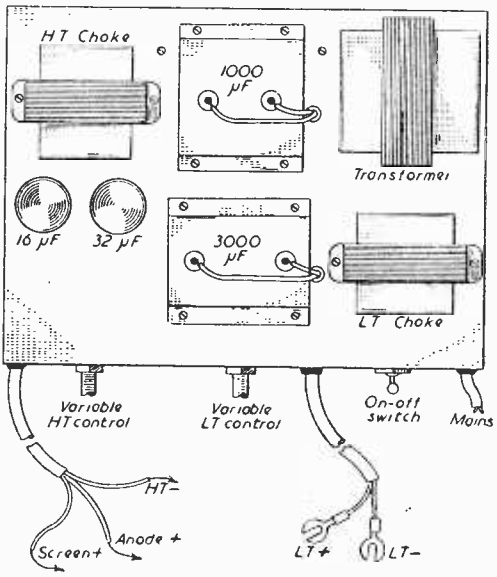


Fig. 2.—Plan view of unit.

negative connections for both supplies are brought out in insulated flexible wire because differences in receivers are such that H.T. and L.T. negatives may not always be "commoned." Two spade terminals are used to terminate the connections, black and red respectively, and the leads are about 2ft. long to save moving the unit about the bench too much.

In conclusion, a final reminder may not be out of place. Do check the L.T. output voltage before connecting the unit to a receiver. A little time spent that way is better than a ruined set of valves.

The Problem of Fidelity

SOME INTERESTING DETAILS FOR THE QUALITY ENTHUSIAST

By R. Hindle

THE maker of musical instruments has as his aim the production of an instrument that, apart from covering the range of audio frequencies considered proper for the particular kind of instrument, is capable of giving, when in the hands of a talented performer, a satisfying quality of tone by the addition of overtones and formative tones to the fundamental frequency that it is producing. The instrument has to be given an individuality —a tonal quality that distinguishes it from all others. The designer of electronic reproducers, on the other hand, is anxious to prevent any showing of individuality and to subordinate completely the personality of his equipment to that of the matter that it is to reproduce. To allow it to superimpose anything of its own making is to cause distortion. The purpose of the reproducer is not merely to produce a pleasing noise but rather to produce an exact replica of the original, pleasant or otherwise.

In the various branches of electronics there are many different kinds of signal requiring faithful reproduction and the principles applied are similar in all cases. Fundamentally, the intelligence is translated into electrical fluctuations which have to be amplified and reconverted into readable form, according to its purpose. A picture of the electrical fluctuations can be drawn in the form of a graph, which is then said to indicate the waveform, and these can take on an infinite variety of shapes, but fortunately all these shapes can be shown to be combinations of waves all of one simple form, the sine wave form, of varying frequency, amplitude and phase, and it is practicable, therefore, to approach the problems of fidelity from the point of view of the reproduction of sine waves of various dimensions. When a single frequency is spoken of a sine wave of that frequency is indicated ; if it were anything else but a sine wave it would no longer be a single frequency but would, in fact, be a combination of a number of frequencies.

PRACTICAL WIRELESS has as its special concern the reproduction of sound and it is from this point of view that the problem is approached. Sound is a mechanical vibration conveyed in the form of waves of pressure through the air, and convertible into equivalent electrical waveforms by means of microphones. Sound waves can vary in three respects ; in frequency or pitch, in intensity or loudness (equivalent to amplitude in the resultant electrical waveform), or in phase, a variation in phase arising by delaying the sine wave without altering in any way its waveform. The range of frequencies involved in speech is between the extremes of 100 c/s and 10,000 c/s. Musical instruments extend over a wider range, an orchestra requiring reproduction from 40 c/s to 15,000 c/s ; there are some difference tones even below this range. The sound intensities encountered in speech vary over a wide range, the loudest being some 500,000 times that of a faint whisper, whilst the maximum sound from an orchestra may be 10,000,000 times as great as its minimum. For true fidelity audio frequencies must be reproduced even though they may be above the audible perceptibility of the listener. This may seem absurd at first glance, but the reason is that the frequencies above audibility interact with lower frequencies, the ear itself being to a degree non-linear and acts as a detector, to produce interfering frequencies within the audible range that the ear requires to form the illusion of perfect quality of reproduction.

Binaural Effect

Another factor affecting the quality of sound is the binaural effect, i.e., the effect of listening with two ears. Sound travels through the air at the relatively low speed of approximately 1,130 ft. per second. Supposing that the sound emanates from one side of the listener. The wave strikes the near-side ear first, but takes a little longer to travel to the other ear : in other words, the message to the second ear is slightly delayed and the signals in the two ears are a little out of phase. The brain can detect these phase differences and from them can estimate the direction from which the sound comes. Some such phase difference will occur when the sound arrives from any direction except from immediately in front or behind. So the binaural effect gives the sense of direction to the function of hearing and also the effect of size of the sound origin, i.e., the effective spread of an orchestra compared with the compact source of a single instrumentalist.

It should be noted that the true effect of binaural listening can be conveyed electronically only by two entirely separate channels, two microphones in the relative positions in the auditorium feeding entirely separate transmitting chains (though possibly carried by the same carrier) which are accepted by entirely separate receivers, each of which feeds its signal to only one ear of the listener. It is quite useless, from this point of view, to split up the signal receiver over a single transmitting channel in an attempt to feed binaural signals to the listener, and it is equally absurd to use a twin- or multi-speaker system from a single channel, splitting the signal on a frequency basis by means of cross-over networks, and to separate the speakers appreciably in the hope of simulating the effect of binaural listening. If only one transmitting channel is to be used its limitations have to be accepted and the listener must resign himself to what is in effect monaural listening with the resultant loss of directivity. Under these circumstances, which are normal in present-day methods of reproduction, all the sound should preferably come from a single point and ideally a single, wide range speaker would be best, other things being equal. If, for practical purposes, a greater overall range of frequencies is obtainable, or if other forms of distortion can be reduced, by using a multi-speaker installation, then the various units should be as close together as possible so that the sound source is as near as practic-

able to a single point. If this is not done the component parts of a single sound will be torn apart so that, for instance, the fundamental note played by an instrument may emanate from the bass speaker, the middle harmonics that should accompany it come from the middle-range speaker and the higher harmonics come from the tweeter. If these speakers were widely spaced the sound of a single instrument or a vocalist will appear to be smeared over a wide area instead of coming, as it should, from a single point. The binaural property of the hearing mechanism will then create an absurd illusion.

The ear itself is far from being a perfect device from a scientific point of view. Normally, frequencies down to 20 c/s can be heard and noises below this frequency are perceived by the sense of feeling rather than hearing. At the other end of the range, few people can detect frequencies higher than 20,000 c/s, the upper limit tending to fall with age. Sensitivity of normal hearing varies with frequency, weaker signals being audible within the range 1,000 to 3,000 c/s usually than at higher and lower frequencies. An upper limit of volume is set by the " threshold of feeling " above which sounds are painfully loud. The threshold of feeling also varies according to frequency.

Intensities of sound are estimated by the ear on a logarithmic basis. This means that the ratio of sound intensities is involved, not the absolute intensities. Thus, a 100 per cent. increase in intensity from, say, 1,000 to 2,000 pressure units is no greater in effect than an increase from 10 to 20 units, also 100 per cent. increase. The smallest perceptible change in sound intensity is about 10 per cent.

The logarithmic scale also applies to pitch. A two-fold increase in frequency is equivalent to one octave. Thus, a note of 200 c/s is an octave above a note of 100 c/s, and there is precisely the same difference of one octave between notes of 20,000 c/s and 10,000 c/s.

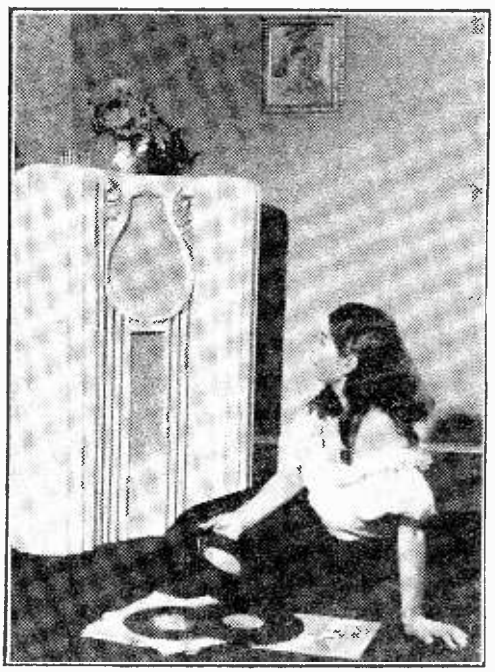
Types of Distortion

The following types of distortion are likely to arise :

(1) Frequency distortion, i.e., the limitation of frequency range. In a broadcast receiver or other form of reproducer intended to handle music a response of from 40 c/s to 15,000 c/s might be accepted as reasonably distortionless. A cut of one octave from the bass response (making the lower limit 80 c/s) is not very noticeable on most kinds of music and the illusion of adequate bass is helped, under these limited conditions, by the ability of the hearing mechanism to reconstruct a fundamental when harmonics are heard. This effect has been turned to good account in at least one practicable amplifier design in which the bass reproduction was severely limited but the harmonics of bass notes were artificially accentuated to produce the illusion of true bass. At the upper end of the audio spectrum the clipping off of one octave (to a limit of 8,000 c/s) still allows quite good reproduction. Such limitations will not be accepted under the title of fidelity, however.

(2) Amplitude distortion is the introduction of variation in the amplitudes of different frequencies compared with the original. The effect of variation in amplitude is not in itself very serious because generally it can be corrected, though for highest fidelity the amount of correction required should be kept to a minimum. More serious trouble arises from the non-linearity of the device or circuit causing the amplitude distortion, because it gives rise to the production of harmonics that were not present in the original and also, even more seriously, it acts as a partial detector allowing interaction between component frequencies producing " sum " and " difference " frequencies. This is why non-linear devices such as tone controls and cross-over networks are themselves liable to introduce distortion. Often the problem is not to avoid distortion so much as to decide which of two forms of distortion, one of which is inevitable, can be tolerated. Amplitude distortion is the common result of overloading an amplifier stage.

