The Wireless World

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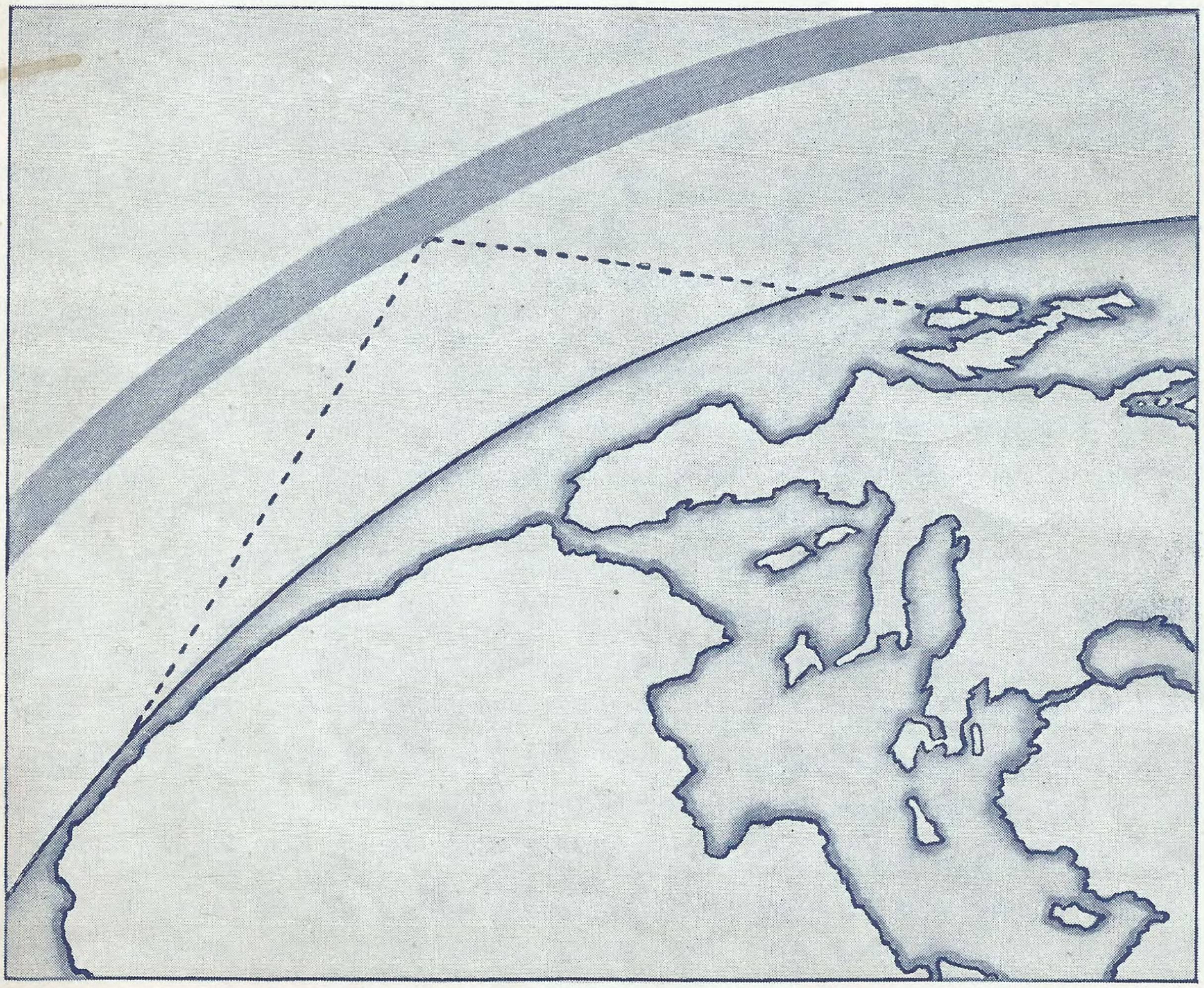
FEBRUARY, 1941

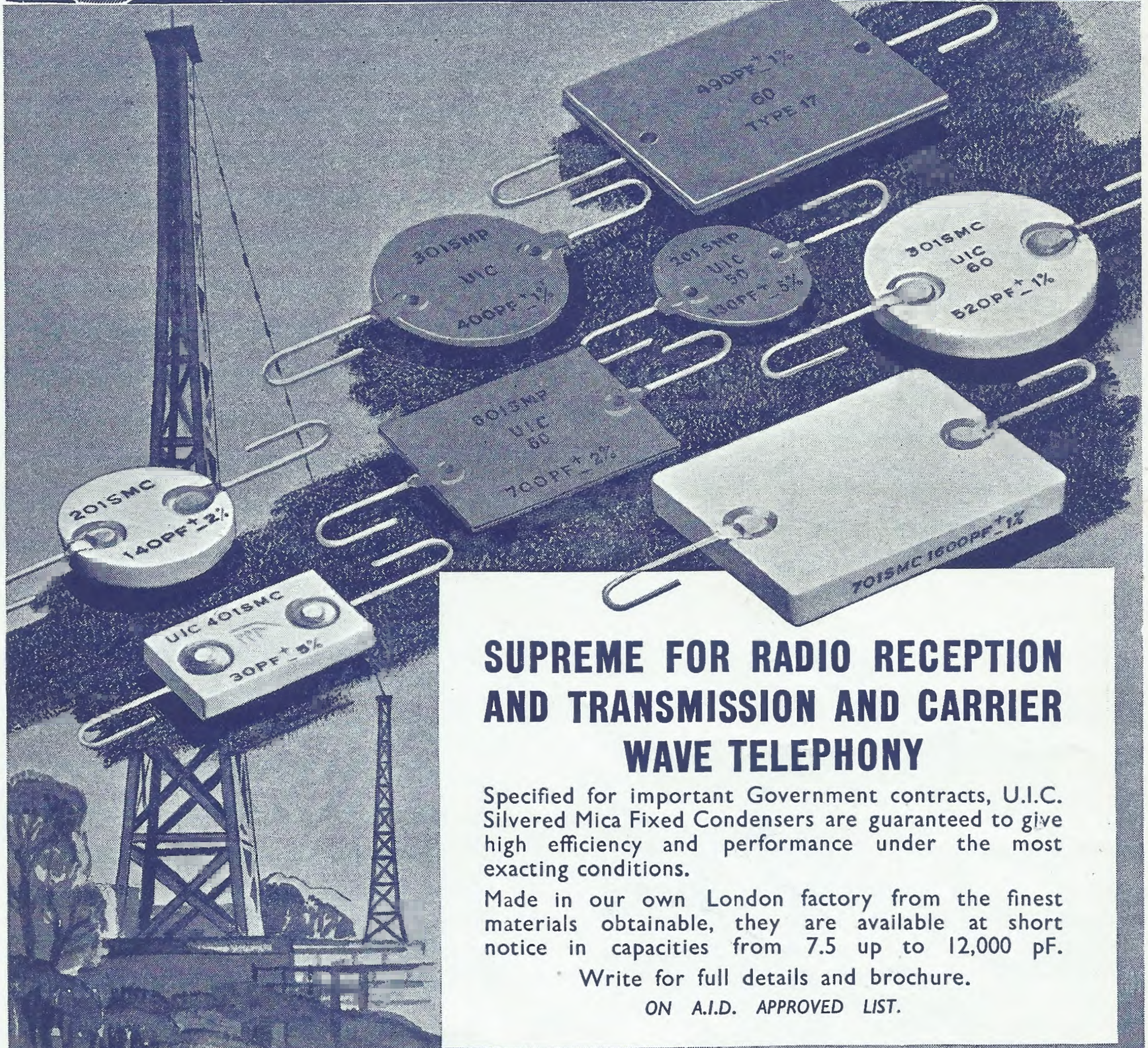


CHARACTERISTICS OF SHORT WAVES

No. 1064 Vol. XLVII No. 2

SILVERED MICA FIXED CONDENSERS

U.I.C



SUPREME FOR RADIO RECEPTION AND TRANSMISSION AND CARRIER WAVE TELEPHONY

Specified for important Government contracts, U.I.C. Silvered Mica Fixed Condensers are guaranteed to give high efficiency and performance under the most exacting conditions.

Made in our own London factory from the finest materials obtainable, they are available at short notice in capacities from 7.5 up to 12,000 pF.

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The Pioneers of Low Loss Ceramics

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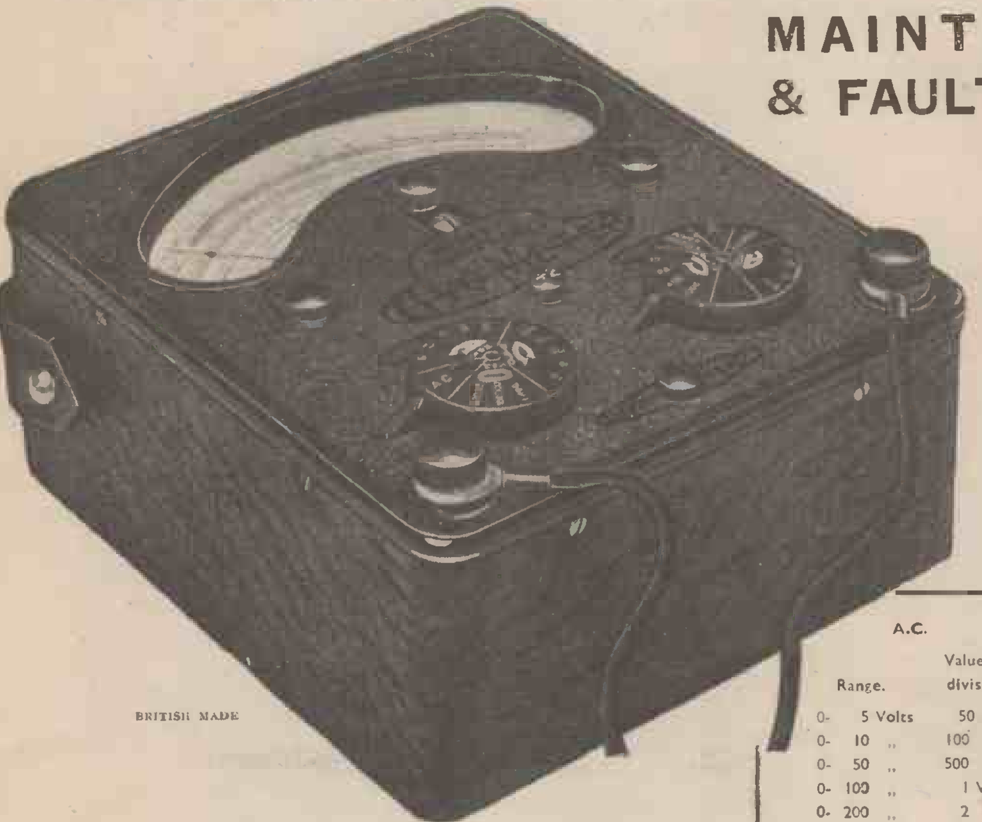

BRITISH MADE

46 Ranges of Direct Readings

VOLTAGE

A.C. Range.	A.C. Value per division	D.C. Range.	D.C. Value per division
0- 5 Volts	50 mV.	0- 50 mV (1 mA range)	0.5 mV.
0- 10 ,,	100 ,,	0- 100 mV (2 mA range)	1 ,,
0- 50 ,,	500 ,,	0- 500 mV	5 ,,
0- 100 ,,	1 Volt	0- 1 Volt	10 ,,
0- 200 ,,	2 ,,	0- 5 ,,	50 ,,
0- 400 ,,	4 ,,	0- 10 ,,	100 ,,
0- 500 ,,	5 ,,	0- 50 ,,	500 ,,
0-1,000 ,,	10 ,,	0- 100 ,,	1 Volt
		0- 200 ,,	2 ,,
		0- 400 ,,	4 ,,
		0- 500 ,,	5 ,,
		0-1,000 ,,	10 ,,

CURRENT

A.C. Range.	A.C. Value per division	D.C. Range.	D.C. Value per division
0- 5 mA	50 μA	0- 1 mA	10 μA
0- 10 ,,	100 ,,	0- 2 ,,	20 ,,
0- 50 ,,	500 ,,	0- 5 ,,	50 ,,
0-100 ,,	1 mA	0- 10 ,,	100 ,,
0-500 ,,	5 ,,	0- 50 ,,	500 ,,
0- 1 Amp.	10 ,,	0-100 ,,	1 mA
0- 5 ,,	50 ,,	0-500 ,,	5 ,,
0- 10 ,,	100 ,,	0- 1 Amp.	10 ,,
		0- 5 ,,	50 ,,
		0- 10 ,,	100 ,,

RESISTANCE

Range.	First indication.	
0-10,000 ohms	0.5 ohms	using internal 1½-volt cell.
0-100,000 ,,	5 ,,	using internal 1½-volt cell.
0- 1 megohm	50 ,,	using internal 9-volt battery.
0-10 ,,	500 ,,	using external source of A.C. or D.C. voltage.
0-40 ,,	2,000 ,,	using external source of A.C. or D.C. voltage.

CAPACITY	POWER	DECIBELS
0 to 20 mFd.	in 4,000 Ω internal resistance	reference level 50 mW
First indication 0.01 mFd.	0 to 4 watts First Indication 1 mW	—10 Db. to +15 Db.

DESIGNED by technicians who have made a special study of the service and maintenance engineers' problems, the Model 7 Universal AvoMeter is acknowledged throughout the world as the one indispensable combination testing instrument. A single meter, yet at the touch of two simple switches it provides for any one of the 46 ranges of measurements for testing and tracing all electrical faults.

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40-range Universal AvoMeter.

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Regd. Trade Mark

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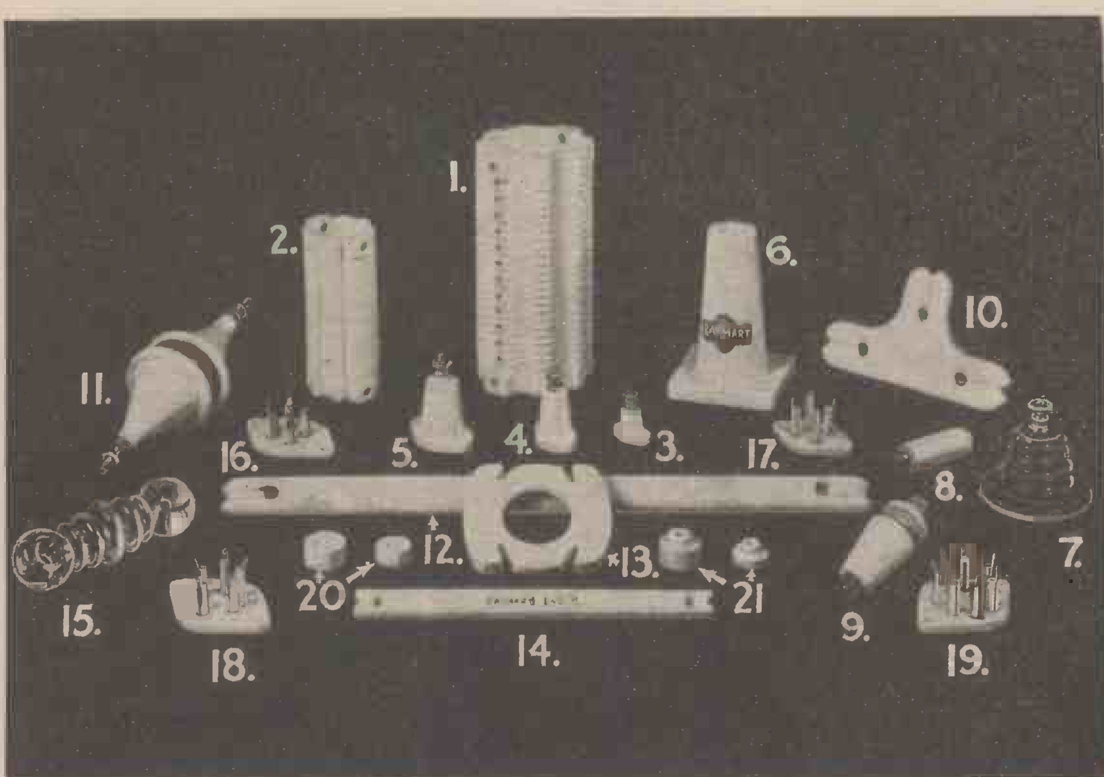

OUR ILLUSTRATION GIVES BUT A SMALL INDICATION OF THE WIDE VARIETY OF INSULATORS AND CERAMIC GOODS AVAILABLE FROM RAYMART, WHO CARRY THE LARGEST RANGE OF THESE PRODUCTS IN THE COUNTRY. THERE ARE MANY OTHER RAYMART LINES APPROVED AND USED BY H.M. SERVICES. MICRO-VARIABLE CONDENSERS—PRECISION DIALS AND A LARGE SELECTION OF SPECIALITIES FOR SHORT-WAVE WORK.

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1. **Type TFX.**—Coil Form, grooved and ribbed, 2½" dia., 5" of winding space with mounting holes and provision for link or inductive coupling.
2. **Type BTX.**—A similar coil form, 1¾" dia. ×3½" long.
3. **Type ST.**—White glazed vitreous porcelain stand-off insulator, fitted with nickel-plated terminals; height excluding terminals ½".
4. **Type SS.**—Similar in all respects; height excluding terminals 1".
5. **Type SM.**—The largest of this type of stand-off insulators, 1¼" excluding terminals.
6. **Type SX.**—Heavy stand-off insulator, 3½" high, four-hole fixing, no terminal supplied, but we have sockets specially made to fit.
7. **Types SG and SL.**—Standard beehive insulators; two versions are available—(*a*) Brown glazed (SG); (*b*) Unglazed (SL)
8. **Type SP.**—A special low-loss pillar insulator, produced primarily for ultra-high frequency use, the lowest loss insulator ever offered of this type. 1¾" long × ½" dia. and internally threaded at both ends 2BA; supplied with screws and cork washers.
9. **Type FTI.**—Double-cone feed-through insulator for feeding H.T. or R.F. through baseboard of chassis, mounting coils, etc. Height above chassis 1⅜"; below chassis ⅜". Full insulation provided on chassis up to ½" thick. Supplied with two cork washers and 2BA all-thread with nuts.
10. **Type AT.**—Aerial T piece, designed to facilitate erection of transposed or zeppelin type aerials.
11. **Type SCL.**—Lead-in insulator or H.F. bushing, provides maximum surface leakage path, highly glazed. Rubber ring washers ensure absolute weather-proof qualities. For especially exposed positions our Type DCL Insulator is identical with the SCL, but has at one end an overlapping double cone, so ensuring that no moisture shall form a path on the insulator.
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15. **Type AG.**—Flint-glass aerial insulator, with an excellent high frequency characteristic and long leakage path.

16 & 17. **English Ceramic Valveholders** with silver-plated contacts, both four- and five-pin.

18 & 19. **Ceramic Sockets** with silver-plated contacts for American valves.

20 & 21. **Type FTL and FTS.**—Feed-through bushes in ceramic. Type FTL passing a 2BA screw; Type FTS a 4BA screw. Extremely useful for carrying high voltage or R.F. through metal panels

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Cables: Raymart, Birmingham. Telephone: Midland 3254

PREMIER RADIO

PREMIER SMOOTHING CHOKES

Type	Current	Henrys	Res	Prices
C 40/500	40 MA	20-34 H	500 ohms	5/3
C 60/180	60 MA	8 H	180 ohms	5/3
C 60/400	60 MA	25-34 H	400 ohms	7/6
C 60/500	60 MA	18-30 H	500 ohms	5/3
C 100/400	100 MA	20-34 H	400 ohms	9/6
C 150/185	150 MA	20-34 H	185 ohms	13/6
C 200/145	200 MA	20-34 H	145 ohms	15/9
C 250/120	250 MA	25 H	120 ohms	17/6
C 60/2500	60 Speaker Field Replacement		2500 ohms	7/6

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Heads (will fit any tone-arm) 7/6
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ANOTHER SPECIAL OFFER
Rothermel Brush Piezo Crystal Pick-ups. New Junior P.U. with arm, 24/6. Standard, S.8 Model with arm, 34/9. P.U. head only, De Luxe Model, 24/6.

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	Kit of Parts with Valves	Completely Wired and Tested
4-watt A.C. Amplifier	£2 14 0	£3 11 6
4-watt A.C./D.C. „	3 0 0	3 17 6
6-watt A.C. „	6 16 6	7 13 6
8-10 watt A.C./D.C. „	6 11 6	7 9 0
15-watt A.C. „	7 18 9	9 8 0

Black Crackle Steel Cabinet, 17/6 extra.

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Wire-ends. All L.T. Windings Centre-Tapped

SP 250 250-0-250 v. 60 ma., 4 v. 1-2 a., 4 v. 2-3 a., 4 v. 2-3 a. ... 11/9
SP 300 300-0-300 v. 60 ma., 4 v. 2-3 a., 4 v. 2-3 a., 4 v. 2-3 a. ... 11/9
SP 301 300-300 v. 150 ma., 4 v. 2-3 a., 4 v. 2-3 a., 4 v. 1 a., 4 v. 1 a. ... 15/-
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Auto Transformers. Step up or down. 100-125 v. to 200, 230 or 250 v. A.C., 60 watts, 9/11; 125 watts, 13/6; 250 watts, 18/6.

L.T. Transformers, all C.T.

4 v. 2-3 a. ...	9/11	6.3 v. 2-3 a. ...	9/11
2.5 v. 5 a. ...	9/11	7.5 v. 3 a. ...	9/11
5 v. 2-3 a. ...	9/11	12 v. 3-4 a. ...	15/-

Push-Pull Driver Transformers, 3 : 1 ... 6/6
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Will match any output valves to any speaker impedance.
11 ratios from 13 : 1 to 80 : 1, 5-7 watts, 15/9. 10-15 watts, 20/6. 20-30 watts, 35/-.

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Heavy Duty TX Key on Cast Base... ... 10/-
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Send for full details

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Westinghouse Rectification complete and ready for use

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2 volts at ½ amp.	11/9	6 volts at 1 amp.	22/6
6 volts at ½ amp.	19/-	12 volts at 1 amp.	24/6
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40 m.mfd. ...	2/-	250 m.mfd. ...	2/11

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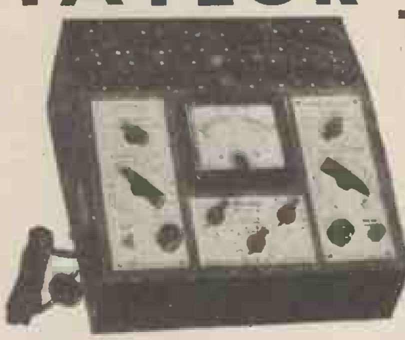

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MODEL 45

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is supplied complete with a grid connecting lead—comprehensive book of instructions and an up-to-date Valve Chart Manual.
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(PATENTS APPLIED FOR)

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In the Automobile, Electrical, Radio, Plastic, Cooker and Refrigerator Industries, to mention only a few, this modern fastening method is accelerating assembly, halving handling time and effecting considerable savings in costs and material.

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Investigate the Speed Nut System NOW.

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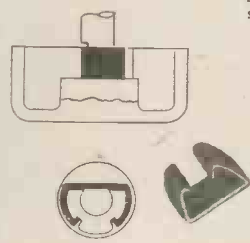
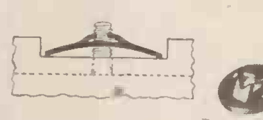
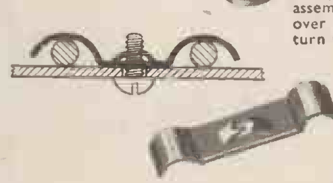


SPEED CLIP CA 728
For moulded knobs of the thermo-setting type. This Spring Collar simplifies fastening and replacement. The knob is moulded with a "D" shaped hole to prevent turning, and the spring SPEED CLIP engages frictionally with the shaft. Eliminates the difficulties of internal springs and grub screws.



SPEED NUT NR 404
Designed for assemblies which require tightening from the nut side. It has two holes for use with a two-prong key. For rapid assembly, nut is zipped down over threads and given a turn to tighten.



SPEED NUT NS 1037
These Speed Nuts, which in each case eliminate a stamping, a nut and a lock washer, solve the problem of holding wires, conduits and coils securely in place. The flexibility of the Speed Nut enables it to be used with conduits of different diameters.

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GREAT WEST ROAD, LONDON.

Longleys

The
Wireless World

COVERING EVERY WIRELESS INTEREST

30th Year of Publication

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No. 1064 Vol. XLVII. No. 2

FEBRUARY, 1941

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How much wood . . . ?

TWO years ago it was the standard practice to make Radio cabinets from Beech plywood. Cabinets built from plywood may be made with large surfaces, with curves, or with rounded corners, which cannot easily be imitated in solid board; and they may be finished with veneers of Mahogany, Rosewood, Walnut, Bubinga or any of a great variety of other woods capable of taking a high polish.

When the War began it was immediately clear that plywood could no longer be easily imported from Sweden, Poland, Finland and Russia, and that some changes in cabinet technique would be necessary if we were to have any chance of keeping up a reasonably steady supply of radio cabinets. It was with this in mind that the cabinet used for our A.90 and D.90 Table models was designed.

This cabinet is a simple design built up from a rectangular frame work, with four flat sides of solid board, stained and polished, and an inset front covered with fabric. A moulded bakelite panel surrounds the grouped controls and scale in the lower part of the front, and provides a background for the knobs which is not easily scratched or dirtied.

The plain polished sides may be made from any of a number of woods: Beech, Pine, Obechi, Mahogany, Oak and Teak have all been used as one or other became available. The fabric covering enables us to make the front itself from grades of plywood which are still obtainable, but which are not suitable for polishing or veneering. In periods of extreme shortage of wood it has been found possible to make the bottom and front of the cabinet from a very hard pressboard and tests carried out in a warm and humid atmosphere show that this has no ill effects on the strength, durability and appearance of the receiver.

As another method of saving wood we have used a moulded bakelite cabinet for the AD.94 receiver. We don't regard bakelite and the other plastics as "substitutes" for wood—materials to be finished a mottled brown and made to look vaguely like wood. They never do look like wood, and there seems to be no very good reason for trying to make them do so.

Plastics have possibilities of their own, and a bakelite cabinet should be designed to suit the material. The "94" itself is a case in point, since its shape, interesting enough and easily handled as a moulding job, is quite unsuited to woodworking technique.

It will be seen that we have met the wood shortage in two ways—by designing for one receiver a cabinet which uses the wood that is available and by using a bakelite cabinet for a second model. These changes, coupled with those in other parts of the receivers, have enabled us to make at least some of the radio sets the public needs, at a time when raw materials are very difficult to obtain.

Wartime cabinet design has been adapted in the case of the "90" Table Models (left) to the available supplies of wood. Economy in timber is also achieved by using bakelite for a second receiver (right).

MURPHY

All Murphy Sets, exclusive of valves and batteries, guaranteed for a year. *Murphy Radio Limited, Welwyn Garden City, Herts.*

C.R. Casson 968

The
Wireless World

COVERING EVERY WIRELESS INTEREST

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Editorial Comment

Planning for Peacetime

A GOOD number of our readers will demand that the post-war world shall provide them, among other desirable things, with facilities for taking part in what is surely the finest of all hobbies—amateur wireless transmitting. Writing with a lively recollection of the difficulties experienced by the amateur in regaining his privileges after the end of the last war, we feel that it is not too early to begin making plans now for organising the whole matter on a satisfactory basis. One reason for doing so is that there is bound to be an enormous number of would-be recruits to the amateur movement from the ranks of Service wireless personnel.

We will not argue that, because amateur transmission has proved such a valuable training ground for entrants to the wireless branches of the fighting services, everything possible should be done to encourage it in preparations for future wars. That would seem like a distressingly cynical counsel of despair. Rather would we urge that the post-war amateur will help to forge a link in the chain of international co-operation and mutual understanding that will be so urgently needed.

It is for these reasons that we tender no apology for publishing at the present time an article, appearing elsewhere in this issue, which offers some constructive suggestions as to the conditions under which amateur licences should be granted in the future.

It is evident that on one point at least our contributor takes much the same attitude as expressed in this journal in 1938, when we urged the abandonment of the condition (which had even then become farcical) that applicants for licences should prove that they had serious scientific experimental work in view. A genuine interest in wireless and the attainment of a reasonable standard of proficiency should be enough.

There must be no misunderstanding about one important matter. No reasonable person knowing anything about the subject would suggest that the ether should be thrown open to any incompetent and irresponsible applicant for a transmitting licence. In pleading for some relaxation of the official attitude we have always maintained that proof of a reasonably high standard of operating ability should be required before the granting of a full licence. If the amateur movement grows, a technical examination may also be necessary. An incompetent operator has enormous potentialities for disorganising wireless communications, and proper safeguards are essential.

Saturation Point?

It has been suggested that there is not room for many more amateur transmitters, but, given proper organisation of their activities, that attitude seems to be quite untenable. As we pointed out in 1938, some 40,000 amateurs in the U.S.A. then seemed to accommodate themselves fairly comfortably within the confines of waveband allocations very little more generous than those occupied by a mere 7,000 in the whole of Europe. In any case, the question of saturation, so far as the band of wavelengths with world-wide range is concerned, should really be considered on a world basis, and not from a local or national point of view.

The advantages of having a cut-and-dried scheme, ready for submission to the Post Office immediately war ends, is obvious, and it is hoped that readers who have alternatives to "Navigator's" suggestions will not hesitate to put them forward.

Noise in FM Transmissions

FIELD TESTS CONFIRM ADVANTAGES OVER AMPLITUDE MODULATED SYSTEMS

In view of the importance of possible future developments in frequency-modulated broadcasting, extensive calculations and experiments have been made in America to determine quantitatively the improvements which are to be expected in the service range of FM stations. This article summarises the results obtained, which show close agreement between theory and practice

IN the matter of signal-noise ratio, the superiority of frequency-modulated broadcast systems over those with amplitude modulation is not solely due to the action of the limiter stage[1] of the receiver in "ironing out" amplitude variations. There are fundamental differences in the way in which noise voltages combine with the carrier in FM and AM receivers, and in nearly all circumstances the resultant effect is to the advantage of FM.

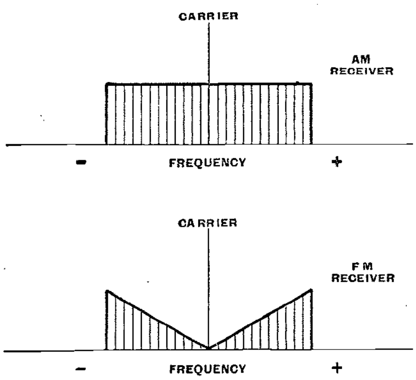


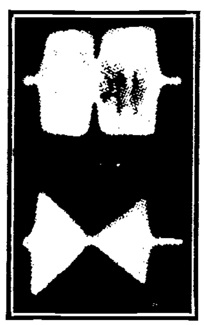
Fig. 1.—The frequency spectrum resulting from the combination of noise with a carrier is rectangular in the case of amplitude modulation and triangular with frequency modulation receivers.

Random noise such as that arising from valve hiss comprises a continuous spectrum of frequencies ranging from zero upwards in which the components approximate to a constant amplitude. Mathematical analysis[2] has shown that when the noise is combined with a carrier the resultant spectrum in a receiver for amplitude modulation is rectangular, whereas in an FM receiver it is triangular. (See Fig. 1.) Put in another way, the audio noise at the output terminals of an AM receiver is constant at all frequencies, but in FM reception it increases proportionally to the frequency of each component of the noise. Experimental proof is furnished by the cathode-ray oscillograms of Fig. 2, obtained by swinging a heterodyne oscillator across the carrier to which the receiver was tuned.

When amplitude and frequency modulation are competing on equal terms, i.e., with 100 per cent. modulation in the case of AM, and a deviation ratio of unity in the case of FM (frequency departure equal to upper audio limit), the signal-noise ratio can be shown[2] to be $\sqrt{3}$ or 1.73 times better in FM than in AM reception. This is an initial gain for FM of 4.75 db.

But the deviation ratio is rarely as low as unity, and in practice is usually about 5:1 (75 kc/s frequency deviation for an upper audio limit of 15 kc/s). From Fig. 3 it will be seen that the FM noise spectrum reaches its maximum at 75 kc/s, whereas the 15 kc/s audio cut-off in the receiver or loud speaker rejects the greater part of the triangle and passes the small darkly shaded area which is only one-fifth of the whole. Thus there is in this case a gain in signal-noise ratio of 1.73×5 or 18.75 db.

Fig. 2.—Oscillograms from amplitude (top) and frequency modulation receivers obtained by tuning the set to a carrier and swinging a heterodyne across the carrier to simulate noise. The nick in the AM oscillogram is due to "pulling" near zero beat.