(3) Phase distortion refers to the shifting in relative phase of the various component frequencies of a signal ; a phase shift of all the frequencies in the signal by the same time interval is not distortion but merely time delay. For instance, there is a change in sign (positive to negative and vice-versa) from grid to anode of the perfect valve that is equivalent to a phase shift of 180 deg., but all frequencies are affected similarly and so this is not distortion. The intervalve couplings do cause phase shift depending on the frequency of the signal and so do cause phase distortion. The ear is incapable in the ordinary way of detecting phase distortion unless the phase shift is so great as to introduce an appreciable time delay (more than about 0.04 seconds). Phase distortion does, however, noticeably upset the reproduction of transients, i.e., sharp, sudden sounds such as the clash of drums or handclaps. These require a sharp, steep wavefront amounting practically to the leading edge of a square wave. Such a waveform is, in fact, equivalent to the presence of a fundamental with harmonics up to infinity. Now, if the circuit phase shifts the higher harmonics compared with the lower fundamental, the sharp rise is lost and the transient reproduction is spoilt.



An example of a special loudspeaker cabinet designed for high-fidelity reproduction.

Phase distortion has taken on a serious aspect with the development of modern high-quality amplifiers using negative feed-back. In these circuits an exact 180 deg. phaseshift per stage is assumed, and sufficient stages are included (or a transformer is enclosed within the feedback loop : a transformer gives, ideally, either 180 deg. or 0 deg. shift according to the connections) for the amplifier to end with the signal in opposite phase to the original and part of this signal is fed back to the input. If, however, phase distortion is present, some frequencies will be shifted in phase by some angle other than the required 180 deg. and if the accumulated discrepancies of the various parts of the circuits are sufficient the output may have a component actually in phase with the input at some frequency instead of being 180 deg. out of phase and positive feedback results, making the amplifier unstable.

(4) The relative sensitivity of the ear to different frequencies varies according to the loudness of the sounds. Thus, supposing a full orchestra is performing and the music is broadcast but the listener in his home, with due respect for his neighbours and the baby upstairs, turns down the volume of reproduction to a low level. Now, even if the transmission is perfect, and even if the listener has achieved perfect linearity in his reproducer, the results will not be a perfect reproduction of what he would have heard in the concert hall. At low levels the ear is more sensitive to frequencies in the middle and upper middle frequency ranges between 1,000 and 5,000 c/s ; it is much less sensitive to the lower audio frequencies and to a lesser degree sensitivity to the higher frequencies also falls off. Thus by turning down the volume of even a perfect reproducer the bass notes and the upper frequencies disappear. This kind of distortion has been given the name "scale distortion," and is obviously quite out of the hands of the designer who, if he cannot persuade the listener to operate the equipment at the sound intensity of the original, is left no option but to deliberately introduce distortion (normally given the more genteel name of "tone correction"!) to counteract the scale distortion.

(5) Room effects both at the transmitting and receiving end have their effect on fidelity. When a sound is made in a room it tends to persist for a while after the cessation of the original noise for an interval depending on the room size and the sound-absorbing power of the wall surfaces and contents. This reverberation is an essential part of the experience of listening and without it sounds are dead and unpleasant. The binaural effect allows the ears to detect the different source directions of original and reverberation and the original stands out clearly. The single microphone or transmitter channel is unable to distinguish directions, however, and consequently the transmitted sounds cannot be completely faithful to the original. The effects of reverberation are transmitted, but the lack of directivity results in more interference with the original sound.

At the receiving end the effect of listening room acoustics, its own reverberation time and its echoes, are superimposed on the reproduction. Obviously, none of these were present in the original and so must be looked upon as distortion.

(6) The introduction of noise bearing no relation to the original by the reproducing equipment must be looked upon as a distortion and would not be tolerated in high-fidelity work. Hum and valve hiss form a background that might easily mar the reproduction of soft passages and make it necessary to deliberately introduce distortion by limiting the range of sound intensities that are transmitted to something less than the range of the original.

This list of possible distortions appears formidable and, indeed, it seems surprising that in face of it the production of tolerable results should prove possible, but, in fact, the tolerance and the ability of the hearing mechanism to reconstruct the original from what is actually heard permits very lifelike results to be achieved by careful designing of the equipment and by intelligent placing within the room.

Middle East High-power Transmitter

A NEW short-wave broadcasting transmitter which has begun operation at Abu Zaabal, near Cairo, is the most powerful of its kind in the Middle East and is intended as the "voice" of all Arab speaking countries. The transmitter was designed, manufactured and installed by Marconi's Wireless Telegraph Co., Ltd., who erected the first major broadcasting transmitter in Egypt—more than 20 years ago—and who have recently supplied all equipment for the extension of broadcasting in Upper Egypt.

The plan to build this 100-kilowatt short-wave transmitter, and a 100-kilowatt medium-wave transmitter with aerial system, now under construction by the company at the same site, was originally drawn up some years ago with the intention of giving world-wide and local coverage for the Arabs.

The Egyptian State Broadcasting authorities required that programmes from the short-wave transmitter should reach all Europe, the Far East, both North and South America, Australia, New Zealand and South Africa, and from the medium-wave (620 kilocycles) to the Middle East.

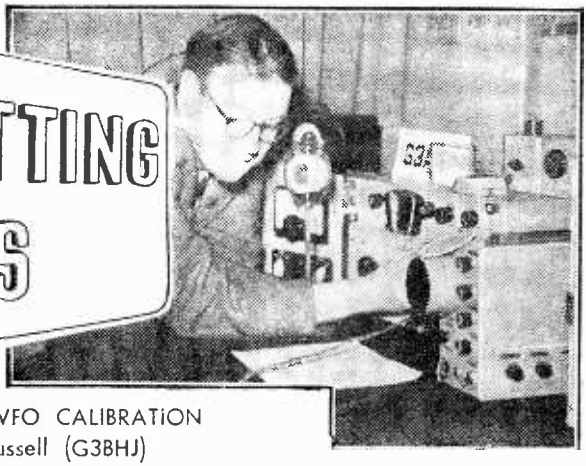
In both transmitters the valves are air-cooled. This same technique is being used in the Third Programme transmitters, installed for the BBC at Daventry, and is far more efficient and economical than the water-cooling method.

The short-wave transmitter operates on six frequencies, and is so designed that rapid selection of any one frequency can be carried out in less than three minutes.

Masts for the medium-wave aerial system are each 680ft. high—200ft. higher than the Great Pyramid—and each weighs about 70 tons. The base of each mast rests on a ball of only 7.5 cm. diameter ; this acts as a pivot and allows the mast a certain amount of sway.

The short-wave transmitter is the first of its kind in the world to go into service. Its range is such that people from any part of the world will now be able to listen to Egyptian programmes without any difficulty.

TRANSMITTING TOPICS



DIRECT READING VFO CALIBRATION

By O. J. Russell (G3BHJ)

SOME readers have queried the information that in order to obtain a linear dial calibration with a VFO it is necessary to use a tuning capacity having a straight-line frequency characteristic. However, this is a natural consequence of the fact that an amateur band VFO must of necessity cover only a limited frequency range, so that the desired amateur band (or bands) are spread over the dial for convenience and accuracy of tuning. Fig. 1 shows the type of tuned circuit with capacity padding that might be employed in the usual "High C" type of oscillator circuit dealt with previously. Similarly, Fig. 2 shows the circuit variously ascribed to G. Gouriet and to Clapp, which applies the "High L" condition. In both cases the tuning capacitor is swamped by a fixed capacitor so that the tuning is bandspread over the tuning range, thus allowing easy tuning on crowded bands and ease of setting to frequency. Further, of course, if any dial calibration is attempted it is useless to try accurately to calibrate an amateur band if this only occupies a quarter of an inch or so of dial space.

Accordingly, it is good practice to arrange that the VFO covers no more than the required frequency range. DX operators interested purely in CW may even restrict the VFO to the CW portions of the bands. The exact frequency span decided upon will depend upon the individual tastes of the operator. If 80 metres is only covered in part, then the 7, 14, and 21 Mc/s bands will be spread more fully on the dial. If complete coverage is required from 3.5 to 3.8 Mc/s on 80 metres, then the 7, 14, and 21 Mc/s bands, together with the whole of the 28 Mc/s band, will be covered, with overlap.

The fact that a straight-line capacity condenser gives an almost exactly linear scale can now be explained. As the expression for the frequency of a tuned circuit is :

$$F=\frac{1}{2\pi\sqrt{LC}}=\frac{1}{(2\pi)}.\ (LC)^{-\frac{1}{2}},$$ we can immediately see that if for one frequency F_0, $F_0=\frac{1}{2\pi}.\ (LC_0)^{-\frac{1}{2}}$, and if we increase the tuning capacity by a small amount c, so that the new tuning capacity value is (C_0+c), then F_1 the new (and LOWER) frequency of oscillation will be given by :

$F_1=\frac{1}{2\pi}.\ (L)^{-\frac{1}{2}},\ (C_0+c)^{-\frac{1}{2}}$. Expanding the last term of this expression by the Binomial Thereom, we have :

$$F_1=\frac{1}{2\pi}.(L)^{-\frac{1}{2}}.C^{-\frac{1}{2}}\left[1-\tfrac{1}{2}(c/C_0)+(\tfrac{1}{2})^2\,\tfrac{1}{4}\cdot\frac{1}{1.2}(c/C_0)^2-\text{etc.}\right]$$

If c is small compared with C_0, we can see that the CHANGE in frequency (F_0-F_1) is directly proportional to $-\frac{1}{2}\left(\frac{c}{C_0}\right)$, and hence proportional to c, as C_0 is a constant. This is true if we neglect the higher order powers of $\frac{c}{C_0}$, and fuller evaluation of the expansion will show that for VFO conditions the departure from linearity is SMALL. Unless a specially shaped condenser designed specifically for the amount of bandspread used were made, this is the most favourable state of affairs open to the amateur without the use of complex compensating circuits. The use of Log-midline or Straightline frequency shaped condenser vanes will result in the L.F. portions of the bands being compressed, and the H.F. portions of the bands being expanded. This is undesirable, especially for the keen C.W. man who would prefer the L.F. band sections to be expanded on the dial. Accordingly, the very nearly linear scale given by

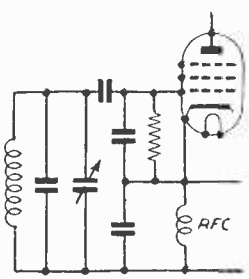


Fig. 1.—V.F.O. circuit of the "High C" type.

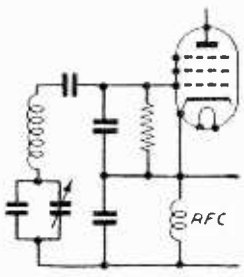


Fig. 2.—V.F.O. circuit of the "Clapp" type of circuit.

the semi-circular straight-line capacity condenser is the easiest solution, and the only one conveniently available to the amateur.

Method of Calibration

The fact that a precisely linear frequency scale is difficult to achieve, renders direct frequency calibration of a VFO difficult, as each 100 Kc portion of the dial will not be exactly the same as the others. If a precise linear scale were achieved, calibration would be a simple matter. Each 100 Kc calibration point could be marked on the dial, and accurately subdivided by mechanical means. A Vernier scale of the usual type would then allow reading to a Kc. This is not possible, however, with the slight inequalities between successive 100 Kc points. Thus, if in the case of the 3.5 Mc/s band the 3.8 position was marked, and the range 3.5 to 3.8 Mc/s divided into three equal portions, and marked as the 100 Kc portions, then errors of some few kilocycles would occur if the scale was marked out uniformly on this basis.

Fortunately, an easy solution to this difficulty can be found, and the final accuracy of dial reading is equivalent to a vernier scale, so that the VFO can be set with considerable accuracy.

It will be assumed that reasonably accurate calibration devices are available. Thus, a BC221 wavemeter or a Class D wavemeter will permit individual dial calibration points to be marked every 10 kilocycles. If these accurate wavemeters are not available, a standard 100 Kc/s crystal will enable, first, the 100 Kc points to be marked. If one then zero beats the VFO second harmonic with the 100 Kc crystal harmonics, 50 Kc intermediate VFO fundamental points can be marked. Each 50 Kc point can then be sub-divided into 10 Kc points. Referring now to Fig. 3, radial lines are drawn from each 10 Kc/s calibration point to a concentric circle lying beneath the calibrations. With the aid of compasses and an accurate ruler for setting, 10 equally-spaced concentric circles are drawn. The diagonal lines joining the intercepts of each 10 Kc radial division are then added. Fig. 4 shows how dial readings are taken by means of a transparent Perspex cursor with a fine black hairline. Thus, the second circle down is the one at which the black cursor hairline intersects both the circle and the diagonal line. Thus, the reading shows that the fractional part of the reading is 2 Kc/s to be added to the dial reading. Thus, the true dial reading is 3.532 Mc/s, or 3,532 Kc/s. This device enables the dial to be direct reading to good accuracy, without any great difficulty. However, it is of course essential that the VFO itself be constructed with solid rigid wiring, and with a high grade tuning condenser in order that stability be adequate. A useful refinement is a "trimming" condenser of very low capacity which can be set so that the calibration can be aligned from time to time, so that the 100 Kc positions agree with a master 100 Kc crystal frequency standard. This will enable the accuracy to be maintained throughout its use, and is in any case in compliance with official regulations.

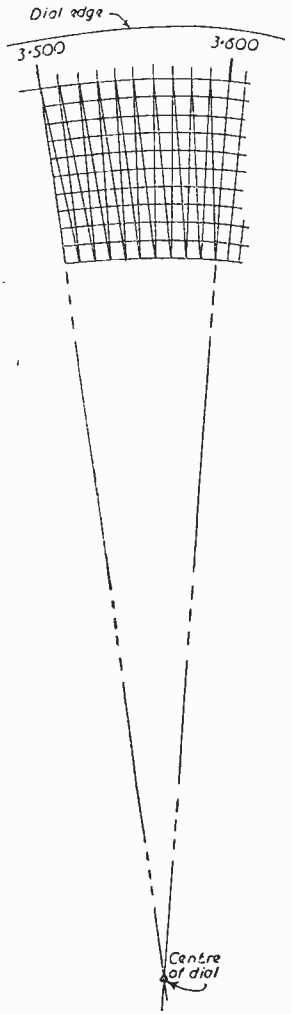


Fig. 3.—Illustrating the method of dividing the dial.

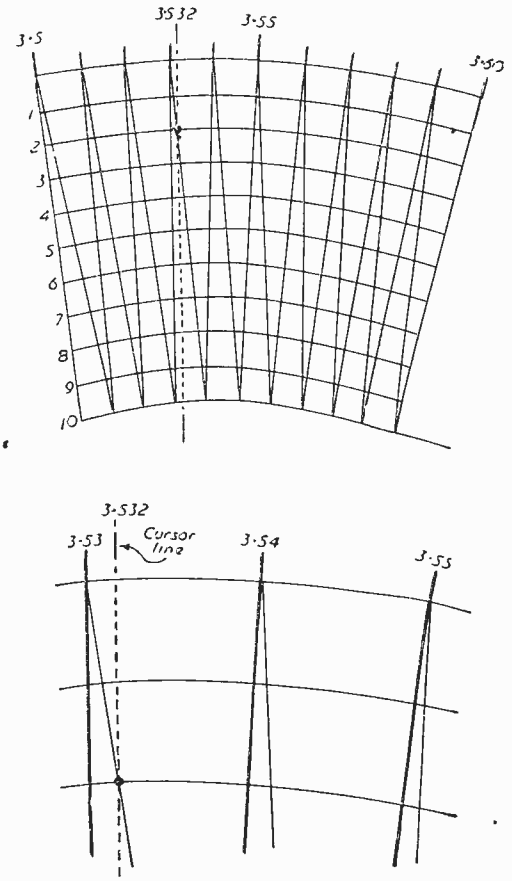
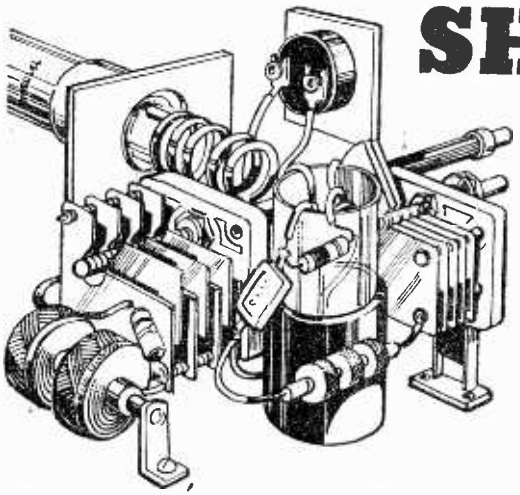


Fig. 4.—(Top) An enlarged view of part of the dial, and (below) showing how readings to 2 Kc/s are taken.



SHORT-WAVE SECTION

LISTENING ON THE SHORT-WAVE BROADCAST BANDS

By A. W. Mann

WHILE the number of amateur band listeners is increasing, so also are those whose interest centres on the short-wave broadcast bands. There is, in fact, one listeners' organisation in which short-wave broadcast listener members predominate.

The most consistent reporters to listener publications are methodical and consistent listeners, some of whom are the fortunate owners of modern and expensive communication type receivers, while others use simpler home-constructed types. The latter, nevertheless, hold their own in the quest for DX.

Some are apt to decry this sphere of listening because the medium is used by some nations for propaganda purposes. This, however, does not apply to all stations, and the listener is not forced to listen to such transmissions.

Keeping a Log

Much has been written concerning the logging and reporting of amateur transmissions. The logging of short-wave broadcast transmissions is of equal importance to those who specialise in this branch of reception. It enables accurate reports to be compiled and sent to those concerned.

In most instances an accurate report is verified by card or letter. There are, however, a few South American stations which either verify at intervals, or not at all.

No matter how keen the listener, he will find that it is impossible to remember all the technical and programme details associated with the various transmissions received. The log book is an essential source of reference.

There is also another aspect which cannot be too strongly emphasised. The log book is a useful reference as to the results achieved during past experiments.

For example, the writer during the years in which short waves have been his chief interest, has built a considerable number of receivers, and has erected several unconventional types of aerials. Details as to their construction is to be found in technical data books. Reference to old log books provides performance data, and the prevailing reception conditions during tests.

Setting Out the Log Book

Fig. 1 shows in detail how to rule out the pages of the log book. Additional columns can, of course, be included if desired. One can, however, overdo things in this respect with the result that active listening time is cut down in order to keep the log book up to date. It will be noted that different symbols are used to denote the particular receiver and aerial used. These can be inserted in the call and location columns.

Programme Matter

It should also be noted that space has not been allocated in the log for programme details. It is in my opinion a much better idea to use a separate book for this purpose. Stiff-backed exercise books are most suitable when one considers the amount of handling such books will undergo.

Calibration

Short-wave receivers of commercial design in most instances incorporate directly calibrated tuning dials. The same applies in lesser degree to home-constructed types. The majority of the latter type, however, are fitted with some form of degree scale tuning dials.

With care, the degree scale types can be very accurately calibrated using transmissions of known frequency. A complete set of charts in which dial reading is plotted against frequency in megacycles can be drawn, and thus the complete tuning range of the receiver can be covered. In addition, separate and additional charts for the band-spread dial will assure most accurate logging. I reiterate, care must be exercised when undertaking the calibration of short-wave receivers.

Headphones-speaker

The average superhet and the four-valve T.R.F. type receivers provide very good loud-speaker reception of the more powerful short-wave broadcast transmissions.

In the author's opinion, however, provision for headphone listening in a form which cuts out the power output stage is essential if one wishes to listen during the early morning hours, and in addition add to the number of DX transmissions heard.

Those who now depend entirely on loud-speaker reception for DX listening will find that they can receive clearly a considerable number of transmissions which are below the receiver noise level when the output stage and loud-speaker are used.

Aerials

Crowded wavebands call for good selectivity. This does not mean that the average T.R.F. and regenerative two is useless. They are capable of providing good results if attention is paid to aerial coupling and the aerial.

Some prefer a comparatively short aerial as an aid to selectivity—a laudable objective. This idea, however, should not be carried to extremes. Pick-up for instance cannot be sacrificed beyond a certain point and it is necessary to compromise in this respect.