Still further improvement is obtained by the "pre-emphasis" of

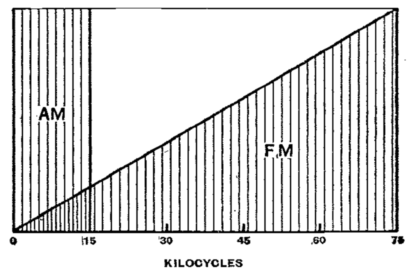


Fig. 3.—With an upper audio-frequency limit of 15 kc/s, the noise in the output of a 75 kc/s FM receiver is limited to the area shown by the small triangle.

high frequencies in the transmitter and a converse "de-emphasis" in the receiver. The R.M.A. and F.C.C. have standardised this practice in America for television and UHF transmissions in accordance with the impedance-frequency characteristics of a series inductance-resistance network having a time constant of 100 micro-seconds, and when the curves are analysed to find the RMS signal-noise improvement a further gain of 7.35 db. is found, giving a total of 26 db. over amplitude modulation.

All the foregoing considerations are based on the assumption of a reasonably large carrier-noise ratio, i.e., greater than unity. Below a carrier-noise ratio of unity, the signal-noise ratio at the output of the receiver ceases to be proportional to the input carrier-noise ratio. The reasons for this effect have been worked out in theory[2], and the curves of Fig. 4 show the calculated

[1] "Receivers for FM Transmissions," *The Wireless World*, December, 1940.

[2] "Frequency Modulation Noise Characteristics," M. G. Crosby, *Proc. I.R.E.* April, 1937.

Noise in FM Transmissions—

magnitude of the effect. The physical process by which the signal is depressed below the "improvement threshold" or limiting carrier-noise ratio is somewhat involved and the waveform of the noise is an important factor.

Fluctuation noise due to valve and circuit hiss, which in spite of its name is of comparatively steady average amplitude, produces a greater depression than impulse noise such as that due to car ignition systems. In the latter type of noise the peaks are not only limited by the frequency characteristics of the system, but they also depress the signal and punch holes in it in a similar manner to certain noise suppression circuits which have been developed for amplitude modulation receivers. Another important point is that receivers designed for a high deviation ratio should require a higher carrier input to reach the "improvement threshold" than low deviation receivers, the reason being that the wider IF band width of the high deviation receiver accepts more noise. At certain carrier levels near the fringe of the service area of a FM station the low deviation receiver may be expected to give a better signal-noise ratio than the high deviation receiver, because one will be working above and the other below its threshold.

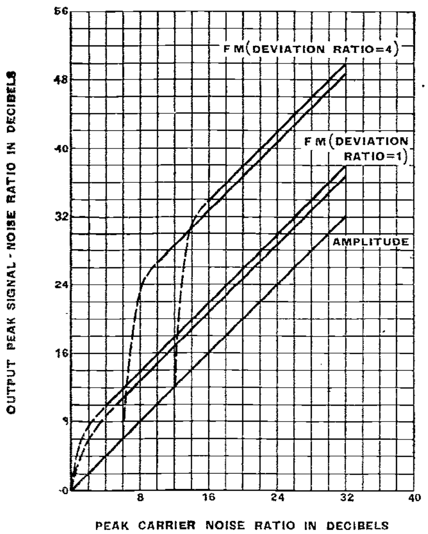
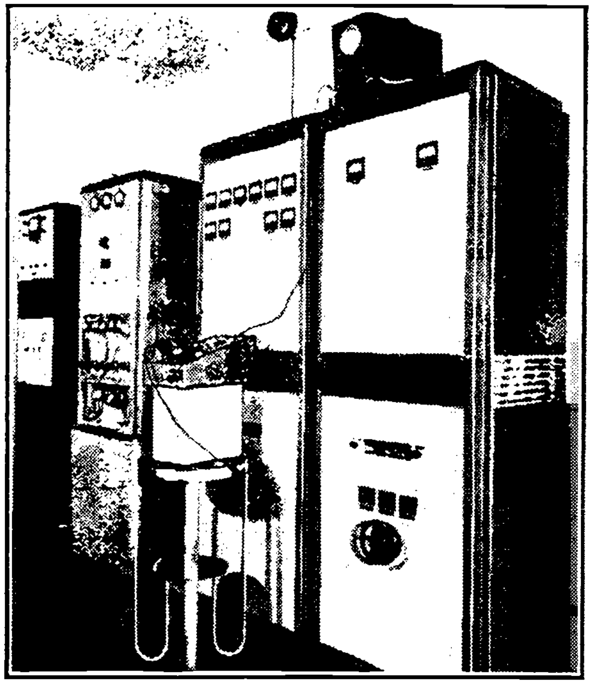


Fig. 4.—Calculated signal-noise ratio characteristics of frequency and amplitude modulation. In each pair of curves the higher is for impulse noise and the lower for fluctuation noise.

All these theoretical predictions have been confirmed by laboratory experiments, and more recently[3] by field tests undertaken by the National Broadcasting Company in America. These tests were of an exceptionally thorough and painstaking character and were designed to settle once and for all the rival claims of amplitude and frequency modulation and of the relative merits of different deviation ratios in the latter system. As far as quality of reproduction was concerned it was regarded as axiomatic that there was nothing to choose between FM and AM and that the governing factors were the use of an ultra-short wavelength for transmission which permitted an extension of the 10 kc/s band width permitted on normal broadcast bands. The tests were therefore directed primarily to the evaluation of the frequency-modulated system in terms of the suppression of noise and interference, using the amplitude-modulated system as a reference standard.

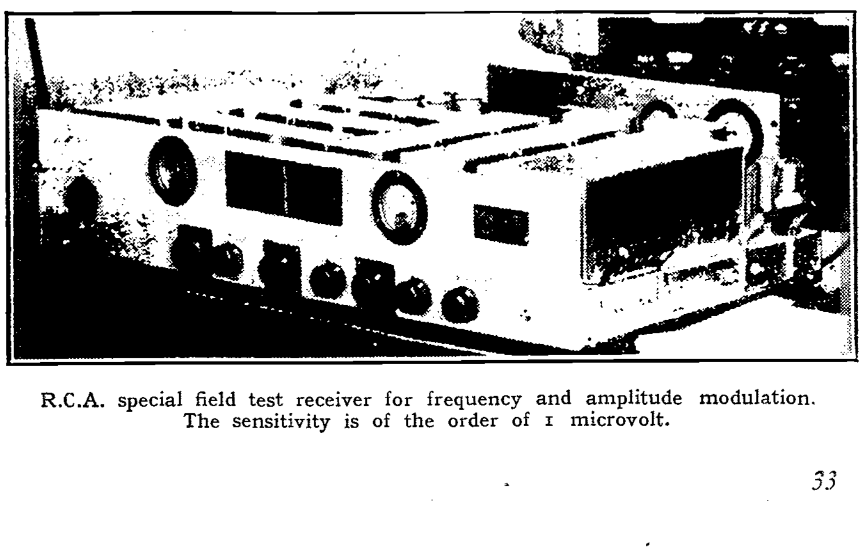


General view of the transmitter at station W2XWG. The change over from amplitude to frequency modulation is effected by relays. An accurate check of the transmission line voltage was obtained by the GR multi-range valve voltmeter seen on the stool in the foreground.

To eliminate every possible disturbing factor it was decided from the start to use the same transmitter, receiver, aerial systems and measuring equipment for each system of modulation.

The transmitter was a 1 kW RCA unit designed originally for amplitude modulation and modified for alternative frequency modulation, the circuit changes being effected by a number of relays. A reactance control in the primary circuit of the

[3] "NBC Frequency-Modulation Field Test," by R. F. Guy and R. M. Morris, *R.C.A. Review*, October, 1940.



R.C.A. special field test receiver for frequency and amplitude modulation. The sensitivity is of the order of 1 microvolt.

Noise in FM Transmissions—

main rectifier gave a continuously variable control of power from 1,000 watts to less than 0.1 watt during transmission with frequency modulation. The power delivered to the aerial was accurately measured by a GR valve voltmeter across the aerial transmission line. Modulation was effected by the reactance valve method and a crystal-controlled oscillator in conjunction with a discriminator circuit was used to keep the average carrier frequency stable.

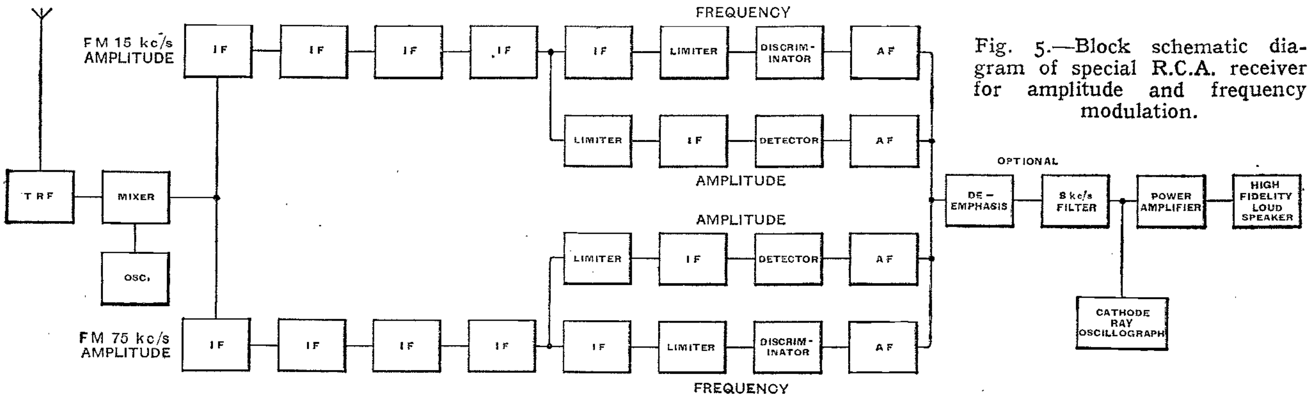


Fig. 5.—Block schematic diagram of special R.C.A. receiver for amplitude and frequency modulation.

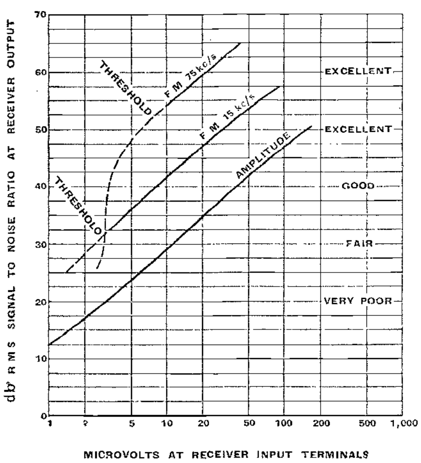


Fig. 6.—Signal-noise performance with valve and circuit noise only.

The aerial system normally used was the television aerial on the top of the Empire State Building, New York, but an auxiliary folded dipole was available for periods when the main antenna was occupied for television. The station was given authority to transmit either FM or AM on 42.6 Mc/s and was licensed as W2XWG.

Four receivers were built specially for the tests, and no expense was spared to make them as nearly ideal and alike as possible. RF frequency changer and output stages were made common to both systems of reception, and the change-over was effected only in the IF and detector or discriminator sections of the chain. Parts of the same IF system were used for AM and 15 kc/s FM, but a separate IF amplifier was used for 75 kc/s FM. A single switch selected the type of modulation required.

A shielded mutual inductance type attenuator was used between the aerial and the receiver. By using this in conjunction with control of the transmitter power and of the power radiated from artificial noise sources, any combination of carrier and noise voltages could be produced. The transmitter and receiver were equipped with "pre-emphasis" and "de-emphasis" filters.

Auxiliary apparatus at the permanent receiving stations included cathode ray oscillographs, noise and distortion meters, a harmonic analyser, disc recording equipment, noise producing devices such as diathermy machines, automobile ignition systems, etc.

The two permanent stations were situated in the NBC laboratory at a distance of one mile, and at Bellmore, Long Island, 23 miles away. Observations were also made at nine temporary stations up to distances of nearly 90 miles. The equipment of the temporary stations was built into two cars, one of which is shown on the next page. This vehicle was equipped with field intensity measuring sets mounted in aviation shock absorbers, a universally mounted dipole, a broadcast loop aerial, a vernier speedometer and distance recorder, and a magnetic compass.

After a preliminary survey of the field intensity contours of the transmitter, investigations were made to determine the minimum field intensity which would provide a good service. The curve in Fig. 6 shows the results which were obtained with a signal generator feeding directly into the input terminals of the receiver. Under these conditions there was no external noise interference, and receiver hiss was the limiting factor. Measuring along the 10 microvolt vertical ordinate, it will be seen that the difference in signal-noise ratio between amplitude modulation and 75 kc/s frequency modulation is 26 db, so that the full theoretical advantage is realised.

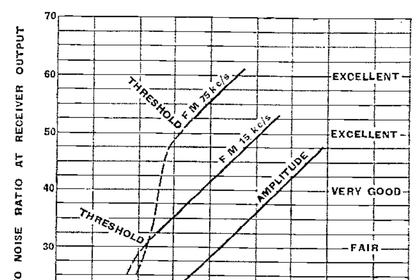


Fig. 7.—Performance with circuit hiss and miscellaneous quiet neighbourhood noise. Transmitter W2XWG, New York City and receiver R.C.A. special receiver at Bellmore, Long Island.

Noise in FM Transmissions—

The curves of Fig. 7 were taken at Bellmore under representative receiving conditions, and show the results which were obtained with a combination of circuit hiss and quiet neighbourhood noise. Noisier conditions would shift all three curves to the right without altering the vertical distances between points on the curves.

The data obtained in these tests were plotted in the form of a bar chart (Fig. 8), showing the calculated service ranges for 30 kc/s deviation and for higher transmitter powers. An interesting point is that a 30 kc/s deviation with a signal-noise ratio of 40 db, which may be regarded as a satisfactory minimum for good service, has a better range than the 75 kc/s deviation, owing to the greater limitation imposed by the "improvement threshold" which occurs at a signal-noise ratio of 60 db, but for practical purposes does not become severe until about 53 db for the higher deviation. Above this value 75 kc/s deviation is definitely better than 30 kc/s, but for maximum coverage the latter would seem to be the optimum frequency deviation.

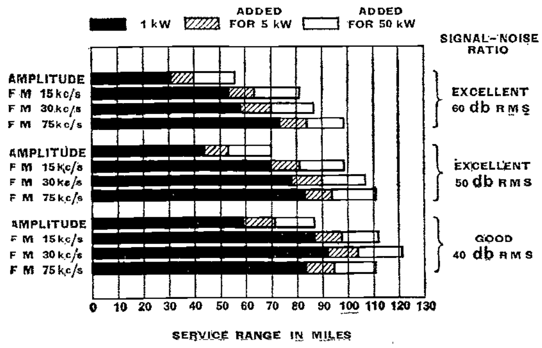


Fig. 8.—Bar chart of estimated average service ranges of various transmission systems. Calculations are based on noise levels in the Bellmore neighbourhood and the assumption of an aerial height of 1,000ft. and receiver height of 30ft.

With regard to simultaneous operation of two FM stations on the same channel, it was found that interference and cross talk were unnoticeable when the carrier voltage of the desired station was 20 db greater than the undesired station. The opinion is expressed that with a reduction of this difference to 12 db the service would be still tolerable. With amplitude modulation, on the other hand, a minimum power difference of 40 db is essential.

On adjacent channels with 200 kc/s separation, tests showed that the undesired carrier should not exceed the desired carrier by more than 10 db. This was the average value obtained with two commercial FM receivers. With the R.C.A. special receiver, on the other hand, a difference of 17 db could be tolerated.

Tests for the signal-noise levels at which the "improvement threshold" begins gave levels of 60 db for 75 kc/s and 35 db for 15 kc/s.

In all the foregoing experiments the noise was predominantly of the continuous hiss type. Tests with ignition interference confirmed that for similar subjective estimates of service quality a signal-noise ratio (peak in this case) 10 db less than hiss gave equivalent results.

Diathermy interference was largely dependent on the type of HT supply; machines with raw AC were characterised by a transmission band about 15 kc/s in width. Observations made with a machine of this type with fairly weak interference centred exactly on the desired carrier showed a superiority of FM over AM of 20 to 25 db for 75 kc/s, and 10 to 12 db for 15 kc/s deviation. With the interference off the carrier frequency, conditions were quite altered, and at 5 kc/s off tune, AM was approximately equal to 15 kc/s FM, and was in some cases actually superior to 75 kc/s FM. When the diathermy interference was centred at the edge of the 15 kc/s FM and AM pass-band, the interference was highly attenuated, but with 75 kc/s FM it was extremely severe, as the interference products were well within the pass-band of the latter system. It would seem that a locality with strong diathermy interference calls for narrow band receiving systems, but the wide band is superior when interference is weak.