Vertical aerials are worth considering as they enable one to obtain the benefits of height and reasonable shortness.

Reporting

Like the amateurs, the broadcasters desire useful discriminating and comprehensive reports. These should be divided into two parts. Technical and programme details respectively. Quite apart from technical information the station authorities require sufficient evidence that the listener has listened to the various items throughout a reasonable period. Thus the Australian stations refuse to verify even an accurate report unless it covers at least half an hour's listening.

In writing such reports the various items should be listed together with the names of the individual performers or combinations. If a news bulletin is heard, one or two items should be copied verbatim. Opinions concerning the programme will also be appreciated. Critical and concentrated listening is obviously necessary.

Aids to Listening

The short-wave listener is well catered for in the way of frequency lists, handbooks, and publications in which space is devoted to time schedules and so forth.

Stations Listed

A really comprehensive list is apt to produce some surprises, especially with regards to the number of stations listed between 60 metres and 136 metres. Because a station is listed, however, it does not mean that one can hear it if tuned to the frequency.

A considerable number of listed stations are not likely to be heard in this country at any time due in some instances to their low power, and in addition to the fact that the frequency is shared with one or more high power transmitters.

Aimless Tuning

While aimless tuning is not to be encouraged, do not entirely avoid what are found to be the usually silent sections of the tuning dial. These should be carefully and consistently covered as there is always the possibility of tuning in some rare DX plus the unexpected testing out of a new transmitter not at the time in the news. Some of the most interesting conversations I have heard during such tests have had nothing to do with radio, centring on happenings long ago and far away.

The world's short-wave broadcasting services cater for all tastes, providing a wide choice in the fields of information, education and entertainment. One can also follow the trend of world opinion.

Items of Interest

Certain stations devote time to matters of radio amateur and listener interest, travel and adventure. It is, I think, more or less true to say that there is always something to be heard on the short-wave broadcast bands. Even though many transmitters on these bands are of comparatively high power as compared with those operated by amateurs, a high signal-to-noise ratio should be the aim when building a suitable receiver. On the short-wave broadcast bands the DX enthusiast will find plenty of scope for the exercise of his tuning skill.

SHORT WAVE BROADCAST STATION RECEPTION LOG

RECEIVER USED
* T.R.F. 3
+ R.1155A
X 640
XX O-V-1

RECEIVER LOCATION
{ Lat. Lon
Include in reports }

AERIAL USED
Folded V beam
⊖ Vertical rod

DATE	TIME	GMT BST	R.F Dial Reading	Det. Dial Reading	Band Spread Dial Reading	FREQ. Kc-Mc	Station Call	Location	R Strength	Q.S.A.	Q.S.B	Rec. Conditions	Barometer and Temp.	Weather Conditions

Fig. 1.—A typical "ruling" for a log book.

Volume Controls

Midget Ediswan type. Long spindles. Guaranteed 1 year.
LESS Sw. S.P. Sw 3/- 4/-
D.P. Sw. 4/9
ALL VALUES. — 10K. to 2 MEG.

80 ohm CABLE COAX

STANDARD ¼" diam. Polythene insulated.
REDUCED PRICE
9D. A YARD
NOT Ex. Govt.
COAX PLUGS, 1/2 each.
SOCKETS, 1/2 each.
LINE CONNECTOR, 1/2.

BALANCED TWIN FEEDER per yd. 6d } 80
TWIN SCREENED FEEDER per yd. 1/- } ohms

TRIMMERS, Ceramic. 35, 50, 70 pf., 9d. ; 100 pf. 150 pf. 1.3 ; 250 pf., 1/6 ; 600 pf., 1/9.

RESISTORS.—All values : ½ w., 4d. ; 1 w., 6d. ; 1 w., 8d. ; 2 w., 1/-.

WIRE-WOUND RESISTORS.—Best Make Miniature Ceramic Type—5 w.. 15 ohm to 4 K., 1/9 ; 10 w., 20 ohm to 6 K., 2.3 ; 15 w.. 30 ohm to 10 K., 2/9 ; 5 w. Vitreous, 12 K. to 25 K., 3/-.

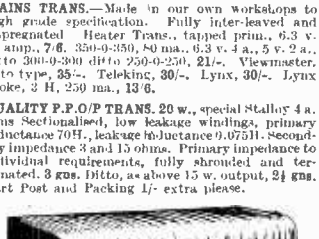
WIRE WOUND POTS. 3 WATT, FAMOUS MAKES.—Pre-Set Min. TV. Type Knurled, Slotted Knob. All values 25 ohms to 30 K, 50 K and 100 K (Carbon Track.) 3/- each. Standard Size Pots, 2½in. Spindle. High Grade All Values. 100 ohms to 50 K, 5/8 ; 100 K, 6/6.

O/P TRANSFORMERS.—Tapped small pentode, 3/9. Heavy duty 70 ma., 4/6. Ditto, tapped, 4/9.

L.F. CHOKES 10 h. 65 ma., 4/6. 20/25 h. 100/150 ma., 12/6. 5 h. 250 ma., 15/-. 15 h. 100 ma., 10/6.

MAINS TRANS.—Made in our own workshops to high grade specification. Fully inter-leaved and impregnated Heater Trans., tapped prim., 6.3 v. 1½ amp., 7/6. 350-0-350, 80 ma., 6.3 v. 4 a., 5 v. 2 a., ditto 300-0-300 ditto 250-0-250, 21/-. Viewmaster. auto type, 35/-. Teleking, 30/-. Lynx, 30/-. Lynx choke, 3 H, 250 ma., 13/6.

QUALITY P.P.O/P TRANS. 20 w., special Stalloy 4 a. lams Sectionalised, low leakage windings, primary inductance 70H., leakage inductance 0.075H. Secondary impedance 3 and 15 ohms. Primary impedance to individual requirements, fully shrouded and terminated. 3 gns. Ditto, as above 15 w. output, 2½ gns. Part Post and Packing 1/- extra please.



MIDGET WALNUT CABINET.—12in. x 7in. x 5in. complete with punched chassis, dial, back-plate, drum, drive, cord, spring, pointer, 28/6, plus post 2/-.

TYANA.—Midget Soldering Iron 200/250 v., 16/9.

SOLON.—Ditto 25 w., 19/8.

100 ASSORTED RESISTORS.—10 useful values, ½ w. and ¼ w. Brand new, 12/6.

EX GOVERNMENT UNITS.—Our selection, 3 different. All containing useful parts. TO CLEAR, carr. paid, 15/-.

TAG STRIPS.—2-way, 2d. ; 3 to 5-way, 3d. ; 6-way, 4d. PLATED Terminals, 6d. each

MARY ANN Vacuum Cleaner Flexible Hoses, plated ends, standard fitting, 10/6. 12ft. appliance lead, switched connector and combination adapter, 6 9.

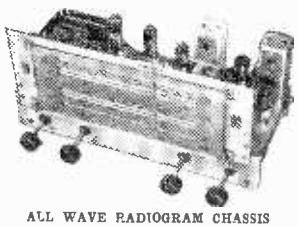
EXTENSION LOUDSPEAKERS.—6½in. P.M. 3 ohm unit, less transf., attractive wooden cabinet, complete, 35/-.

SCREENED GRID CAPS int. oct. or Mazda, 6d. each.

WHIP AERIALS.—Steel (copper plated) 4ft. long, 2/- each. Carr. paid.

TV. AERIALS.—Full range popular types in stock, Aerialite, etc. All channels. Indoor loft type Inv. T., 13/6. Outdoor single dipole, 37/6. H type with chimney lashings, etc., 92/6. X type Dublex, 7ft. mast and chimney lashings, etc., 88/6. Fringe models available.

TOGGLE SWITCHES EX-GOVT. "On-Off," 9d. M'core solder 60-40, 16G., 5,6 ½ lb. ; 4d. yd. ; T.C. wire 18 to 22 s.w.g., per yd., 2d. PVC Connecting wire, 10 colours. Single or stranded, 2d. yd. B7G Valveholder and Screening Can, 1/6. Vholders, octal, pax., 4d. ; moulded, 6d. ; EF50, B7G, 9d. ; B8A, B9A, 1- ; B12A (CRT), 1.3, etc.



ALL WAVE RADIOGRAM CHASSIS

3 WAVEBANDS

		VALVES
S.W.	16m. — 50m.	LATEST MULLARD MIDGET SERIES
M.W.	200m. — 550m.	ECH 42, EF 41, EBC 41, EL 41,
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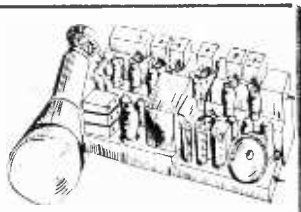

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Fixing Extra Channels to Amplifiers

TYPES OF MIXER UNITS

By Kenneth Dall

OFTEN it is required to use a microphone and a pick-up with a favourite amplifier. Perhaps it is for dance instruction requiring only one extra input, or perhaps it is for theatrical use requiring mixers, faders and extra channels *ad lib*. With the latter is is far better to design a separate unit, with its own power supply and smoothing. This latter type of unit is ideally suited for use with such amplifiers as the practical low power hi-fi and single ended hi-fi amplifiers. These were both designed to use a high-power output pick-up such as the high output magnetic or crystal types.

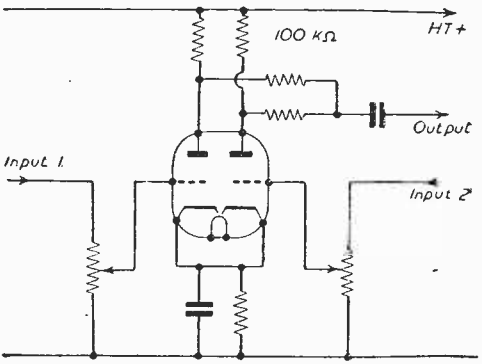

Fig. 1.—Mixer circuit for low gain.

Nearly all types of mixer units give extra gain to a circuit.