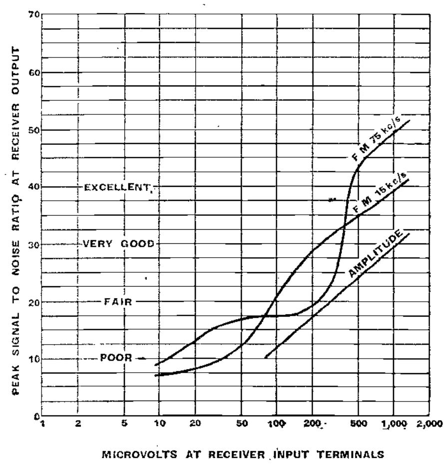


Fig. 9.—Signal-noise curves for peak ignition noise (56 uV/metre) from car 100ft. distant travelling at 30 m.p.h. Modulation was simulated by detuning the 15 kc/s system by 6 kc/s and the 75 kc/s system by 24 kc/s.

N.B.C. Radio Facilities engineering car equipped with field intensity measuring sets, vernier speedometer and distance recorder, compass, etc.

Propagation of Short Waves

HOW THEY TRAVEL THROUGH SPACE

This simplified explanation of the way in which short-wave signals travel over vast distances through space is published for the benefit of the large numbers of readers who, since the war, have turned to short-wave broadcasting for information and interest.

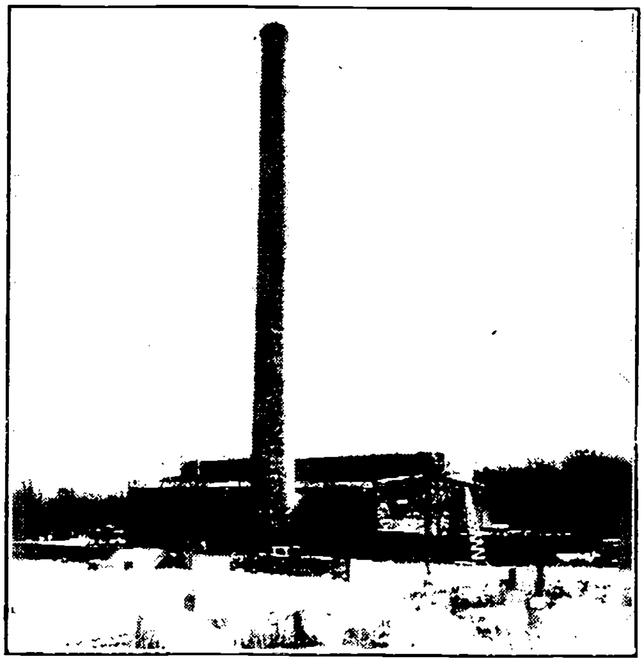
By D. W. HEIGHTMAN

THE newcomer to short-wave reception soon finds that a knowledge of fundamental matters concerning the propagation of such waves is of considerable assistance in obtaining best results with a minimum waste of time. It is our purpose here to go into such matters in a simple manner, taking little previous knowledge of the subject for granted.

We are chiefly concerned with frequencies between 5 and 30 megacycles, or wavelengths of 10 to 60 metres. Compared with long and medium waves, where the "ground wave" is of most importance, short-wave signals are received over long distances by virtue of the "sky wave." The terms ground wave and sky wave are probably self-descriptive enough, but it might be mentioned that the ground wave is propagated along the surface of the earth without any form of reflection between transmitter and receiver. On long and medium waves the ground wave is attenuated to a far less extent than on short waves, consequently the lower frequencies are more suitable for ordinary broadcasting, providing reliable signals up to a hundred miles or so. Unless the aerials are erected abnormally high (as in the case of television) the ground wave in the case of short waves is of little use over 30 miles or so. To cover long distances on the short waves we rely on the sky wave, which leaves the transmitter, travels upwards for a hundred miles or so until it reaches the ionosphere, where it is then reflected (more correctly refracted or bent) back to the receiver many miles away.

The ionosphere is that part of the earth's atmosphere, extending mainly between 25 and 250 miles above the surface of the earth, which is ionised by the sun's rays. By ionisation we infer the splitting of a gas, generally rarefied, into charged particles known as ions, by the passage of a radiation or stream of electrons through the gas. Electrons are, as it were, knocked off from their atoms or become attached to other atoms, by the radiation. Unless the gas is rarefied the free electrons soon recombine with the ions and the gas is no longer ionised. Such an ionised gas has the property of bending waves of radio frequency on the passage of such waves through the gas. The amount of bending depends on the ionisation density and the frequency of the wave. The higher the frequency of the wave the less it is bent, and also the higher the density of ionisation the higher the frequency of the wave that can be refracted. In the present instance, of course, the outer atmosphere of the earth is the rarefied gas and the ultra-violet radiation from the sun the main ionising agent.

While there is still much for the scientist to find out about the ionosphere, in recent years much data has been obtained, and the following is a brief picture of it as we understand it to-day. The ionisation is not evenly distributed with height, and at certain heights is considerably more intense. Thus we speak of the various layers of the ionosphere. It must be remembered, however, that the layers can be as much as one hundred miles thick and seldom exist as thin reflecting surfaces, the inner and outer boundaries of the layers being quite indefinite. There are two layers of the ionosphere which chiefly affect radio signals. These are known as the E and F layers. Their heights above the earth's surface and



WRUL, Boston, is one of the most consistently well received of American broadcasters, as the 19- and 25-metre bands, used simultaneously for transmissions beamed on Europe during the early evening, are generally suitable for propagation conditions then existing. At about midsummer and midwinter, however, waves respectively shorter and longer than either of those used would often provide better signals. The photo shows one of WRUL's curtain beam aerials at Scituate, near Boston.

their ionisation density depend on several variables, some known and others unknown. During daytime from about March to October, and particularly in midsummer, the F layer splits into two layers, called the F1 and F2 layers, which recombine at dusk to form the single night-time F layer. The effect is seldom observed in winter when there is only one F layer. The E layer, which generally has a less ionisation density than the F layers, exists at an average height of 110 km. (70 miles), while the night-time F layer is at an average height of 300 km., dropping to some 200 km. during daylight in winter. When it exists the F2 layer is subject to considerable variation in height, reaching its maximum height in the middle of the summer day, around 400 km., and dropping back to the night-time F layer height as the day proceeds. The F1 layer does not vary in height to the same extent as F2 and averages about 200 km.

Short-wave Paths

From the foregoing we arrive at the simple diagram of Fig. 1 which demonstrates the fundamentals of short-wave propagation. It should be remembered that the lines in this figure only represent the points of greatest ionisation in layers of considerable thickness. The distribution of ionisation with height would be somewhat as represented by the shaded area on the extreme right of the diagram. Obviously from Fig. 1 the factors controlling the distance covered by the short-wave signal will be (1) the transmitter frequency, (2) the angle at which the main radiation leaves the earth, (3) the layer heights, (4) the ionisation density of the layers. In practice we have to adjust (1) and (2) to suit existing conditions of (3) and (4). While this sounds simple enough, matters are considerably complicated by the fact that the ionosphere is subject to many irregularities, and also that the distribution of daylight over the path of the signal is often very uneven, especially over long distances east or west.

The line *a* in Fig. 1 represents the path of a low-frequency signal leaving the transmitter at a high angle. Since the ionisation of the lower layer is sufficient to reflect a signal of low frequency, such as *a*, this signal returns to earth at a comparatively short distance. Path *c*, however, is that of a signal of considerably higher frequency which leaves the transmitter at the same angle as *a*, but which passes through the first layer, where the ionisation is insufficient to return it to earth, and is reflected by the higher layer of greater ionisation, thus arriving at a point considerably farther away than *a*. covered by a lower frequency signal, taking path *b*, in two or more hops and relying on reflection from the ground (or water) at intermediate points. For a given power radiated by the transmitter, however, it would be found that the lower frequency signal would be weaker than the single-hop high-frequency signal; this is due to the attenuation which occurs in the multiple reflection in the ionosphere and in the imperfect reflection from the ground. A low-frequency signal is also subject to greater attenuation on its passage through the ionosphere. Therefore, for any signal route, strongest signals are obtained using a frequency near the highest usable frequency under any given conditions.

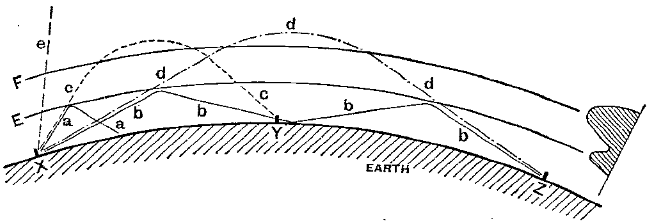


Fig. 1. — Fundamentals of short-wave propagation via the ionosphere. For simplicity only two layers are shown, such as would exist on a winter day. The heights of the layers are of necessity, deliberately exaggerated. Approximate distribution of ionisation with height is shown by the shaded area on the extreme right of the diagram.

The signal *e* of the same frequency as *c*, but leaving at a high angle, passes through both layers, and is not returned to earth. In this instance, signals leaving at a higher angle than *c* will not be returned to earth, so that the distance X – Y represents the shortest distance that can be covered by a signal of the higher frequency *c*. Between X and Y no signals will be receivable (except over a few miles close to the transmitter due to the ground wave and at intermediate distances due to other secondary effects producing very weak signals) and the distance XY is known as the skip distance for waves of a given frequency. It should be realised that the skip distance will vary with frequency, and will not be constant for any particular frequency, since it depends on existing conditions in the ionosphere. Alternatively, the longest distance that can be covered in a single hop will be that of a signal which leaves the transmitter at a very low angle such as *d*. The actual distance covered will depend on the layer heights and distribution of ionisation over the signal path, and can be anything from 3,000 to 6,000 miles or so.

Signals leaving at intermediate angles between *d* and *c* will be receivable at any point between Y and Z. The distance X – Z could be

"Critical Frequencies"

In order to be able to forecast radio conditions and also to keep a record of them for future reference, various scientific bodies in different parts of the world carry out daily observations, by means of special apparatus, on the heights and "critical frequencies" of the various layers. Briefly, a transmitter is arranged to send waves vertically upward in a series of very short impulses. These signals, reflected by the ionosphere, are picked up on a nearby receiver, the output of which is connected to a cathode-ray tube. On the cathode-ray tube is seen a large deflection due to the impulse received direct from the transmitter and smaller deflection due to the reflected impulse. From the distance between these two impulses on the tube screen it is possible to determine the time taken by the signal to go up to the layer and back. Knowing the speed of radio waves (186,000 miles per second), it is then a fairly simple matter to arrive at the dis-

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tance travelled by the signal, half the distance in this case being the approximate height of the ionised layer. Thus it is possible to measure what is known as the "virtual height" of the various layers. The virtual height obtained in this way will be somewhat greater than the actual height to which the signal travels, since the signal is slowed down somewhat during its passage in and out of the layer.

As the frequency of the above-mentioned impulse transmitter is gradually increased, say, from 2 megacycles, it will be found that the virtual height of the layer also increases slightly and then suddenly, as the frequency reaches, say, between 3 and 4 megacycles, the virtual height jumps up to something like double the original value. This indicates that the signal of increased frequency is passing through the first or E layer, and is now being reflected by the F layer. The highest frequency of waves transmitted vertically upward and returned to earth is known as the critical frequency of the particular layer in question.

As the frequency of the transmitter is increased from, say, 4 megacycles, again there is a gradual increase of indicated virtual height until a point is reached, say 12 Mc/s, where no further reflections are indicated. This shows that the waves are now passing into outer space, and in this instance 12 Mc/s would be the critical frequency of the F layer. Fig. 2 gives typical records of virtual heights and critical frequencies for various seasons, etc.

Low-angle Transmissions

Signals of considerably higher frequency than the critical frequency will be returned to earth by the various layers if these signals are transmitted at low angles to the earth (instead of vertically upward as in the case of the critical frequency) for then a signal so transmitted will arrive at the layer at an oblique angle and its passage through the layer will be longer, also it will not require the same amount of bending to return it to earth. Generally the highest frequency of a low-angle signal which will be returned to earth (often termed upper frequency limit) is approximately three times the critical frequency in the case of the F layer and three to five times in the case of the E layer.

Unfortunately in many respects, since the ionisation in the atmosphere is caused by the sun's radiation it is obvious that the ionisation density of the layers will vary almost continually with the earth's rotation, both hourly from day to night and with the various seasons of the year. In addition the sun's radiation is far from constant, being subject to various fluctuations and irregularities. The presence of spots on the sun affect its radiation and, therefore, the ionosphere, considerably. Generally the effect is to increase the ionising radiation and thus the critical frequencies, but the improvement is at times followed by short periods of disturbed conditions. The net result is that the average ionisation in the atmosphere is greatest in sunspot maximum years and follows the sunspot cycle of eleven years average between peaks. Hence, as the sunspots reach their maximum years, the maximum usable radio frequencies are highest, being almost double those usable at the sunspot minimum. The last sunspot maximum was 1937, and since that year conditions on the higher radio frequencies have gradually fallen off.[1]

The critical frequencies of the E and F layers vary as shown in Fig. 2 (*b*) during each 24 hours. It will be observed that the E layer reaches its maximum ionisation around midday, and so also does the F layer in winter, but in summer months the latter layer generally reaches higher

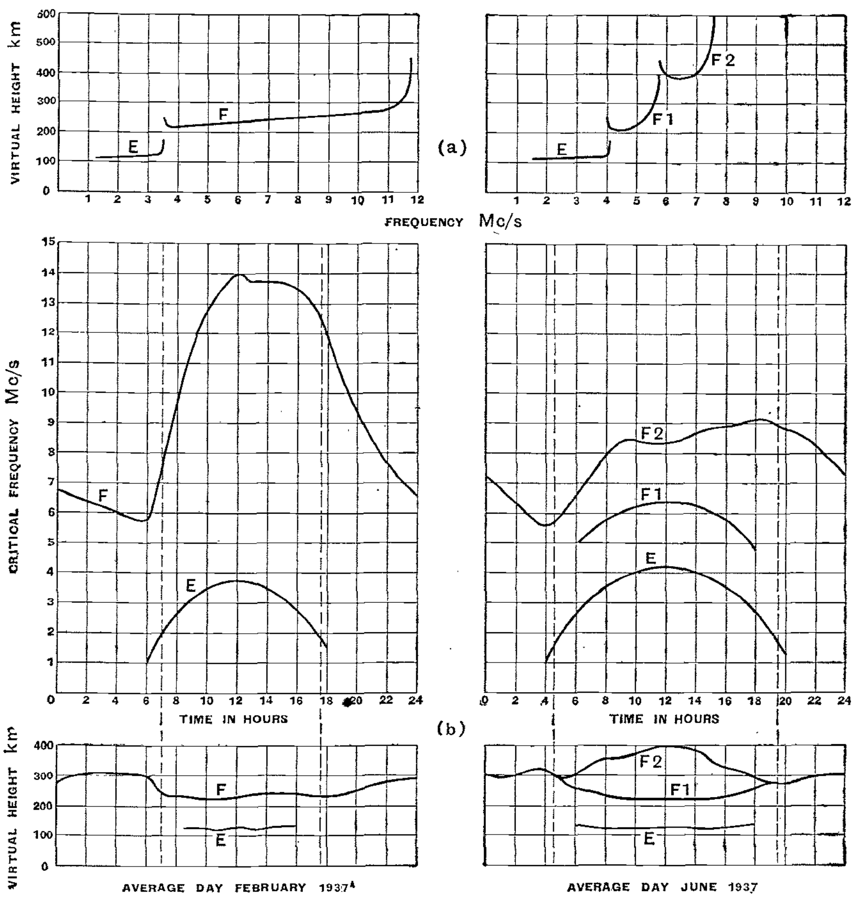

Fig. 2.—(a) Variation of virtual height with increase of frequency for a winter and summer day. (b) Comparing virtual heights and critical frequencies for winter and summer throughout the 24 hours for average days in February and June, 1937 (sunspot maximum). (*After data contained in Sept., 1937, report of Nat. Bureau of Standards, Washington.*)

[1] "Collecting Short Wave Data," *The Wireless World*, August, 1940.