The size of the mains transformer will, of course, depend on the power output required, but for many purposes the little TV pre-amp type are suitable as they give some 25 mA and usually use a metal rectifier for rectification. It is always advisable to isolate equipment completely from the mains as with theatrical use it may quite easily be used by someone who is unaware that the chassis may be "live." This latter can be fatal. One point against the little pre-amp transformer is that it rarely seems to have more than one ampere for the heaters. This latter can be overrun providing that it is not overloaded by more than 100 per cent. and that the equivalent power is deducted from the H.T., i.e., if a transformer is rated at 250 volts 30 mA and 1 amp at 6.3 volts, and 2 amps are required at 6.3 volts, then it will be seen that the rating of the H.T. will have to be reduced by 6.3 watts. As 1 mA at 250 volts is a quarter of a watt then 6.3 will mean a reduction of 26 mA. This, of course, is more power than there is to spare so a larger transformer has to be used. The constructor would do well to remember that it is far better to spend a few extra shillings at the outset than have to replace a burnt-out transformer due to one of slightly lower price being overrun. The overrunning of a transformer is quite easily done, and may not show up until such times as one of the smoothing condensers goes slightly low, the few extra milliamps required can just do the damage. The writer has had experience of this with pre-war commercial receivers in which the price had been cut to the last ounce.

Rectifier

Another point that should be watched is the rectifier valve chosen. If the current rating is too high it is possible for the transformer to be burnt out by an electrolytic being burnt out. It is best to choose a rectifier valve as close above the rating as possible; this ensures that the valve has a good chance of burning out before the transformer is damaged. For this particular type of service the Mullard EZ40 and EZ41 will prove satisfactory. This firm now makes a 5-volt indirectly heated 120 mA type, the GZ30.

Having chosen the transformer and the rectifier valve there comes the smoothing. With the mixer this has to be very good, the amount of hum that will do for an amplifier will not do here, as any hum in the output will be amplified by the amplifier being fed. The PRACTICAL WIRELESS single ended hi-fi is capable of a very high bass lift at 50 and 100 cycles so that if the hum is present it can be amplified to an alarming degree. Hum can be very disturbing to an audience. It is better here to use a choke-capacity filter, as it is far more efficient than resistance-capacity. This is due to the impedance of the smoothing choke being very many times its ohmic resistance; it is also better to have two sections to the filter. It may be found that one very often gets a lower hum level by using three 8μF condensers and two 10-henry chokes joined so as to form a double Pi or M filter, than if an 8 plus 16μF condenser was used with a 20-henry choke in a Pi filter. This is due to a large extent to the fact that the electrolytic condenser must be regarded as a resistance in series with a condenser and no matter how good the condenser, it always has a certain

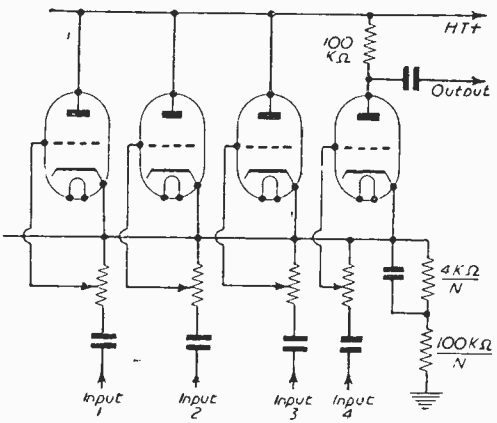

Fig. 2.—A differential mixer circuit.

amount of power factor, due to a small amount of resistive impedance. This laboratory has on several occasions checked old condensers, that is those that have been stored for many years, and found that although the capacity is within the maker's limits the power factor has risen very considerably so that the efficiency is reduced. It is always better to buy new condensers than rely on surplus types, as these are not always reliable as they may have been stored under bad conditions.

It has been found from experience that one of the best condensers for this type of unit is the Dubilier type CT323235, which is a 32 plus 32 with a working voltage of 350. A type CT1635 can be used for the reservoir and the smoothing chokes two Elstone type SC80 so mounted that the cores are at right angles to each other thus preventing any linkage between them.

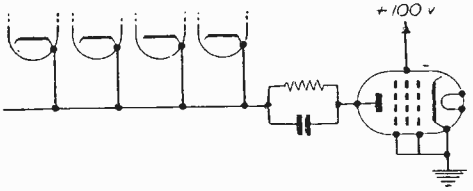

Fig. 3.—Connections for L.F. pentode substituted for coupling resistor.

Smoothing

We have now got our H.T. well smoothed. Next comes the design of the mixer proper. Double triodes form the most convenient type of valve, the simplest case is that requiring two inputs. This can be done in several ways. If the gain is only required to be low the circuit in Fig. 1 can be used. The amount of power required can be obtained from the amplifier it is to be used with in most cases. The gain of the stage is in most cases about one fifth of the amplification factor of the valve being used. For instance if the valve is an ECC41 the maximum gain obtainable will be about six. One circuit that can be used for an almost indefinite number of channels is a modification of the Schultz phase split circuit or differential amplifier, a circuit very often confused with the long tailed pair. The main difference in these two circuits is that the Schultz circuit has a resistor in the cathode circuit for coupling whilst the long tailed pair gets a more efficient coupling by employing a pentode valve. This latter is advisable where a very large number of stages are required to be mixed. The differential mixer circuit is shown in Fig. 2. If the number of stages, or should we say inputs, are too large the value of the coupling resistor will be too small to be effective. Under these circumstances an L.F. pentode can be substituted with its grid taken to cathode and chassis, whilst about 100 volts are fed to the screen by a suitable dropper. The anode of the valve is then joined as shown in Fig. 3. If an EL41 is used for the L.F. pentode and ECC91's are used for the triodes a voltage gain of 25 per channel will be obtained. There are many different types of valves that can be used in these circuits such as the ECC33, ECC35, ECC40, ECC81, ECC91, 6SN7GT, 6SL7GT and very many others of different makes. The method of calculating the cathode resistor is to find the value used by one valve, this is usually given in the maker's tables for the valve in question and dividing by the number of valves being used. I use the term valve here, not as meaning the number of "Bottles," but of triode sections. For example, three ECC91's would be six valves for the purpose of calculations. The coupling resistor can be found by dividing the number of valves into 100,000 ohms. This gives a figure that is of general use. There is no reason at all why one bank of mixers could not be fed into another bank. For example, it may be required to "mix" four footlight microphones, or sound effect microphones together, and fade out all together, then bring in, maybe, a gram, or another studio. It is then useful to have one or two extra banks of mixers feeding into a master mixer. The design of these units is just the same as described, with the exception that there must be ample decoupling between each bank of mixers. In many cases these extra banks of mixers can be used in place of pre-amps for microphones. For example, if a certain type of pick-up required a voltage gain of 100 extra to the gain of the amplifier, and it was used through two banks of faders each giving a maximum gain of 12, there would be gain to spare.

Attenuator

Having power to spare at the input of these mixers brings us to another point, that of designing a suitable input attenuator. By far the best is the switched type using a wafer switch. A very useful switch is the Bulgin type S435, as it has eighteen positions. A good sequence of resistors to choose is one that drops the level to a definite power ratio, i.e., 100, 70, 50, 33, 25, 16, 10. Here we have got from full power down to 1/100 power in seven steps of about 3 db, that is the volume is cut to a half at each step. It should be remembered here that power is proportional to the voltage squared, so if the voltage is dropped to 1/10 then the power will fall to 1/100. Another set of six steps would give a further drop of 20 db making a total of 40 db, a further number of steps can be added if required. The standard 20 per cent. resistors are suitable, and if a 1 M input impedance is required the following resistors will be required: 300K, 200K, 150K, 100K, 82K, 68K, 30K, 20K, 15K, 10K, 8,200, 6,800, 3,000, 2,000, 1,500, and 2,500. This will give a total of from full to a cut of 46 db, and "off." The latter is important if the amount of stray noise is to be kept to a minimum. All inputs not being used should be turned to zero.

The best type of output has not yet been mentioned, and it has been found that as low an impedance as is possible should be used. This, of course, calls for the use of the cathode follower. It should not be forgotten here that the output coupling condenser should be as high as possible. One of paper as high as 10 μF is useful, but as these are so very expensive, providing that the input resistance of the amplifier is high, that is 0.25 Meg. or higher, one of 0.1 μF can be used, but, unless the leads are well screened, it can introduce hum.

Whilst the foregoing does not give all the circuits for mixers it gives enough to set the experimenter thinking, and gives enough information to help in the design of a very useful piece of equipment for the theatrical field.

Programme Pointers

By MAURICE REEVE

Coronation Broadcasts

THE month has very largely been taken up with a number of Coronation outside broadcasts, and the amenities of the ordinary programmes have consequently suffered. These broadcasts must have presented some selection difficulties—at least we hope so—and one wonders whether, the Coronation itself apart, most of them were worth the large amount of time they occupied, or whether they offered superior entertainment to the items they replaced.

They inevitably suffered from a considerable similarity. Troop movements, cheering crowds, formal speeches, toastmasters' "Your Graces, My Lords, Ladies and Gentlemen," commentators' observations, "Battalion, or-der heips"; everything was governed by the occasions and the occasions were all very much alike.

Test Matches

Test matches against Australia, too, are not often with us, and the commentaries on these were curtailed from time to time, usually, however, by irritating half hours of light music and stuff we are given every day all the year round. Regarding a note in the *Radio Times*, to the effect that "*during the hours of play* (my italics) latest scores will be given between programmes," I would like to mention that this was often honoured in the breach rather than the observance.

Talks

Esmé Percy gave an unqualifiedly delightful talk of reminiscences of Sarah Bernhardt. They were very juvenile and wholly adulatory, but wonderfully evocative and picturesque. And who are we, anyway, to say if they were in any way exaggerated or too heavily underlined? Bernhardt belonged to an age when great people were not only very plentiful, but when the art of wearing "the grand manner" was far more widely known, and understood.

The current serics of "In All Directions," by Peter Ustinov and Peter Jones, subtitled "Some diversions in search of An Outlet for Self-expression," is an entertainment of varying quality, which seems likely to arouse admiration and hostility in equal parts. It seems to me to be getting too imitative, a form of art of which, I venture to suggest, we already have far too much. The number to which I recently listened had, for its main dish, a fair-sized copy of a boxing contest by Raymond Glendenning, with in-between-rounds summaries by Barrington Dalby. If we must have more of this sort of thing, others can do it much better.

"Guest Night"

Henry Hall's five hundredth "Guest Night" was an event. That seemingly shy, reticent, bashful and stumbling, but very artful and experienced, voice grows in popularity with the passage of the years. No longer "the old hundredth," nor, indeed, "the old five hundredth" any more; we wish him well till he can be acclaimed "the old thousandth." Good old Henry!

"Curtain Up" is now engaged in a series of request repeats, of which I have heard "An Inspector Calls," by Priestley, and "Libel," by Edward Wooll. Each of them seemed very familiar after they had run for only a few minutes. The latter seemed less convincing on a second hearing, but the former more so. Priestley's story, like all good stories, sets before us certain human types with absolute fidelity, and in this particular example a powerful story concludes with a dramatic *coup de théâtre*. After listening to the Inspector unravelling the story of a particularly shoddy, self-made man, brilliantly played by Frank Pettingell, and his disreputable son and self-satisfied wife, the seduction and callous dismissal of an unfortunate girl and her subsequent suicide, with other Priestleyan ingredients, the gentleman departs. Then, after much discussion and recrimination, it suddenly dawns on them that he might have been, and finally was, a fake; that they have aired all the family's dirty washing in public for nothing, and that all is well with the world. Mr. Birling's knighthood is secure, after all. But just as they are wishing each other goodnight and pleasant dreams, the 'phone goes. A girl *has* committed suicide; an inspector *is* on his way up to the house! Finis. A fine piece of theatre and entertainment.

Plays

"Libel," on the other hand, is a very artificially contrived piece of patchwork designed chiefly to explain certain points relating to the law of libel. So far so good. But the improbabilities of the story, and the complete hoodwinking of a cute and alive newspaper by a transparent blackmailer, with more than one "term" to his discredit, seemed so unlikely that the credit balance was largely discounted.

"The Reaping"—theme, as ye sow, so shall ye reap—was quite a good story by Joan Brampton, and well put over by Monica Gray, Ursula Hurst, Nan Marriott-Watson, Richard George and some others.

The "Take It From Here" show from H.M.S. *Indefatigable* at the Naval Review was enormously funny. Very nearly as good as "Itma's" from Scapa Flow during the war.

Why must we have the hideous and appalling moans, squeaks, dirges and rusty five-barred gates called music butting into some of the plays and documentary programmes? Most of them are really and truly dreadful. "Noises by so-and-so" would be a more correct *Radio Times* entry.

Guide to the Exhibitors

List of Exhibitors in Alphabetical Order, with Stand Numbers

Name	Address	Stand No.
Aerialite Ltd. ...	Castle Wks., Stalybridge, Cheshire	79
Allen Radio, Ltd., Richard	Caledonia Rd., Batley, Yorks	85
Ambassador Radio (R. N. Fritton, Ltd.)	Princess Wks., Brighouse, Yorks	5
Antiference, Ltd....	67, Bryanston St., Marble Arch, W.1	53
Argosy Radiovision, Ltd.	Argosy Wks., Hertford Rd., Barking, Essex	3
Association of Radio Battery Mnfrs.	41, Gordon Square, London, W.C.1	99
Automatic Coil Winder & Elec. Equip. Co., Ltd.	Winder House, Douglas St., S.W.1	15
Baird Television, Ltd.	Lancelot Rd., Wembley, Middx.	59
Balcombe, Ltd., A. J.	52, Tabernacle St., London, E.C.2	101
Belling & Lee, Ltd.	Cambridge Arterial Rd., Enfield, Middx.	102
Boosey & Hawkes, Ltd.	Electronics Division, Deansbrook Rd., Edgware, Middx.	209
Bowmaker, Ltd. ...	Bowmaker House, Lansdowne, Bournemouth	210
Brown Bros., Ltd.	Browns Buildings, Gt. Eastern St., London, E.C.2	70
Bulgin & Co., Ltd., A. F.	Bye-Pass Rd., Barking, Essex	1
Bush Radio, Ltd.	Power Rd., Chiswick, W.4	74 & 97
Champion Elec. Corp.	Champion Wks., Newhaven, Sussex	71
Cole, Ltd., E. K.	Ekco Wks., Southend-on-Sea, Essex	100
Collaro, Ltd. ...	Ripple Wks., Bye-Pass Rd., Barking, Essex	35
Co-operative Wholesale Society, Ltd.	Publicity Dept., 99, Leman St., London, E.1	6
Cosmocord, Ltd.	700, Gt. Cambridge Rd., Enfield, Middx.	234
Cossor, Ltd., A. C.	Cossor House, Highbury Grove, N.5	90
Decca Record Co., Ltd.	1/3, Brixton Rd., London, S.W.9	48
Domain Products, Ltd.	Domain Wks., Barnaby St., N.W.1	13
Dubilier Condenser Co. (1925), Ltd.	Ducon Wks., Victoria Rd., North Acton, W.3	98
Dynatron Radio, Ltd.	Perfecta Wks., Ray Lea Rd., Maidenhead, Berks	112
Econasign Co., Ltd.	92, Victoria St., London, S.W.1	20
Edison Swan Elec. Co., Ltd.	155, Charing Cross Rd., W.C.2	51
Electronic Precision Equipment, Ltd.	Elpreq House, High St., Wealdstone, Middx.	222
E.M.I. Sales & Service, Ltd.	Head Office, Hayes, Middx.	93 & 104
English Elec. Co., Ltd.	Queens House, Kingsway, W.C.2	52
Ever Ready Co. (G.B.), Ltd.	Hercules Place, Holloway, N.7	30
Ferguson Radio Corp., Ltd.	105, Judd St., London, W.C.1	57
Ferranti, Ltd. ...	Hollinwood, Lancs	49
Garrard Eng. & Mfg. Co., Ltd.	Newcastle St., Swindon, Wilts.	103
General Elec. Co., Ltd.	Magnet House, Kingsway, W.C.2	89
Goodmans Industries, Ltd.	Axiom Wks., Wembley, Middx.	37
Gramophone Co., Ltd.	Head Office, Hayes, Middx.	92
Hunt (Capacitors), Ltd., A. H.	Bendon Valley, Garratt Lane, Wandsworth, S.W.18	88
Imhof, Ltd., Alfred	112/116, New Oxford St., W.C.1	211
Invicta Radio, Ltd.	Parkhurst Rd., Holloway, N.7	47
J. B. Mfg. Co. (Cabinets), Ltd.	86, Palmerston Rd., Walthamstow, E.17	27
Kolster - Brandes, Ltd.	Footscray, Sidcup, Kent	32
McMichael Radio, Ltd.	190, Strand, London, W.C.2	34
Marconiphone Co., Ltd.	Hayes, Middx.	58
Masteradio, Ltd.	10/20, Fitzroy Place, N.W.1	46
Mullard, Ltd. ...	Century Hse., Shaftesbury Ave., W.C.2	91
Multicore Solders, Ltd.	Maylands Ave., Hemel Hempstead, Herts	111
Murphy Radio, Ltd.	Welwyn Garden City, Herts	31
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(*Continued on page* 554)

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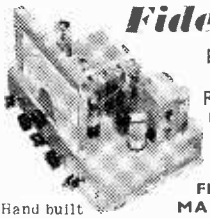

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OPEN TO DISCUSSION

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

CR100 Tuning

SIR,—There must be many readers, like myself, who have bought the CR100 or B28 coil-pack, I.F's, 4 gang, etc., as advertised. Finding I could not tune over the ranges specified, I had the 4-gang tuner checked on an E.M.I. bridge, and I found it was only 200 pF maximum. Well, there was the trouble. The coil-pack is made to tune with a 437 pF variable 4 gang.

On obtaining the correct tuning condenser everything was O.K. I also found that by changing the EF39's in the two R.F. stages for 6BA6's the signal to noise ratio was greatly improved.

Can anyone give the procedure for aligning the crystal filter properly? I have a signal generator available.

I find the coil-pack gives excellent results on the 21 and 30 Mc/s amateur bands.

Will anyone who can help please contact me at the address herewith.—W. S. HARDY (105, Humber Avenue, Coventry).

Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply diagrams or provide instructions for modifying surplus equipment. We cannot supply alternative details for constructional articles which appear in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. If a postal reply is required a stamped and addressed envelope must be enclosed with the coupon from page iii of cover.

The Amateur Licence

SIR,—Being one of many novices who would very much like to become an amateur transmitter, I heartily agree with the remarks made by Mr. Hector Coles and Mr. C. Roberts on the subject of "Amateur Radio and the Novice."

It is my opinion that the time is long past whereby the amateur transmitter is licensed on the pretext of conducting experiment and research. Such work should be left to the bodies of highly-skilled technicians which are formed for that sole purpose, and I maintain that amateur transmitting should be regarded as a very pleasurable hobby.

I would advocate the abolition of morse test and a simplified theoretical examination; let the novice use a limited power and compulsory crystal control for the first year (with severe penalty for anyone breaking these two rules).

I am sure that many will agree when I say that the novice will soon find out that to communicate any considerable distance he will have to learn morse and learn it well, or other hams will report signals unreadable.—A. MACRO (Cardiff).

Noise and the R1155

SIR,—I refer to Mr. C. B. Cruickshank's article on page 384 of the July issue of PRACTICAL WIRELESS.

I have made the adaptor as he describes, with the exception that the lead to the screen has been taken out in the same way as he suggests for the grid lead and taken to H.T.+ on the exposed contacts at the base of the tuning eye. This applies to the R.F. stage. I have not experimented with the I.F. stages. By this method I have avoided the fearsome task of interfering with the contents of the coil box and get results as he describes.

It seems to me that if, as he suggests, the 27 KΩ resistor between H.T.+ and pin four of the valve-holder were shorted out, the full H.T. would exist across the 22 KΩ resistor, which in my set connects this pin to chassis, and would soon burn it out. It runs warm as designed with no alterations. Incidentally, there is little alteration in H.T. current which is about 75 mA in my case, Type 1155A—54593.

Another suggestion which gives me very good results is to substitute VR53 for the R.F. valve and the second I.F. valve. For reasons of stability I leave the original KTW62 in the first I.F. stage.—JOHN HOLLAND (Manchester).