Propagation of Short Waves—
critical frequencies later in the day, an hour or two before sunset. The F layer ionisation is greatest at the end of February and the end of October, reaching a minimum in midsummer and slightly falling off in midwinter. Thus, during the winter months the upper frequency limit for long-distance transmission during daylight is considerably higher than in summer and also a much wider band of frequencies can be used without undue attenuation towards the lower frequencies. In the summer daytime, when the E layer critical frequency is at a maximum and is much nearer the values of the F layers, only a comparatively narrow band of frequencies are suitable for daytime long-distance transmission *via* the F layers, because the higher ionisation in the E layer reflects most frequencies back to earth at short distances.

During the summer months, and occasionally at other times, there occurs what is known as "sporadic E" or "intense E" layer ionisation during which the ionisation in the E layer is greatly increased and is thought to be more stratified. Signals of 60 Mc/s or more are reflected under such conditions. Sporadic E conditions do not, however, last for more than an hour or two and are of a comparatively local nature.

At night-time, both in winter and summer, transmission on frequencies over 1-2 Mc/s takes place *via* the F layer. The summer night-time F layer critical frequencies are generally higher than those in winter when the lowest values for the layer are recorded.

Occasionally conditions in the ionosphere occur which cause complete or partial fade-outs of signals from certain directions. The first type of fade-out is characterised by a sudden disappearance of signals for short periods of a few minutes to an hour or two, only during daylight, with a rapid return to normal conditions. This sudden or short-period fade-out is said to be due to chromospheric eruptions on the sun, causing suddenly greatly increased ionisation below the E layer, which results in great attenuation of short-wave signals. The effect of this type of fade-out is greatest where the sun's radiation is perpendicular, i.e., in southerly directions from this country. The lower frequencies down to 2 Mc/s or so are more affected by the short period fade-out than are the higher frequencies.

The second type of fade-out, which is of a more serious nature, occurs when what it known as an ionosphere storm takes place. During such a storm the ionisation in the F layer is considerably reduced and the virtual height is subject to considerable variation, particularly over parts of the world near the polar regions. Signal routes in southerly directions are seldom affected; at any rate, never so seriously as routes north of east or west. The ionosphere storm is thought to be caused by the arrival of charged particles from the sun, chiefly at the polar regions of the earth. It is accompanied by a "magnetic storm" (when the earth's magnetic field suffers considerable variation) and also often by the Aurora Borealis. The onset of the ionosphere storm is generally slow, taking several hours to reach a maximum and the fade-out lasts with diminishing intensity for two or three days, conditions gradually returning to normal. The higher frequencies are most badly affected by the long-period type of fade-out, the deterioration in conditions becoming less the lower the frequency. In this country we notice the effect of ionosphere storms mostly on signals from North America, since the signal paths pass near to the north pole. Many signals which do not completely fade-out during an ionosphere storm are subject to extremely rapid "flutter" fading.

In a subsequent article we will consider, in relation to everyday short-wave reception, the more practical aspects of the phenomena that have been discussed.

In What Direction?

CORRECTED RULES FOR USING THE WEIR NOMOGRAM

IT is regretted that the rules for applying the Weir Nomogram, as given in the article in the January, 1941, issue of *The Wireless World* were incorrect on account of the scales being interchanged. The scale COC′ is actually the (distant) station latitude scale and the latitude curves E represent the observer's latitude. The amended rules are:—

1. Find X, the point on the latitude scale corresponding to the station latitude.
2. Find Y, the point of intersection of the observer's latitude curve and the longitude difference curve.
3. Join XY and through O, the centre of the circular scale, draw a line OZ meeting the scale at Z where the angle θ may be read off (the parallel lines may be drawn by the aid of a ruler and set square).
4. If the longitude difference is greater than 90 degrees use the intersection point in the opposite quadrant.
5. The scale reading θ gives the bearing East or West of North.

Example 1: The point X on the nomogram is the 40-degree division on the North Lat. scale. The point Y, since, $120>90$, will be in the opposite (South) quadrant (Rule 4) and is at the intersection of the 120-degree Long. Diff. curve and the 53-degree latitude curve (found by interpolation). A line OZ is now drawn through O parallel to XY and cuts the circular scale at the 44-degree graduation. Hence the bearing is 44 degrees West of North.

Example 2: The point X on the nomogram is the 30-degree division on the S. Lat. scale. The point Y is the intersection of the 150-degree Long. Diff. curve with the 53-degree Latitude curve, and since 150 degrees$>$90 degrees it will (Rule 4) be in the North quadrant. OZ is drawn through O parallel to XY and the circular scale reading is 55.5 degrees. The bearing is thus 55.5 degrees East of North.

From the World's Journals

THE January issue of our sister journal, *The Wireless Engineer,* includes nearly 300 abstracts from, and references to, articles on wireless and allied subjects recently published in the technical journals of America, Russia, Germany, India, Japan, Canada, Italy and Great Britain. The abstracts and references section is a regular monthly feature of *The Wireless Engineer,* which is published on the first of the month, and is obtainable to order through newsagents or direct from our Publishers at Dorset House, Stamford Street, London, S.E.1, at 2s. 8d. post free.

The application of the locked-in oscillator to automatic tuning and modulation is dealt with in an article in the same issue. Another article deals with the question of interference in relation to amplitude, phase and frequency modulated systems.

An index to the 4,500 abstracts published during 1940 was included in the December issue of *The Wireless Engineer.*

The Future of Amateur Radio

PLANNING FOR THE POST-WAR TRANSMITTING BOOM

By "NAVIGATOR"

NOW that, after a period of more than fifteen hectic years, all British amateurs are silent once again, it would appear to be a suitable time to review the past and to prepare plans for the future. That the "amateur spirit" in this country did not die on the outbreak of war is shown in many different ways, not the least important of which is the interest apparent amongst service operators. It may well be that, if the authorities accede to the demand that will certainly arise at the conclusion of the war, the number of transmitting licences will reach a figure undreamt of in September, 1939. It is with these considerations in mind that the writer, an ex-amateur, will attempt to point out how beneficial modifications could be introduced into the licensing regulations. It must be obvious to all who came into contact with conditions as they existed during the last few years that, unless some alterations are made, amateur radio will probably cease to be of use to anyone, and will certainly lose those features which made it unique amongst hobbies.

The valuable nature of the part which amateurs have played in the development of world-wide short-wave communication is generally recognised. That this work, however, was not confined to the early twenties is sometimes forgotten, and it may not be out of place to recall one or two matters which apply particularly to the last few years. Outstanding has been the use made of 28 Mc/s, the result not of mere chance, but of organised and persistent effort by a small but skilled band of experimenters who were rewarded by seeing the time come when transatlantic amateur signals were being received in this country far louder than those of the high-power broadcasting stations. Again, much of the UHF equipment used by the Services of the belligerent nations is closely related to the portable amateur stations which were in vogue some time before the war. Although many other similar instances could be quoted, the writer will be content to mention only one further point; the extensive "amateur market" has been an important factor in the improvement and cheapening of commercial apparatus.

Despite the work done by amateurs, their status in this country immediately preceding the war was none too high, a fact that may lead to unpleasant consequences later. The chief reason for this was probably the state of the 7-Mc/s band, which was made hideous by a small minority of amateur telephony stations vying with each other in the use of redundant Americanisms and "baby-broadcaster" procedure. Another aspect which must be viewed with alarm by all who hope for an early resumption of activity is the suspicion with which all matters concerning amateur transmitting is viewed by the public, the Press, and possibly the authorities. The closing down of stations in a country at war is understandable, but we have now come to the stage when a country nominally at peace, the United States, has forbidden its amateurs to communicate with foreign countries. The continued operation of certain German "amateurs" must have made many persons wonder whether their peacetime activities were quite so innocuous as they sounded.

Courtesy T & R Bulletin

KEEPING THE AMATEUR SPIRIT ALIVE.—Although there is no non-professional transmission nowadays, amateur radio is very much alive, and its adherents are actively engaged in planning their doings for after the war. Here is a group of amateurs, in and out of the fighting services and including many Canadians, who met at Farnborough to renew old friendships.

Before putting forward any suggestions, it is necessary briefly to review the regulations as they existed prior to September, 1939, and to consider the questions that arise from them. To facilitate this, the main problems have been classified under five main heads. They are: (1) Licences and Examinations, (2) Frequencies, (3) Power, (4) Telephony, and (5) Traffic Handling.

Two types of licences were issued:

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(*a*) The non-radiating artificial aerial licence, and (*b*) the full radiating licence. The AA licence, known only in this country, was, in effect, practically issued upon application, since, apart from references and a birth certificate, it was only necessary to state that some scientific object was in mind. This last point was often overcome by enlisting the aid of another amateur! Despite this, most amateurs will agree that the scheme was excellent in many ways. Its detractors made much of an occasional case of "pirating" by AA holders; but the writer is of the opinion that the AA licence did much to lessen this curse, because many who, if they had had no licence at all, would have been tempted to transmit, were restrained from so doing by the fear that they would lose what privileges they had, and they would render impossible the achievement of their ambition, a "full ticket." The obtaining of this was circumscribed by the morse test of 12 wpm; it is interesting to note that the corresponding speeds in U.S.A. and Canada were 13 wpm and 10 wpm respectively.

Deterring the Dabblers

Thus the number of amateurs was limited, since, while anyone sufficiently interested could soon reach this speed, the faint-hearted often fell by the way. The position, however, at the end of the war will be very different, as there will be hundreds of thousands of men more or less expert at morse. While many of these will, given the chance, no doubt become first-class amateurs, it will be necessary, in order to prevent overcrowding of the bands, either to raise the speed or to introduce a theoretical radio test. This second method could easily be adopted, and, in fact, has for a long time been in force in many countries. In the U.S.A., for example, an examination set by the F.C.C. must be taken. This includes transmitter theory, amateur regulations, and elementary operating procedure.

The second point that will need considerable attention before licences are reissued is the thorny problem of frequencies. No one could dispute the statement that before the war the most crowded portions of the ether were the 7-Mc/s and 14-Mc/s bands, which, although used regularly by at least 25,000 amateur stations, together covered a frequency range of only 700 k/cs. Of these 700 kc/s, 100 kc/s (7,200/7,300 k/cs) were rapidly being rendered unusable by the 7-Mc/s broadcasting stations, whose numbers have greatly increased since the outbreak of war. Knowing how in the past the broadcasting stations, once they have established a "bridgehead," soon infiltrate over a wide area, the outlook as regards this band is none too bright. As regards the other bands, the position was much better; 1.7 Mc/s, although shared with other services, was, on the whole, a very useful frequency, and the surprising lack of interest shown in it was no fault of the G.P.O., which was always ready to allow its use; 3.5 Mc/s was also shared, and in this case use of it was reserved to a selected few. This was a great pity, as it led to the overcrowding of 7 Mc/s for semi-local contacts more suited to the 3.5-Mc/s band. If, as is the case in the States, telephony was generally allowed on 3.5 and not 7 Mc/s, one of the abuses that might be at least checked is that of the "baby broadcasters," who relied on the large number of all-wave sets which seldom cover 3.5 Mc/s.

OTHERWISE ENGAGED—Many hundreds of British amateurs are doing wireless work in the services, and particularly in the R.A.F. They are getting experience of apparatus of a vastly different type from that to which they have been accustomed; here, for example, is the relatively high-powered installation of a Sunderland flying boat.

A few years ago considerable interest was aroused by the suggestion that transmission on 112 Mc/s and above should be thrown open to all bona-fide experimenters without all the "red-tape" connected with the ordinary licence. While this is in many ways an excellent plan which might do much to develop UHF communication, the following difficulties appear to be almost insurmountable. First, it is doubtful whether any remarkable results could be achieved by experimenters who had little experience of low-frequency transmitters, especially in view of the trend towards crystal control on the UHF. Secondly, it is extremely doubtful whether the G.P.O. would ever consider allowing anyone to possess transmitting equipment without the formalities connected with the ordinary licences when it is remembered that the G.P.O. would be unable to monitor these transmissions effectively.

More Power?

Another question which is always of importance to amateurs is that of licence power. Many regarded the regulations in this country, limiting the beginner's power to ten watts, as unreasonably severe when compared with other countries. It should be pointed out, however, that there are many dangers in the immediate granting of permits for, say, 100 watts, and it is felt that, in principle at least, the G.P.O. was wise in keeping power strictly in check.

The writer hesitates before plung-

The Future of Amateur Radio—
ing into the bitter controversy as to the merits of telephony versus telegraphy which arouses more bad feeling than any other subject. The fact remains that, while both systems are equally indispensable in their own spheres, a telephony station in the hands of a poor operator is of far more danger to the status of the amateurs than a badly operated CW station.

"Traffic Handling" is another question which, while arousing interest, is never likely to be translated into fact in this country where all third party communication is a monopoly of the G.P.O. The main advantage of allowing traffic handling is that it raises the standard of telegraph operating as can be seen in the difference between the standard in this country compared to that existing in the United States. As opposed to this the danger of attracting persons not interested in the radio side of their hobby must be considered; another factor is that in a small country such as Great Britain its use would be very limited.

Post-war Plan

The writer having reviewed the regulations as they were, now ventures to give a skeleton outline of those alterations which will be necessary to meet the changed situation which will exist after the war.

(1) There should be three types of licence: (a) Artificial Aerial, (b) Intermediate, and (c) Full. The issue of AA licences to be much the same as in pre-war days. A simple theoretical and procedure examination and morse test of 12 wpm to be held before the issue of the Intermediate licence. A test of 15 wpm, more advanced procedure examination and at least six months holding of the Intermediate licence to be required for obtaining a Full licence.

(2) The Intermediate licence to be for telegraphy only and with a power not exceeding 15 watts on the 1.7-, 3.5-, 7-, 14- and 56-Mc/s bands.

(3) The Full licence to include 28 Mc/s and 112 Mc/s, a power of 50 watts with higher power only in special cases and the use of telephony on 1.7, and 3.5 Mc/s and 14,100-14,250 kc/s and on all bands above this.

(4) The system of Post Office inspectors to be regularised so that at a minimum there should be one visit a year.

In conclusion, it is suggested that, as soon as possible after the cessation of hostilities, a committee, including some pre-war active amateurs, should be set up and should be given full powers to advise the G.P.O. Such a committee might come to occupy a permanent place in the amateur sphere and could do much to prevent those abuses already mentioned. This would be in accordance with the British idea of a New Order; we all know only too well what Hitler would like to do to us and we have not forgotten the disappearance of first the Austrian and then Czechoslovakian amateur transmitters

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Correspondence

High-quality German Recordings—and an Opportunity

AS I had the pleasure of originating the correspondence on high-quality commercial recordings (*The Wireless World*, February 17th, 1938) may I offer a few comments on the present revival of interest in the topic?

At the risk of being suspected as a fifth columnist I suggest that the criterion for high-quality recording is the German Telefunken series, formerly available in this country. For consistently smooth recording with apparent auditory perspective, especially in orchestral recordings (*e.g.*, Telefunken E.2686, an Overture by Auber, Berlin Philharmonic Orchestra), I have found none superior. The use of adequate reverberation contributes largely to the natural "atmosphere" of these recordings. I am glad to be able to say that a number of English records (*e.g.*, Columbia LX.880, Rhapsody "Espana," by Chabrier, London Philharmonic Orchestra) equals the best Telefunken, but they have to be carefully selected. In my opinion, the order in technical quality for the major record-producing countries of the world is (1) German, (2) English and (3) American.

At one time the Germans were leading the world in such fields as the manufacture of glass for lenses, certain branches of chemical science, and in night photography, but now British technology has supplanted them. Can't we do likewise with gramophone recording?

In this connection it is pertinent to quote a few lines from a recently published statement of Mr. W. S. Purser, Technical Recording Manager, E.M.I., who said, ". . . the technical side of recording is not standing still; on the contrary, the research, development and trial of new ideas and improvements are continually going on, and have never been relaxed even to-day. The improvements which are wanted in recording are well known and appreciated by the technical staff, while the commercial and other limitations to their achievement, although known also, are no deterrent to our research. One of the limitations, of course, is the price at which a reproducing instrument can be sold." Mr. Purser also mentioned that "no reproducing machine has yet been made which gives all there is on the record."

Lastly, I add my quota of records of outstanding quality:

"Horn Concerto" (Mozart); B.B.C. Symphony Orchestra. H.M.V. DB3973-4.

"Capriccio Italien" (Tchaikovsky); B.B.C. Symphony Orchestra. H.M.V. DB3956-7.

"Swan of Tuonela" (Sibelius); Stokowski and Philadelphia Orchestra. H.M.V. D1997.

"Largo al Factotum" (Rossini); Lawrence Tibbett (baritone). H.M.V. DB1478.