Circuit versus Wiring Plan

SIR,—I have just read your "On Your Wavelength" page in the August issue and note the plea of Mr. J. H. White, of Swinton, for component layout drawings in your magazine instead of the usual circuit diagram, and your invitation for comments regarding same.

It is only comparatively recently that I took up radio as a hobby and straight away let me say that I certainly prefer the *circuit diagram* and I cannot recall that it has ever presented any complication to me even from the very beginning. Component layout drawings are, in my opinion, more difficult to follow.

Regarding the beginners' trial and tribulations in finding information, I think things are a little sparse for the beginner in any radio journal and I find myself hoping each month the answer might arrive in the next issue. I must say, from your journal I have gleaned most valuable information. Particularly good are the articles which have appeared "Designing the 'so-and-so' Stage," by J. S. Kendall—a lot more articles of that nature would be particularly useful to the multitude like myself.

PRACTICAL WIRELESS is a very good magazine, and I look forward to it each month. Circuit diagrams, test gear and more articles by J. S. Kendall and I'm sure all beginners will be delighted.—GEOFFREY A. DUNFORD (Yorks).

Amplifier A.1135A

SIR,—Over the last two years articles have appeared in PRACTICAL WIRELESS relating to conversions of the ex-Service amplifier A.1135A.

Is it possible for any reader to show the normal circuit of this amplifier before stripping down, with the connections for the Jones plug?

Also, can anyone state the purpose for which the amplifier was used by the Services and whether it could be satisfactorily used without making any civilian alterations whatever?

I daresay among regular readers are technicians whose Service duties brought them closely into touch with this small three-valve amplifier; if so, perhaps they would kindly help.—W. R. CLEMENTS (Richmond).

Quality Amplifier

SIR,—As I have just completed the construction of the De Luxe Direct-coupled Amplifier, designed by Bonavia Hunt, I should like to reassure Mr. E. Wells, of York, that he will have no trouble whatever in getting this superlative amplifier in order.

I am only an amateur, but I have built many amplifiers and heard many more in my search for true fidelity and *musical* reproduction, and I can truthfully say that never have I had less trouble in getting an amplifier in order.

That the amplifier is expensive I must admit, and I have spared no expense in obtaining the best possible components, but the results fully justify the cost.

I cannot give Mr. G. A. Knight the technical proof he asks for; I can only suggest he builds the amplifier himself and judges by results.

If he has heard better top-line quality or more satisfying bass reproduction I shall be very surprised. —T. H. ALLCOCK (Nottingham).

Receiver Kits

SIR,—As an amateur with a transmitting licence since 1933, I am at a loss to understand why no manufacturer has produced a kit of parts for a communications receiver (superhet) which would compare with a modern commercial type receiver. I feel that there are numerous amateurs and short-wave listeners who cannot afford to purchase a good communications receiver but would purchase a kit of parts. What about it, manufacturers?—PUZZLED (Braintree).

(*Continued from page* 550)

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Sobell Industries, Ltd.	Langley Park, Slough, Bucks	55
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Standard Telephones & Cables, Ltd. (BRIMAR)	Footscray, Sidcup, Kent	9
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Whiteley Electrical Radio Co., Ltd.	109, Kingsway, W.C.2	109
Wolsey Television, Ltd.	75, Gresham Rd., Brixton, S.W.9	61
Wright & Weaire, Ltd.	138, Sloane St, London, S.W.1	110

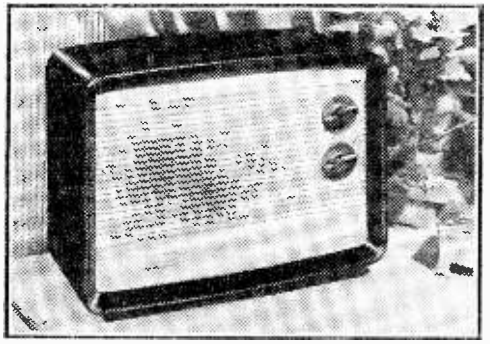
News from the Trade

Ekco Radio Model U195

E. K. COLE, LTD., are extending their range of pre-tuned Radio Receivers with the introduction of a new four-valve A.C./D.C. superhet, housed in an attractive two-colour plastic cabinet.

Model U195 has a 6in. speaker which handles a 2½-watt output with excellent quality of reproduction, the twin inbuilt aerial system, giving maximum signal pick-up. Provision is made for pre-tuning any required selection of four stations within the following wave ranges :

1. 188-343 metres.
2. 245-435 metres.
3. 310-550 metres.
4. 1,200-1,800 metres.



The Model U195 by Ekco referred to above.

Dimensions of the U195—10in. high x 13in. wide x 6¼in. deep. Price £15.7.6. (Tax paid.)—E. K. Cole, Ltd., Southend-on-Sea, Essex.

Roding Laboratories (Change of Address)

WILL readers please note that the address of Roding Laboratories has been changed from Hurn Airport, Christchurch, Hants, to Bournemouth Airport, Hants. It is the airport which has changed its name—the actual premises have not moved.

Kendall and Mousley Chassis

EXPERIMENTERS who make up test equipment often find difficulty in satisfactorily housing the apparatus, especially where it is desirable that screening should be incorporated, for instance, in a signal generator. Messrs. Kendall & Mousley, can supply a range of metal boxes with chassis and panel for various units at reasonable prices. The cases are of steel and finished in black crackle. Chassis are available with strengthened corners in heavy gauge aluminium, and panels are also of heavy gauge aluminium. A typical sample which we have received measures 12in. by 9in. by 9in., and the panel is fitted to the front by self-tapping screws. The chassis for this cabinet is 10in. by 8in. and the cost, complete with chassis is £2. If the chassis is desired in a red or green finish an extra 4s. is charged.—Kendall & Mousley, 99, Dudley Port, Tipton, Staffs.

Catalogues Received

MESSRS. WEBB'S RADIO have produced a new catalogue, containing 50 pages measuring 11in. by 8½in. Profusely illustrated, this includes various items from terminals to rack-mounted amplifiers, and to assist the user there is a complete index occupying the whole of one page. It is profusely illustrated and costs 1s., and in order to keep the information up to date the publishers arrange to supply supplementary lists to purchasers if they complete the postcard attached to each issue.—Webb's Radio, 14, Soho Street, W.1.

G.E.C. Germanium Triode Get 1

A GERMANIUM triode of the point contact type which has for some time past been exhibited by the Research Laboratories of The General Electric Co., Ltd., at the Physical Society and similar exhibitions, is now in pilot plant production in the company's works and is available to equipment makers in sufficient quantities for experimental work and prototype equipment. The triode uses single crystal germanium, and the unit is hermetically sealed in a metal can insulated from all electrodes. Flexible leads are provided for the connections.

The triode is suitable for use in amplifiers, oscillators and for electronic switching applications. Its low power consumption and electrical characteristics make it ideal for digital computer work.—G. E. C., Ltd., Magnet House, Kingsway, W.C.2.

Valve Service Depot

MULLARD LIMITED have now opened a Valve Service Depot at Renfrew Chambers, 20, Renfrew Street, Glasgow, C.2. (Telephone : Douglas 7772). Like the other Valve Service Depots at Birmingham and Halifax, the new depot will work in close co-operation with the main Mullard Valve Service Department at Waddon, Surrey. The Depot Manager is Mr. A. H. Adie.

The official opening of the new depot took place on 18th June, and, since this was the first occasion in recent years for the Mullard Company to establish an address in Scotland, representatives of Scottish Radio Industry were invited to attend. Welcoming the guests on behalf of Mullard Limited, Mr. L. A. Sawtell, Commercial Manager of the Entertainment Valve Department, outlined the policy of the company and the pleasure they felt in opening the depot.

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

BOOKS

NEW. First issue just out: RADIO QUARTERLY. Announcing No. 1 of a 96-page magazine of particular interest to SWL's and all who wish to know more about amateur radio. First issue includes constructional articles on: Three Band HF/VHF Converter; A Frequency Meter and CW Oscillator; A Handy Absorption Wavemeter; Feature articles: Short Waves and the Amateur; Tracing Television Troubles; Short Wave Broadcast Listening; The Amateur Transmitting Licence. Listings cover: Short Wave BC Stations; QSL Bureaux of the World; Country Prefix List; Radio Clubs and Societies; Pse QSL. Single copies 4/-, post free; annual subscription of 4 issues, 16/-, from: SHORT WAVE MAGAZINE, 55, Victoria Street, London, S.W.1.

AMERICAN MAGAZINES.—One year Audio Engineering, 28/6; specimen copy, 3/-; High Fidelity, 43/-. Free booklet quoting others. WILLEN, LTD. (Dept. 401), 101, Fleet Street, London, E.C.4.

BOOKLETS: "How to Use Ex-Gov. Lenses and Prisms." Nos. 1 and 2 price 2/6 ea. Ex-Gov. Optical lists free for s.a.e. H. ENGLISH, Rayleigh Rd., Hutton, Brentwood, Essex.

I.P.R.E. TECHNICAL PUBLICATIONS: 5,500 Alignment Peaks for Superheterodynes, 5/9, post free. Data for constructing TV Aerial Strength Meter, 7/6. Sample copy The Practical Radio Engineer, quarterly publication of the Institute, 2/-; membership and examination data 1/-; Secretary, I.P.R.E., 20, Fairfield Rd., London, N.8.

LATEST AMERICAN RADIOS.—New and novel miniature receivers, portables, all-wave receivers, 1 to 6 tube; Electronic equipment, etc. Build your own from available parts. Complete list of blue-prints and parts lists available, with full details, 3d. AMERICAN PUBLISHERS, Sedgford, Norfolk.

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OSMOR for really efficient coils, coil packs, and all radio components, as specified for many "Practical Wireless" circuits. See our advert. on page 502 of this issue for free circuit offer, or send 5d. stamp to address below. OSMOR RADIO PRODUCTS, LTD. (Dept. PC8), Borough Hill, Croydon, Surrey. (Tel.: Croydon 5148/9.)

RESPONSER 3118A, less 5Z4, 58/-; Recorder Mk2 (camera), less cassettes, 23/-; Power unit No. 320, less S130, 13/6; Electronic Ignition Tester, £21; Power Unit No. 33B, 35/-; Tranx 1083, no coils nor valves, 22/6; Junction Box No. 240, 6/6; Control Units, No. 227, 4/-; No. 223, 5/-; HR Double Phones, 12/-; 24v. Motor, 6/-. All above, post free; lists free. ANNAKIN, 25, Ashfield Place, Otley, Yorks.