"Lost Chord" (Sullivan); Webster Booth (tenor). Organ accompaniment. H.M.V. C3130.

Guitar Solos by Vincente Gomez. Brunswick 02820.

"Zigeunerweisen" (Sarasate); Ida Haendel (Violin). Decca K940.

Tango tunes. Mantovani's Orchestra. Decca F7571.

DONALD W. ALDOUS.
Torquay, Devon.

The Wireless Industry

STANDARD TELEPHONES AND CABLES, LTD., announce the temporary withdrawal of the Brimar 25Z6G rectifier valve. To facilitate replacements in AC/DC receivers using this valve a new type 25Z4G has been introduced. The latter is a single diode rectifier, and to ensure that it will function satisfactorily in receivers with parallel anode resistors, pins 3 and 5 in the octal base have been connected internally.

A revised price list has just been issued by Taylor Electrical Instruments, Ltd., 419/422, Montrose Avenue, Slough, Bucks. The increases take effect from January 1st, 1941.

W. Edwards and Co., Southwell Road, Loughborough Junction, London, S.E.5, have just introduced a modified McLeod vacuum gauge to take the place of inexpensive imported types. The new gauge, which will be known as the "Vacustat," covers the range from 10 to 0.01 mm/Hg.

Baird Colour Television

DEVELOPMENT PROCEEDS IN SPITE OF WAR

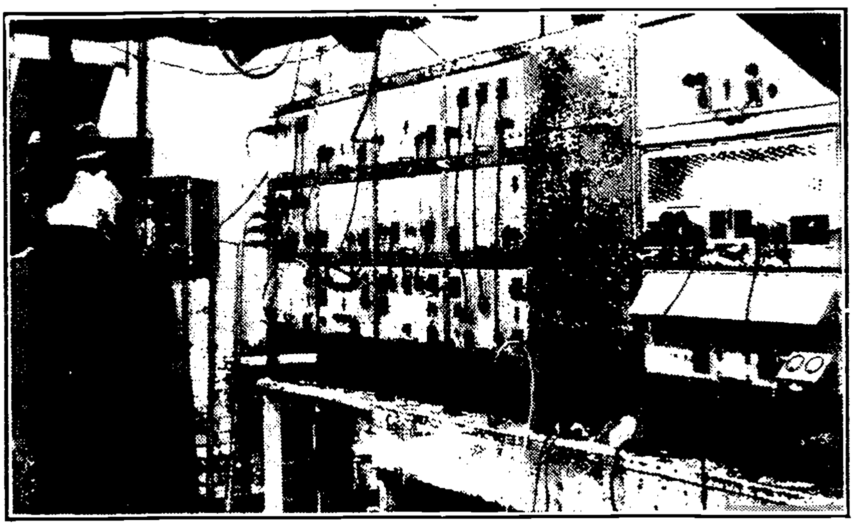
AT his laboratories in Sydenham, Mr. Baird demonstrated on December 20th, 1940, his latest contribution to the television art. He used a large-screen receiver of a type suitable for the home, capable of providing a super high-definition picture in full natural colours as well as reproducing the pre-war standard television transmission as radiated by the B.B.C. In addition to these features, the outfit also functions as an all-wave radio receiver and an automatic record-changing radiogram, all the apparatus being housed in one cabinet. Each portion of the four-in-one receiver is switched into operation by means of a push-button control.

Explaining to a *Wireless World* representative his reasons for continuing development work, Mr. Baird expressed the view that the television industry ought to be in a position to absorb thousands of workers at the end of the war. This would do much to tide us over the critical period that would coincide with the cessation of hostilities. A practical television service was first achieved in Britain, and, continued Mr. Baird, it is in the national interest that this leadership should be maintained. We must not come back to television only to find, like Rip van Winkle, a world that has advanced beyond our ken.

Mr. Baird's first demonstration of television in colour was in 1928 before the British Association. This was followed, after ten years of successes and setbacks, by an 8-foot by 12-foot colour television picture being shown at the Dominion Theatre, London, to an audience of 3,000 people. The transmission was by means of wireless over a distance of eight miles, from the Crystal Palace studio. Both of the above-mentioned results were achieved with the use of all-mechanical methods of scanning at both the transmitting and receiving ends of the links employed. In 1939 a demonstration was given of a 120-line colour picture, using the same type of scanner at the transmitter as that employed at the Dominion Theatre, but making use, at the receiving end, of a cathode-ray tube in conjunction with a rotating colour filter disc. This was the forerunner of the present receiver.

View of the cathode-ray flying spot scanner, with a lay figure in position for scanning.

Before describing the transmitter and receiver which were used in the demonstration, a short account will be given, for the benefit of readers not familiar with the three-colour process, of the principle governing the reproduction of natural colour prints. All colours are produced by mixing the three primary colours, red, green and blue, in the correct proportions. Blue and red mixed results in purple, red plus green gives us yellow, and so forth throughout the whole range of colours. In colour printing this principle is used in the following manner: three pictures are made of the coloured subject, one showing the red component of the subject, one the green component and the other the blue. Upon these three prints being superimposed, a print is obtained which has in its composi-



The transmitter control and power rack. At the centre can be seen the screen of the monitor receiver, upon which the engineer may observe a full colour picture.

Baird Colour Television—

tion the complete colour range of the subject, so providing a reproduction in natural colours.

Mr. Baird makes use of this principle by providing colour filters to his transmitter and receiver scanners, but uses only two colours, red and blue-green, since he has discovered that this combination gives,

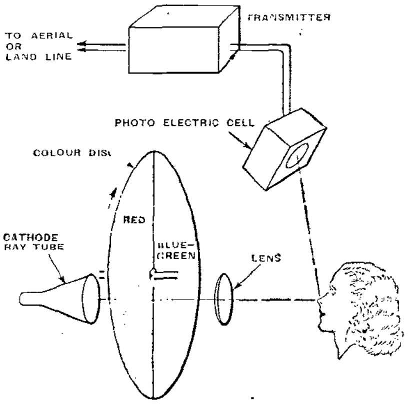


Fig. 1.—Simplified diagram showing the layout of the transmitting scanning system.

with the type of photo-electric cell used, the same results as would be obtained with the three separate filters. This results in a considerable simplification of the scanning mechanism.

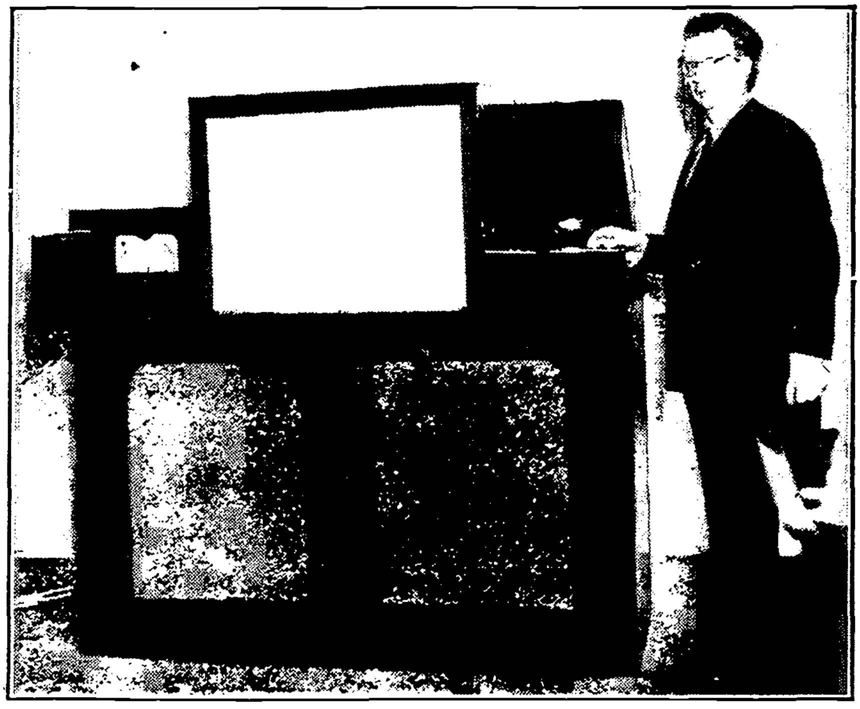
Mr. Baird's original system of flying-spot scanning is employed.* That is to say, the subject is scanned by a moving spot of light which, in the case of colour television, is projected through a disc fitted with the blue-green and red colour filters so that the scene or person being televised is scanned by blue-green and red spots in rapid succession. The standard of scanning with this system is 600 lines per picture, which it should be noted is 50 per cent. greater than the B.B.C. standard.

In the flying spot system of scanning, the moving light spot is not obtained by mechanical means such as scanning discs or mirror drums as in the past, but from the exceedingly bright spot that may be obtained on the screen of a projection cathode-ray tube. The tube used is of the "teapot" type, so named by reason of its shape, operating at a voltage in the region of thirty thousand. The spot is moved in the required scanning motion over the screen by magnetic deflector coils operated from circuits normally associated with such high-voltage tubes. Mounted in front of the tube and driven by a motor is the disc upon which are mounted the colour filters mentioned before. In front of the disc is a lens system which serves to transmit the scanning spot, after it has passed through the filter, to the subject or scene being televised, which is therefore scanned first by a blue-green and then by a red spot, the filter disc being run at the correct speed to allow full coverage for each filter colour. The light from the coloured spots covering the scene is reflected on to three large colour sensitive photoelectric cells, the current from these being amplified and passed to radio or line circuits for transmission to the receiver. In the photograph can be seen the scanning lens in the centre and one of the photoelectric cells. Fig. 1 shows in simplified diagrammatic form the layout of the scanning elements of the transmitter. Another photograph gives a view of the transmitter control and power racks, with a small monitor receiver at the centre, upon which a full colour picture is obtained. This is of use to the engineer for control purposes, and also as a guide to a person being televised, for by a glance at the monitor, he is able to maintain his correct position.

It should be pointed out that the apparatus, although it is, through restrictions of space, at the present moment set up for televising only one or two people at a time, may be readily adapted for large scenes.

All external features of the receiver may be observed in the third photograph. The screen, the largest yet produced in a home receiver, is 2ft. 6in. by 2ft.

The method of reproducing the picture in colour follows the principles of colour printing already explained. The transmitted pictures corresponding to the colours described are superimposed to form the complete television picture in natural colours. The manner in



A view of the receiver, with Mr. Baird standing at the side. To the left of the screen will be seen the all-wave radio receiver, while to the right is the automatic record-changing radiogram. The four control knobs of the television receiver are to the left and right of the central upright upon which are mounted the four push buttons which switch on the radio receiver, the radiogram, the B.B.C. standard television reception circuit, or the Baird natural colour 600-line circuit.

* See *The Wireless World*, August 17th, 1939.

Baird Colour Television—

which this is carried out is the converse of the scanning system at the transmitter, the picture being first produced in black and white on the screen of the cathode-ray tube, in front of which is rotated a filter disc identical with that at the transmitter. By means of impulses transmitted with the picture signal, the disc is kept absolutely in step with its counterpart at the transmitter.

The black and white pictures passing through the filters are coloured blue-green and red and then

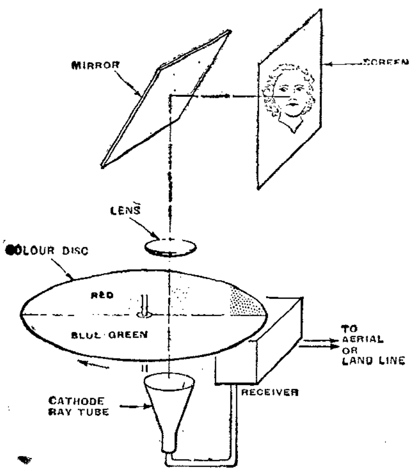


Fig. 2.—A simplified diagrammatic explanation of how the black-and-white picture on the cathode ray tube is converted into a coloured reproduction on the screen.

projected on the screen by means of an efficient optical system, at such speed that the eye sees them there together. The result of this is the same as that achieved in colour printing, namely, they blend to form a picture in natural colours. The projection cathode-ray tube in the receiver is situated at the bottom, throwing the picture upwards on to a mirror and thence to the ground glass screen. The only controls consist of the four knobs under the screen, not counting the push-button switches. For producing a black and white picture the filter disc is simply not used. This, together with the change in scanning circuit necessary to receive the different standard of transmission, is controlled by the one push-button.

The demonstration can only be described as a very considerable success. The colour picture was of more than adequate brilliance, being also both pleasing and restful to watch. The various tone values were produced with a degree of truth comparable with the "Technicolour" films which we are now used to seeing at the cinema. A notable point in connection with viewing the colour picture is an apparent stereoscopic effect which makes the picture stand out to a remarkable degree. This effect was quite apparent when still pictures were used as the subject, but became even more so when their place was taken by a girl with red hair, the tones and sheen of which were reproduced perfectly.

Mr. Baird is now working on a receiver of small cost, which will give a picture in full colours on a normal home-receiver tube, and be within the reach of the average pocket.

Motor Car Ignition Interference

RESULTS OF FIELD STRENGTH MEASUREMENTS AT HIGH FREQUENCIES

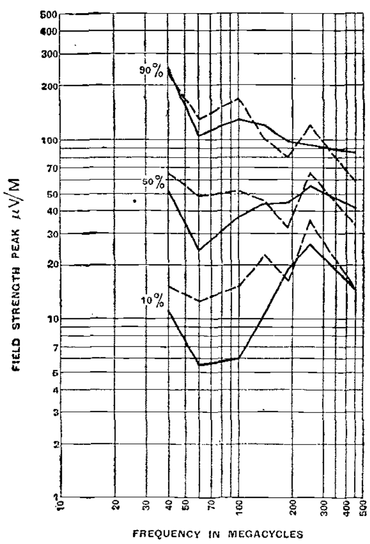
THE development of the ultra-short wavelengths for television and other services has given prominence to the interference produced by motor car ignition systems. One of the first essentials for a successful attack on this problem at the receiving end is a knowledge of the nature and magnitude of the energy radiated.

To this end observations have been made in America[1] to determine the average field strength, polarisation and frequency of the interference from traffic on a standard two-lane highway near Riverhead, Long Island.

The dipole receiving aerial was erected 100ft. from the road at a height of 35ft., and was connected to a double superheterodyne with IF amplifiers operating at 40 and 4.1 Mc/s. The latter was equipped with a relatively strong beat frequency oscillator, and the audio output was passed through a 5 kc/s low pass filter in order to limit the band width (10 kc/s) associated with the peak measurements. The peak indicator circuits consisted of a resistance-capacity time circuit in which the charging time was 15 micro-seconds to over 90 per cent. of the peak voltage of the impulse, and the decay time was 1 second, sufficient to take a reading on a damped meter.

The results of observations of general traffic on 40, 60, 100, 140, 180, 240 and 450 Mc/s are shown in the accompanying curves. There is no very great difference between the horizontal and vertical polarisation, and there is little doubt that the polarisation can be of all kinds.

The radiation from the ignition system is modified by the body of the car, and may vary between cars of identical design. The strength of the radiation at 450 Mc/s is understandable when it is realised that the ignition leads and parts of the car which act as radiators are more comparable with the short wavelengths, and their efficiency compensates for any falling off in the power generated at the higher frequencies. Also, the propagation conditions are improved,



Peak field strength of motor car ignition radiation, with an aerial 35 ft. high and 100 ft. from the road. The dotted curves are for vertical and the full-line for horizontal polarisation. Ninety, fifty and ten per cent. of all cars and lorries produced less than the field strength indicated by the curves.

except at short distances, due to the increased phase difference between the direct and ground-reflected waves at a given point.

[1] "Field Strength of Motor Car Ignition Between 40 and 450 Mc/s," by R. W. George, *Proc. I.R.E.*, September, 1940.

Current Topics

RECENT EVENTS IN THE WORLD OF WIRELESS

BROADCASTING STATIONS OF THE WORLD

Some Interesting Facts

DETAILS have recently been published by the Union Internationale de Radiodiffusion of the number of long-, medium-, and short-wave stations of the world, and the total power output of each country and continent at the end of 1939.

The total number of stations for the world is 2,509, which have an aggregate power of 19,623 kW. The average power is therefore 7.8 kW.

We tabulate below the total number of stations operating in each continent, and the aggregate power. The average power per station is also given.

	Stations	Power (kW) Aggregate	Power (kW) Average
Africa	63	249	2.95
Central America...	195	243	1.24
North	1,058	4,732	4.44
South	396	1,382	3.50
Asia (excluding U.S.S.R.) ...	170	861	5.05
Europe (including U.S.S.R.) ...	463	11,751	25.40
Oceania	164	406	2.48

In 1926, when the Geneva Plan was brought into operation, there were 123 stations in Europe with an aggregate power of 116 kW, which corresponds roughly to an average of 1 kW per station. In the fourteen years which have elapsed, the number of transmitters has increased to 463, which is barely four-fold, whereas the aggregate power, which is now 11,751 kW, is a hundred-fold increase. The average power is now approximately 25 kW as compared with 1 kW.

The number of transmitters in the United States is 839, which is approximately the same as in 1926. The number had, however, exceeded 1,100 a year or two before. The average power in 1926 was very low, for the total power of America's 800-odd stations was roughly the same as that of Europe's 123 stations. The average power of the United States transmitters is now 4.45 kW, compared with Europe's 25.4 kW.

A tremendous increase in the aggregate power of the world's transmitters is noticeable in the past 14 years. In the United States it is in the ratio of 37 to 1, and in Europe, where approximately 60 per cent. of the world's total power output is concentrated, it is 100 to 1.

It is very noticeable from the figures given by the U.I.R. that in countries where broadcasting is State-controlled, and where a system of receiving licences is in force, the number of transmitters is relatively small, but their individual power is very high.

NEW YEAR HONOURS

Scientific Services Rewarded

THE New Year Honours list contained a number of names well known in the world of wireless.

Dr. E. V. Appleton, LL.D., F.R.S., who is Secretary to the Committee of the Privy Council for Scientific and Industrial Research, and was recently appointed to the Government's Scientific Advisory Committee, has been created a Knight Commander of the Order of the Bath (K.C.B.).

Mr R. A. Watson Watt, who was until 1936 Superintendent of the Radio Department of the National Physical Laboratory and is at present Scientific Adviser on Telecommunications at the Ministry of Aircraft Production, is made a Companion of the Order of the Bath (C.B.).

The India Office list includes the name of Mr. Lionel Fielden, who was the first Controller of Broadcasting, Government of India. He has been made a Companion of the Order of the Indian Empire (C.I.E.). In 1940 he relinquished his post in India, and has since taken charge of the B.B.C.'s programmes destined for Indian listeners.

R.S.G.B. RECORD YEAR

IN spite of prevailing conditions, the report of the Honorary Treasurer of the Radio Society of Great Britain shows that the year's income exceeded expenditure by £345—a record in the Society's history. This very satisfactory state of affairs is attributed, first, to the effectiveness of the economies introduced at the outbreak of war, and, secondly, to the splendid support given by members to the appeal to carry on the work of the Society.

The report was presented at the annual general meeting, following which Mr. A. D. Gay delivered his presidential address.

R.A.F. OPPORTUNITIES

Need for Signals Officers

VACANCIES still exist in the Royal Air Force for technical officers for signals duties. Commissions in the R.A.F.V.R. will be granted for the duration of hostilities to suitable applicants between the ages of 21 and 50 years.

Applications are invited from holders of electrical engineering or science degrees with experience of wireless, and from holders of technical college or approved institution diplomas with two years' experience in telecommunications engineering (preferably on the radio side).

A number of posts is also available for candidates possessing a sound theoretical knowledge of elementary electricity and magnetism, of the principles of wireless telegraphy and telephony, and of transmitting and receiving circuits and HF measuring apparatus. Some practical experience is also desirable.

Candidates should apply at once in writing to the Air Ministry S.7 (e) 1, Adastral House, Kingsway, W.C.2, giving full particulars of their qualifications, training and experience. Those who are engaged on important National Work should not submit applications without first consulting their employers as to the possibility of their being spared for R.A.F. duty.

Candidates who have previously applied are requested not to renew their applications.

BROADCASTING HOUSE

IN last month's Editorial, tribute was paid to the B.B.C., which had maintained its service, sometimes under "front-line" conditions, throughout the year. The recent announcement officially making known that Broadcasting House has twice been hit during air raids and seriously damaged shows that the commendation was more than justified. On both occasions the attacks were made during peak hours, but the transmissions in the Home, Forces, European and Overseas services were continued without interruption.

It was learned with regret that a number of the B.B.C. staff were killed and others wounded, most of the casualties being among members of the monitoring staff.

SHORT WAVES

THE Rangoon firm of Misquith, Ltd., writing on the subject of broadcast receivers for the Burmese market, suggests that the most suitable set would cover, in addition to the normal short wavebands, wavelengths of 60-62 and 86 metres, on which the local Rangoon station and the Indian stations are operating. Long and medium waves are not required.

AC is available in the larger towns of Burma, but there is scope for AC/DC models, also for battery-operated receivers up-country and in the jungle.

B.B.C. SHORT-WAVE NEWS

ALTHOUGH there are few changes in the schedule of news bulletins broadcast in the B.B.C.'s short-wave European service, we give below the details for the convenience of readers.

The call signs and frequencies to be used during this month are:—

GSA, 6.050 Mc/s (49.59 m); GSB, 9.510 Mc/s (31.55 m); GRX, 9.690 Mc/s (30.96 m); GSN, 11.820 Mc/s (25.38 m); GSE, 11.860 Mc/s (25.29 m); and GSO, 15.180 Mc/s (19.76 m).

The times (B.S.T.) of the transmission of news and the calls used are:—

0030 GSA
0900 GSA
1245 GSA, GSN, GSE
1415 GSA, GSN, GSE, GSO
1700 GSA, GSN, GSE
2345 GSA, GSB, GRX

CANADIAN NEWS

THE Canadian Broadcasting Corporation's new 7.5-kW short-wave station, recently completed at Vercheres, Quebec, at a cost of approximately £15,000, is intended to serve the French-speaking communities in remote areas of the Quebec Province which are outside the service area of the existing network of medium-wave stations. This station is not intended, as had previously been stated, as an international station.

Licence fees provided $2,906,605 of the C.B.C.'s total income of $3,752,061 for 1939-40. Commercial broadcasting accounted for $700,867.

FROM ALL QUARTERS

Fault Finders' Reserved Age

SINCE January 8th the reservation age from service in their trade capacity for fault finders and testers in wireless engineering has been raised from 30 to 35.

Subtle Propaganda

THE ends to which Nazi agents have gone to sway American public opinion is revealed by the publication of the Report by the Dies Committee. It discloses that desperate efforts were made to enlist the services of commentators on the networks and that steps were taken to colour and control broadcast news through the German-owned Transocean news service.

O.B.E. for W/O

IN recognition of his devotion to duty when his ship was attacked by an armed raider, Mr. George W. Hackston, wireless operator of s.s. *Haxby*, has been appointed an Officer of the Order of the British Empire (O.B.E.). He sent out the position of the vessel and remained at his post in the wireless room throughout the attack until it was set on fire.

Standard Frequency Station Burned

A TEMPORARY 1-kW transmitter is being used by the National Bureau of Standards following the destruction of its standard frequency station WWV at Washington in November. The station transmits a frequency of 5,000 kc/s from 10.0 a.m. to midnight daily except Sunday. The temporary service is CW with announcements in morse.

N.B.C.'s European Manager

MR. FRED BATE, the European manager of the National Broadcasting Company of America, was recently injured when the N.B.C.'s temporary offices close to Broadcasting House, London, were damaged. He had sufficiently recovered from his injuries to sail for the States on January 8th on leave.

French Stations

IT is learned from the U.I.R. that consequent upon the reorganisation of the French broadcasting system the names of the stations have been altered. The name of the town will in future be suffixed by "National" instead of "P.T.T.", etc.—i.e., Lyon-National, Toulouse-National, etc., instead of Lyon P.T.T. and Toulouse-Pyrénées.

Brit. I.R.E. North Western Section

IN accordance with a resolution of the Council of the British Institution of Radio Engineers, a meeting was recently arranged in Manchester for the purpose of forming a North Western Section of the Institution. At this meeting it was proposed to call an inaugural meeting in March.

American Amateurs

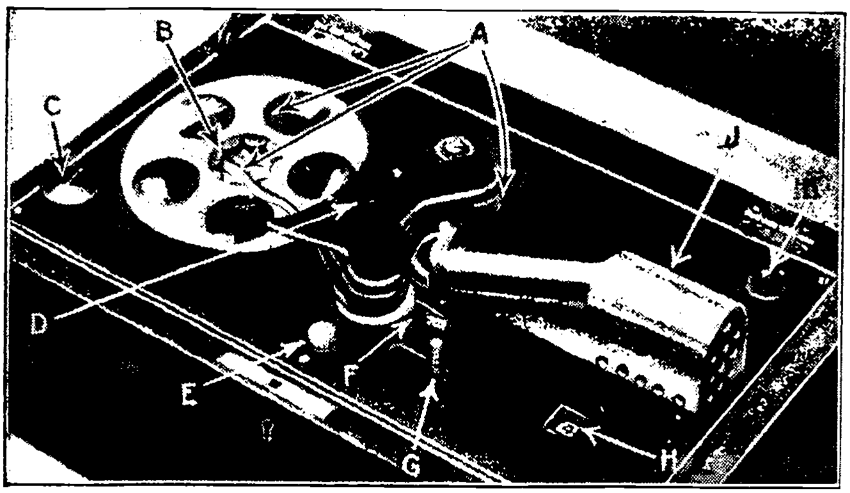
SEVEN members of the American Radio Relay League have been appointed to the Amateur Radio Committee of the U.S. Defence Communications Board. The committee is to consider all questions relating to amateur radio and its place in the national defence programme.

British Insulated Cables

COLONEL J. TENNANT, D.S.O., D.L., M.I.Mech.E., retired from his position of works manager of the Prescot works of British Insulated Cables, Ltd., on December 31st. Mr. D. W. Aldridge has been appointed in his place.

Scott Receivers

AT the annual general meeting of E. H. Scott Radio Laboratories it was stated that, through restrictions in the supply of materials, present and future production of receivers must be greatly curtailed. A large percentage of the existing stock of component parts must



A NEW FILM-GRAMOPHONE, designed by Mr. E. J. Wender, of the Electro-Physical Laboratories, London. Ninety minutes' playing from four sound-tracks on one film is possible with this instrument, which is contained in a box 14in. by 9in. by 7in. Novel features are the endless strip film, i.e., the film feeds from its centre and rewinds round the periphery of the spool simultaneously, thus obviating rewinding after reproduction; also the use of separate small barrier-layer type photo-cells, made by E.P.L., for each track. The change-over of tracks is therefore entirely electrical and no change in position of either film or cells is necessary. Key: A, film (travels anti-clockwise); B, locating pins; C, light intensity control resistance; D, track aligning screw; E, F, automatic track changer and push-button control; G, lever to open gate for threading film; H, automatic track number indicator; J, lamp housing; K, mains switch.

Current Topics—

be reserved for replacement purposes. If frequency modulation comes after the war, the company will be able to embark at once on the manufacture of suitable receivers and adaptor units.

New M.W.T. Chairman

ADMIRAL H. W. GRANT, who is a director of Cable and Wireless, has been appointed chairman and managing director of Marconi's Wireless Telegraph Company.

Wireless for the Blind

IN response to Mr. Ernest Bevin's Christmas Day broadcast appeal more than £8,320 has been given by some 18,000 donors to the British Wireless for the Blind Fund.

NEWS IN ENGLISH FROM ABROAD

REGULAR SHORT-WAVE TRANSMISSIONS

Country : Station	Mc/s	Metres	Daily Bulletins (B.S.T.)
America			
WNBI (Bound Brook)	17.780	16.87	4.0‡, 6.0.
WCAB (Philadelphia) .	6.060	49.50	12.45 a.m.‡, 1.0 a.m.†.
WCAB	9.590	31.28	
WBOS (Millis).. ..	9.570	31.35	11.45.
WCBX (Wayne) ..	11.830	25.36	8.30†.
WCBX	17.830	16.83	2.0, 3.0†, 4.0†, 4.15§‡, 5.0*†, 7.0.
WGEO (Schenectady) .	9.530	31.48	8.30†, 9.55§‡, 11.25‡.
WGEA (Schenectady) .	15.330	19.57	1.0, 2.0‡, 6.0, 7.45, 9.55§‡.
WPIT (Pittsburgh) ..	15.210	19.72	6.0.
WRUL (Boston) ..	11.790	25.45	8.15§‡, 9.30 †.
WRUL..	15.350	19.55	
Australia			
VLQ (Sydney).. ..	9.615	31.20	8.0 a.m., 8.0.
VLQ5	9.680	30.99	1.30, 4.30, 10.30.
VLQ2	11.870	25.27	6.0.
VLQ7	11.880	25.25	8.0 a.m., 3.0, 8.0, 11.0.
VLQ8	17.800	16.85	7.0 a.m.
China			
XGOY (Chungking) ..	11.900	25.21	11.30 a.m., 12.10, 9.30, 10.30.
Finland			
OFD (Lahti)	6.120	49.02	8.55 a.m., 7.15, 10.15, 11.15.
OFD	9.500	31.58	
OFE	11.780	25.47	
OIE	15.190	19.75	
Greece			
Athens	7.075	42.39	11.0
Hungary			
HAT4 (Budapest) ..	9.125	32.88	1.30 a.m.
India			
VUD2/3 (Delhi) ..	9.590	31.28	9.0 a.m., 1.30, 4.50.
VUD4	11.830	25.36	9.0 a.m., 1.30, 4.50, 6.15.
VUD3	15.290	19.62	9.0 a.m.
Iran			
EQB (Teheran) ..	6.155	48.74	7.30.
Japan			
JZJ (Tokio)	11.800	25.42	9.5.
JZK	15.160	19.79	9.5.

Country : Station	Mc/s	Metres	Daily Bulletins (B.S.T.)
Manchukuo			
MTCY (Hsinking) ..	11.775	25.48	8.0 a.m., 10.5.
Nova Scotia			
CHNX (Halifax) ..	6.130	48.94	10.45.
Newfoundland			
VONG (St. John's) ..	5.970	50.25	11.15.
Rumania			
Bucharest	9.280	32.33	10.40‡.
Spain			
FET1 (Valladolid) ..	7.070	42.43	8.50.
EAJ7 (Madrid) ..	9.860	30.43	12.30 a.m.
Sweden			
SBO (Motala)	6.065	49.46	10.20.
Thailand			
HSP6 (Bangkok) ..	11.715	25.61	2.45.
Turkey			
TAP (Ankara)	9.465	31.70	7.15.
TAQ	15.195	19.74	12.15.
U.S.S.R.			
—— (Moscow) ..	7.545	39.76	10.30, 11.30.
RW96	9.520	31.51	7.30, 9.0, 10.30, 11.30.
RAL	9.600	31.25	1.0 a.m.
——	10.724	29.59	11.30.
——	11.499	26.09	12.0 noon.
——	11.710	25.62	10.30.
——	11.830	25.36	7.33 a.m., 7.30, 11.30.
RNE	12.000	25.00	1.0 a.m., 9.0†, 10.30.
——	14.720	20.38	12.0 noon, 5.0.
RKI	15.040	19.95	1.0 a.m.
RW96	15.180	19.76	1.0 a.m., 7.33 a.m., 9.0, 10.30.
——	15.715	19.09	12.0 noon.
——	18.540	16.18	12.0 noon.
Vatican City			
HVJ	6.190	48.47	8.15.
Yugoslavia			
YUA (Belgrade) ..	6.100	49.18	10.25.

It should be noted that at this time of the year changes of wavelength are frequently made and readers are, therefore, advised to try alternative wavelengths. The times of the transmission of news in English in the B.B.C. Short-wave European Service are given on page 47.

REGULAR LONG- AND MEDIUM-WAVE TRANSMISSIONS

Country : Station	kc/s	Metres	Daily Bulletins (B.S.T.)
Bulgaria			
Sofia	850	352.9	9.55 (Th. and Sat.).
Hungary			
Budapest	546	549.5	11.10.
Ireland			
Radio-Eireann ..	565	531	6.45‡, 10.5†, 10.10‡.
Latvia			
Madona	583	514.6	10.0 (Tu. and Fri.).
Kuldiga	1,104	271.7	10.0 (Tu. and Fri.).

Country : Station	kc/s	Metres	Daily Bulletins (B.S.T.)
Rumania			
Radio-Romania ..	160	1,875	10.40‡.
Bucharest	823	364.5	10.40‡.
Spain			
Radio-Coruna	968	309.9	1.10 a.m.
Sweden			
Motala	216	1,389	10.20.
Stockholm	704	426.1	
Goteborg	941	318.8	
Falun	1,086	276.2	
U.S.S.R.			
Moscow I	172	1,744	11.30.