WALNUT Radiogram Cabinets of distinction, stamp details. R. SHAW, 69, Fairlop Rd., E.11.

RATES: 5- per line or part thereof, average five words to line, minimum 2 lines. Box No. 1 - extra. Advertisements must be prepaid and addressed to Advertisement Manager, "Practical Wireless," Tower House, Southampton St., Strand, London, W.C.2.

OUTSTANDING BARGAINS still available. Latest list, 3d. SUSSEX ELECTRONICS LTD., Princes St., Brighton.

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EVERYTHING for radio constructors. Condensers, Coils, Valves, Resistors, etc. Send stamp for list. SMITH, 98, West End Road, Morecambe. Quick service.

ALUMINIUM CHASSIS, the exact size you want at the lowest price, e.g., 9 x 5 x 2½ costs 3/9; you can have any length up to 17in., any width up to 12in., any depth up to 3in.: cost: 1d. per sq. in. of the top surface, ignoring depth, e.g., 10 x 7 x 2½ = 10 x 7 = 70 sq. in. = 70d. = 5/10. We do not cut holes. If you are not already on our mailing list, write to-day for our new list of radio bargains. SERVIO RADIO, 156/8, Merton Rd., Wimbledon, S.W.19. (LIBerty 6525.)

ORGAN KEYBOARDS, 3-octave, on solid base; 19 by 4in.; no key contacts; professional job; ebony and ivorine finish; £4/15/-; carriage paid G.B. Send now to CIRCUITS & SUPPLIES, 10, Duke St., Darlington, Co. Durham.

ELECTROLYTICS, capacity, voltage, size, type of mounting; price post paid, in that order: 16 + 32, 450/525, 1⅜ x 2, clip, 5/6; 24 + 24 + 16, 350/425v, 1⅜ x 2, clip, 4/9; 60 + 200, 275/350v, 1⅜ x 4½, clip, 6/6; 4, 150v, ⅝ x 1⅜, clip, 1/1; 60 + 100, 350/425v, 1⅜ x 4½, clip, 6/6; 500, 12v, 1⅜ x 2⅜, clip, 2/6; 8, 350v, ¾ x 2, 2/-; 6,000, 12v, 1⅜ x 4½, lug, 4/6; 100 + 200, 275/350v, 1⅜ x 4½, clip, 6/6; 8 + 16 + 16, 450/525v, 1⅜ x 2, lug, 5/9; 32 + 32, 350/425v, 1⅜ x 2, clip, 5/-; 2,000, 6v, 1 x 3, clip, 3/3; 8 + 16, 450/525v, 1 x 2, clip, 4/-; 2, 450 525v, ⅜ x 1⅜, tag, 1/6; 2, 350v, ¾ x 1⅜ tag, 1/3; 8, 350/425v, ¾ x 2, clip, 1/9; 16 + 32 + 8, 450/525, 1⅜ x 3½, lug, 5/9; 8, 450v, ¾ x 2, clip, 1/11; 1,000 + 1,000 6v, 1 x 3 lug, 3/6. All are Ali cans: some with sleeve; all new stock; all voltages WKG, with surge v where marked. Television! Set of 3 Components, comprising line output trans. with E.H.T. winding to give 7Kv. using EY51 (heater winding for EY51 also included), and fitted with width control. Scanning coils, low impedance line and frame, focus coil, optional high (10,000Ω) or low (200Ω). Set of 3, 42/-, plus 2 - postage. Diagram of line trans. supplied. T.V. Control Panels, Paxolin plate, 4 x 3in., carrying 5 slider type res., 3 "Welwyn" wire wound 10w (1K, 5K, 10K), and 2 carbon (2 x 50K)., complete with knobs for sliders, 6/- each; post paid. Universal Amplifiers, 8 valve, 20w, AC/DC, 200/250v, black and chrome chassis and cover, overall size, 15 x 7 x 7, first-class components, partridge O.P.T. and driver, Gardiner choke, Mu metal input trans., wired and tested, complete with all valves (2 x EF37, 4 x CL33, 2 x UR3C), and plugs. 15Ω output, high/low impedance input, £10/19/6; carr. paid. RADIO CLEARANCE LIMITED, 27, Tottenham Court Road, London, W.1. (Telephone: Museum 9188.)

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64, inclusive, or a woman aged 18-59, inclusive, unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order, 1952.

AIRCRAFT Radio Mechanics skilled in workshop practice or aircraft installations to work at Stansted Airport, Essex; hostel accommodation available; minimum hourly rates 3/9. Write to the PERSONNEL MANAGER, 7, Berkeley St., W.1.

ENGINEER required by well-known firm of electrical and mechanical engineers in West London, to take responsibility for development work on H.F. heating techniques and their application to production. H.N.C. or equivalent qualification and some practical experience in this field desirable. Salary £550-700 p.a. according to age and experience; pension scheme; good opportunities for advancement. Box No. 237, c/o PRACTICAL WIRELESS.

RADIO (Meteorological) Mechanics required by Meteorological Office. Qualifications: Basic knowledge of radio and radar and experience in maintenance/operation of radar equipment, including oscilloscopes. Successful applicants serve in U.K. and overseas. Commencing London wage £7/17/6 at age 25 or over, rising annually to £9/10/6; deduction of 3/- for each year below 25. Overtime, night duty allowances, etc. Promotion prospects. Apply to: BOROUGH EMPLOYMENT EXCHANGE (Dept. P.W.3), 236, Walworth Road, London, S.E.17.

LABORATORY TECHNICIAN at Norwood Technical College, Knight's Hill, West Norwood, S.E.27. Sal. 69/- wkly. at 16 to 96/- at 19; £270 a year at 20; £18 more for each year above 20 on entry (max. comm. sal. £342); rising by ann. incrs. of £18 to £378, with spec. qualfns. to £414. Partics. and app. form, from PRINCIPAL, returnable within 14 days. (695.)

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SKILLED RADIO and Television Service Engineers who would welcome wider interests and more favourable prospects are invited to apply to a group of Companies situated in the Eastern suburbs of London. The diversified nature of Service and Government contracts, together with the manufacture of a wide variety of civil and domestic products, undertaken by the Group, provide unparalleled opportunities for advancement to men of first-class ability in work of national importance. Conditions are good and average earnings high in a modern factory where adequate canteen and sports and social club facilities are provided. Sympathetic consideration will be given to existing holiday arrangements. Saturday morning interviews by appointment. Please write, enclosing full details of past experience, and quoting reference P.W./687 to Box No. 235.

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RADIO UNLIMITED, Elm Road, London, E.17, offer: :Metal Recs.. RM1 4/-, RM2 4/3, RM3 5/3, RM4 16/6; 8in. P.M. Spkrs., 12/6; Fil/trans., 200/240v, 6.3v at 1.5 amp, 5/9; Stnd. Pent, O/trans., 3/6; 350-0-350, 6v, 5v, 4v, 4v, Mains trans.. 21/-; W.W. Pots.. 4 watt, L/spindle. 500 ohm, 750 ohm, 5K, all at 2/9 each; Carbon Cntrls., all values, 2/6; SP/sw 3/9, DP/sw 4/6; Condensers, 500vw, 8 mfd 2/6, 16 mfd 3/3, 8 x 16 4/3, 8 x 8 4/-, 32 x 32 5/3. Special offer, 8 mfd-450vw, 13/6 dozen; I.F. trans., 465Kcs 8/- pair. New lists available; stamp please.

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NEW VALVES WANTED, small or large quantities; all Television Valves and ECL80, EF80, EBC33, FN4/500, VU39, 6SJ7, 6V6, 6K8, 524, etc., etc. Prompt cash. WM. CARVIS, 103, North Street, Leeds, 7.

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"VIEWMASTER" Valves, exact to specification, guaranteed new and boxed, comprising 5 EF50, 1 6P25, 1 KT61, 1 EBC33, 1 EB91, 2 6K25, 1 6P28, set of 12 £6/2/6; with EF91 or EY51, 7/6 extra. (Post and insurance, 2/-.) 6AM6, EF91, 6F12, Z77, 8D3, 6C4, L77, W77, EF92, 6AM5, EL91, N77, 12AX7, 7/9; EB91, 6AL5, HVR2A, 6/9; 1.4v. miniatures, 1S5, 1R5, 1T4, 3S4, 3V4, 1S4, 1L4, 3Q4, 3A4, 7/6; 6V6G, 6F6G, KT63, Y63, EF39, EBC33, EF50, 20D1, 7B7, 7C5, 7C6, 7H7, 7S7, 7Y4, 7/6; 5Z4G, 5U4G, MU14, U22, U78, DH77, 6AT6, 6J6, 12AT7, ECC81, 6BA6, 6BE6, 6BW6, EC91, Pen46, 6V6GT, PY82, 6F15, 6LD20, 8/6; PZ30, GZ32, 6U4GT, 17/6; N78, ECH35, CCH35, 15/-; 6P25, CL33, U25. 13/6; 6K25, 12/6; UU8, EAC91, ECC91, UF42, UBF80, 6A7, 6F1, DF33, IN5GT, 12/-; PL81, PL82, PY81, X65, 10F9, 10LD11, 10C1, 10C2, 11/-; ECL80, EF80, EY51, PY80, 43, AZ31, CY31, 6K8GT, 12K8GT, EAF42, KT33c, 6C9, 10F1, 10P13, R10, 10/6; 25Z5, 25Z6GT, ECH42, EBC41, UBC41, DL35, 1C5G, DAC32, 1H5GT, DL33, 3Q5G, 10/-; 6SN7GT, 6SL7GT, 6Q7GT, 12K7GT, 12Q7GT, 25Z4G, 25A6G, EF41, 9/6; U50, 5Y3GT, 25L6GT, 35L6GT,50L6GT, 35Z4GT, 6X5GT, 80, UU9, U404, UY41, UF41, EZ40, 9/-; 6K7G, 6K7GT, 6/-. All new and boxed. Postage 4d. per valve extra. READERS RADIO, 24, Colberg Place, Stamford Hill, London, N.16. (STA. 4587.)

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