All times are p.m. unless otherwise stated. * Saturdays only. § Saturdays excepted. † Sundays only. ‡ Sundays excepted.

Short-Wave Portable

LIGHTWEIGHT HEADPHONE SET FOR PRESENT CONDITIONS

Most of the lightweight portable sets produced for wartime conditions have been designed to cover the medium broadcast band. Here is a simple set for short waves only. It will operate with a short extemporised aerial.

By W. H. CAZALY

THE receiver to be described can be contained, together with a 45-V HT battery, a 3-V dry cell LT battery, a couple of plug-in coils and a pair of headphones, in a fibre case of the kind used to carry civilian respirators. From 4 to 14 Mc/s (about 21 to 75 metres) can be covered with suitably wound coils. Consumption is at the rate of about 4mA for HT and 0.1A for LT.

Construction is particularly easy, as the components are mounted on a piece of stout tin-plate which fits in the top of the fibre case and is held by angle brackets bolted to the sides. Care should be taken to leave as much clear space as possible round those parts of the circuit (see Fig. 1) drawn in thick lines; for this reason it is not advisable to enclose the whole receiver in a metal container. The filament choke consists of a glass tube 2in. long by ½in. external diameter wound with No. 34 SWG enamelled wire. The 28-ohm resistance in parallel with the 0.05-amp. filament of the triode detector is a tiny home-made job consisting of No. 38 SWG resistance wire (insulated) pile-wound on a ½in. piece of match stick.

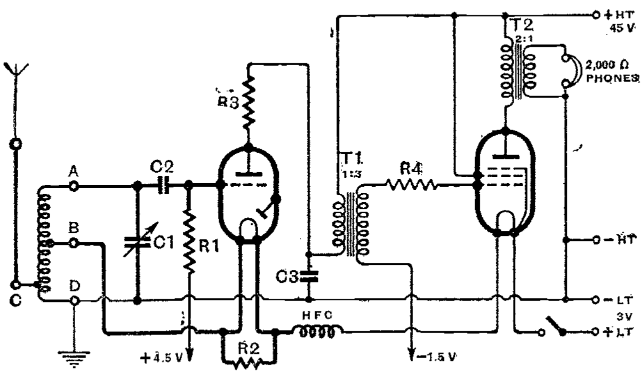
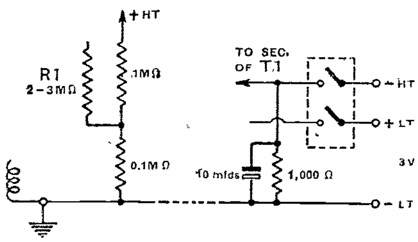


Fig. 1.—Complete circuit diagram; components and wiring shown in heavy lines should be well isolated. Values of components: C1, C2, 0.0001 μF; C3, 0.0005 μF; R1, 2-3 MΩ; R2, 28Ω; R3, 10,000Ω; R4, 0.25 MΩ.

The circuit is obviously a modification of the familiar Hartley reacting detector, followed by a transformer coupled pentode output stage. One unusual feature is the use of quite a large positive bias on the triode grid. This serves to decrease the AC resistance of the valve sufficiently for it to develop enough power in the reaction circuit to bring about oscillation at the high-frequency end of the band covered. Rectification appears to take place fairly efficiently, though distortion is inevitably present; the only noticeable departure from normality is the increase of the anode current from less than 0.1mA to nearly 1mA. In the circuit diagram of Fig. 1 the bias of both detector and output stages is shown as being obtained from batteries, which need be only very small ones: but it may be obtained in each case by resistance networks, as shown in Fig. 2. Reaction is controlled by the 10,000-ohm variable resistance R3, and this component *must* have low self-capacity.

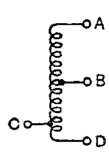
Fig. 2.—To avoid the use of batteries for grid bias, the additional circuits above can be used. If positive bias for the detector is thus obtained, a double-pole on-off switch must be added as shown inside the dotted lines.



The circuit as given has been found to operate satisfactorily over the frequency band mentioned with 45V HT.

The frequency of 14 Mc/s is given as the highest handled by this receiver, because above that frequency oscillation is not *readily* obtained. By taking more than ordinary care about layout and the efficiency of the components involved in the RF portions of the circuit, however, useful reception can be obtained in the 15 Mc/s band and even higher. Stray reactances must be kept down to a minimum; the tuning condenser should be a good SW low-loss type; the valve may be "de-capped" (i.e., have the composition base removed and the electrode leads soldered directly in circuit); the grid may stand a little more positive bias; the optimum taps on the coil for filament and aerial may be found by experi-

COIL TURNS, SPACED 14 TURNS PER INCH.
1½in. diameter ribbed former, 4-pin.



Freq. in Mc/s. (approx.)	A-B Turns	B-C Turns	C-D Turns	Wire (SWG)
4—5.5 (55—75m)	11	6	6	24
5.5—9.5 (32—55m)	6	4½	1⅓	24
9.5—14 (21—32m)	4	3	1	20

Fig. 3.—Coil winding data, subject to alteration through such varying factors as stray capacities, component losses, etc. Average stray capacities acting in parallel with C1 will be about 50$\mu\mu$F.

Short-wave Portable—
ment. By close attention to such details, oscillation can be obtained at higher frequencies with a coil having, say, only 7 or 6 turns altogether.

The output transformer *can* be dispensed with. Owing to the serious mis-matching of the output pentode with its high AC resistance to even the best of phones, however, a considerable loss of power must be expected. If used without a transformer, the headphones should be of the high-impedance type; 4,000 ohms is preferable to the more usual and less expensive 2,000-ohm type. An almost ideal arrangement would be a choke-capacity output coupling feeding a pair of piezo-electric earpieces; but these are very expensive and difficult to obtain nowadays. For an output transformer the author made successful use of a small 1 : 6 ratio intervalve AF transformer, connecting it "the wrong way round," i.e., with the secondary in the anode circuit and the primary feeding the phones. Similar types of conveniently small size are listed in the catalogues of such firms as Bulgin and Premier. The "midget" type of transformer is not to be recommended, as the core is usually of high-permeability alloy, and performance is very seriously affected by passing DC through the windings.

Short-wave Receiving Conditions

PROSPECTS FOR FEBRUARY

(COMMUNICATED BY THE ENGINEERING DEPARTMENT OF CABLE AND WIRELESS, LTD.)

THERE were no prolonged periods of "peak" conditions during December, short-wave reception being frequently subnormal, particularly on the 2nd, 20th to 23rd (inclusive) and 28th to 31st (inclusive) when ionosphere storm effects were reported.

The average Disturbance Factor (on a zero = negligible, and 9 = extremely great basis) was for the period 12th to 31st (inclusive) approximately 33 per cent. in excess of that for the first eleven days of the month. In connection with the above in the December issue of this journal, published on November 20th (see page 484) a reference was made to the probability in December of relatively disturbed conditions during the middle and latter part of that month.

There was no definite evidence of any sudden disturbance of the "Dellinger" type during December. Reception was seldom impaired by atmospherics; the general level of which was, how ver, appreciably above normal during the afternoon of the 10th, when thunderstorms were reported in certain parts of the country.

In high northerly latitudes such storms, whilst of much less frequent occurrence in winter than in summer, are not uncommon in North-West Europe.

Particulars of the broadcast bands wh ch, it is considered, should prove most reliable during February under normal conditions of propagation at the times stated for five selected routes are given below; these may serve as a guide when considering the possibilities of reception from places not too remote from those specified.

Attention is drawn t the fact that a number of factors, for example (a) transmitter power, (b) efficiency of aerials at both the transmitting and receiving end, and (c) ionosphere abnormalities, may often result in better reception being obtained on wavebands other than those quoted. (The times given in this report are GMT.)

Montreal: Midt, 31, 41 or 49 m; 0300, 4 or 49 m; 0600, 49 m; 0900, 25 or 31 m; 1100, 19 or 25 m; 1400, 16 or 19 m; 1800, 19 or 25 m; 2100, 25 or 31 m.

Difficulties may be experienced on occasions between 0700 and 1000 and at other times should ionospheric conditions be disturbed. "Echo" signals are not unusual at this season during the period from 1300 to 1600.

Buenos Aires: Midt, 31 or 41 m; 0300, 31, 41 or 49 m; 0600, 41 or 49 m; 0900, 19 or 25 m; 1200, 16 m; 1500, 13 or 16 m; 1800, 16 or 19 m; 2100, 25 or 31 m.

Reception may prove to be difficult for a period of one or two hours centred on 0830 and 1930; with the approach of the Vernal Equinox the duration of the former will tend to increase and that of the latter to decrease.

Nairobi: Midt, 31 or 41 m; 0300, 41 or 49 m; 0700, 25 or 31 m; 0900, 16 or 19 m; 1100, 16 m; 1400, 16 or 19 m; 1800, 19 or 25 m; 2100, 25 or 31 m.

Apart from the period from 0400 to 0700, when fading may be present, reception should be possible throughout the twenty-four hours.

Cairo: Midt, 41 or 49 m; 0300, 49 m; 0600, 25 or 31 m; 0900, 19 or 25 m; 1200, 19 m; 1500, 19 or 25 m; 1800, 25 or 31 m; 2100, 31 or 41 m.

In general, no difficulty should be encountered on this route except possibly between 0330 and 0600.

Tokio: 0700 19 or 25 m; 0900, 16 or 19 m; 1100, 19 or 25 m; 1300, 25 or 31 m; 1800, 31 or 41 m; 2300, 41 or 49 m.

Short wave reception over this route is expected to be extremely unreliable during the period midt.-0600.

At the time of writing this report the trend of conditions suggests that the average disturbance factor for the period February 12th to 23rd (inclusive) may prove to be higher than that for the remaining days of the month.

1940-1941 Amplifier Handbook and Public Address Guide. By Moe Asch. Pp. 80. Radcraft Publications, Inc., 20, Vesey Street, New York City, U.S.A. Price (in U.S.A.) 25 cents.

TO provide practical everyday information for the sound specialist is the object of this publication, states the author in his foreword. For this reason explanation of fundamentals and the theory of circuit applications have been reduced to a minimum and, bearing this in mind, it can be said that this is an interesting and useful book.

The five sections of the book are as follows: (1) Source (all types of microphone and pick-up); (2) Amplifiers (voltage amplification, power stage, power supplies and design considerations); (3) Distribution (loudspeakers, speaker baffles and housings); (4) Co-ordination (input impedance matching, phasing speakers, etc.); and (5) Public Address Data and Information (the A.B.C. of db., VU, Mu, Gm and Sm, and db. data, etc.).

Loudspeaker matching technique is clearly and fully expounded. Inverse feedback and tone compensation are briefly covered and an explanation of the Volume Unit (VU), a new standard of reference level, which is a steady state of 1 milliwatt across a 600-ohm line, recently introduced by the Bell Telephone Laboratories, is included.

D. W. A.

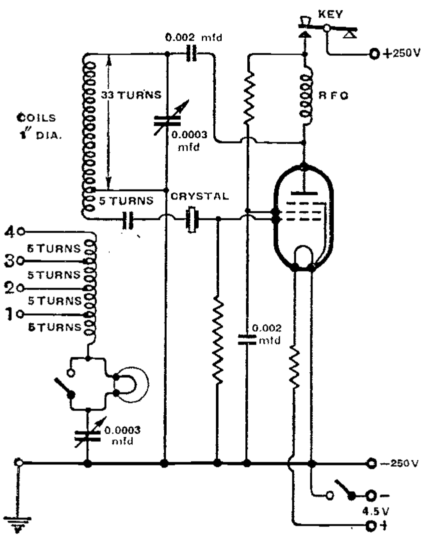
Spy's Transmitter

DETAILS OF THE GEAR USED BY ENEMY AGENTS

IT was recently disclosed that three enemy agents, convicted of spying, had been executed in London. Among other things found in their possession was a complete portable short-wave transmitter, and *The Wireless World* has been given facilities by the authorities to prepare a detailed description of the apparatus.

Some mild disappointment will be felt that the transmitter is not of especial technical interest, either mechanically or with regard to its circuit arrangement. The circuit is, indeed, except for the use of a quartz crystal and a pentode valve, almost exactly the same as that used by a member of the staff of this journal in 1924, when everything to do with the short waves was brand new, and we were all eager to get some first-hand experience of their behaviour. In the matter of mechanical layout the set seems distinctly unhandy, at any rate if, as the fiction writers would have us believe, the enemy agent is always compelled to work his gear under the most difficult of conditions. A rather more finished job might have been expected from the best German technicians, and one is inclined to wonder whether the former owners of the set were, figuratively speaking, free lances, responsible for their own equipment, and merely paid by results.

The transmitter unit, batteries, aerials and accessories are distributed between two leather carrying cases.



Complete circuit diagram of the transmitter with details of the coils. Taps are provided for aerial circuit adjustment, which is carried out with the help of an indicator lamp.

As shown in the accompanying diagram, the circuit is a modified Hartley oscillator, with crystal control at the fundamental frequency of the crystal, which, in the case of the actual transmitter described, is just under 6,000 kc/s (about 50 metres). The oscillator circuit has a useful tuning range of from about 4 to 8.5 Mc/s (about 35 to 75 metres).

The valve is a Telefunken battery pentode, Type KL2, with a directly heated filament consuming 0.27 amp. at 4.25 volts. When operating with the HT batteries provided, which give 210V on load, the anode current is 8mA, rising to 29mA in the non-oscillating condition. Power is thus extremely low, but it is remembered that in 1924 with the transmitter already mentioned (which had a comparable power output and wave-range coverage) ranges of several hundred miles were often worked. It must also be remembered that in those days receivers were much less sensitive.

The complete equipment is contained in two black leather carrying cases with shoulder straps. In the first case, measuring 8½in. by 7¾in. by 4in. and weighing 4lb., are the transmitter unit, a spare valve, morse key and aerial equipment. The second case, which measures 11in. by 6in. by 3¾in. and weighs 7lb., contains three 90-volt (nominal) HT batteries and two 4.5-volt dry-cell LT batteries, with their connecting leads. It should be observed that, before the gear can be put into operation, it must be removed from the carrying cases.

A metal box, measuring 5½in. by 4½in. by 3in., houses the transmitter

Spy's Transmitter—

unit, which weighs about 1 lb. On the top panel are mounted an on-off filament switch, sealed plug-in crystal holder, key sockets, two tuning condenser dials, and aerial taps for adjustment. There is also a small lamp, with short-circuiting switch, to act as an indicator of current in the aerial circuit. Connections for the batteries and aerial and earth complete the external attachments. The key is provided with a 4-foot wandering lead.

Two sets of aerials are provided, and it appears that the usual practice is to use aerial and counterpoise, for which arrangement the circuit is suitable. One aerial measures 11.6 metres and the other 11.45 metres; each has a lead-in connection 1.62 metres long. Over the frequency range covered by the transmitter these aerials would work reasonably efficiently as quarter-wave current-fed radiating systems.

When crystal controlled, the set gives a pure CW note. By removing the crystal and short-circuiting the plug sockets, the transmitter may be operated without frequency control. Under these conditions stability is still of a high order, and the note, as heard on a suitable receiver with BFO, is still pure over the useful part of the tuning range.

Random Radiations

By "DIALLIST"

The Radio Missing Link

FOR a long time I've been pressing for ultra-short-wave radio to supplement one short but very vulnerable part of the communications of my particular bit of the war. I think I'll get it pretty soon now, but there have been many obstacles to break down. One brass-hatted bloke told me that he might do the transmitter, but didn't think he could lay his hands on a suitable receiver. I said that I thought that that left no real difficulties. "What about the receiver? ' sez 'ee; "you can't do without that. What do you suggest?" "Make it," I made bold to reply. *"Make it?* Oh, but you couldn't do that. A most expert job." He was astonished to hear that I'd made and designed scores and scores of receivers of all kinds, and that, given a pound or two to spend on parts, I could guarantee results. Eventually it turned out that receivers were available after all, and that there'd be no need for me to return to my pre-war constructional activities. My missing ultra-short-wave link is promised any day now, and you can imagine how happy I'll be to have it

"Apres la Guerre Fini"

SOLDIER, sailor and airman used to promise themselves all kinds of delightful things in the last war when the desirable, if ungrammatical, state of affairs described in the heading came to pass. And I suppose that all serving wireless men who have seen anything of the radio equipment of the Services have similar beautiful dreams now. What lovely things there will be to buy for a song when we've straightened out the present complications and returned to normal ways of life once more! Some of you will remember how we revelled in Government surplus after the last war. Wavemeters and other measuring instruments, transmitting and receiving sets—or the parts to make them with—come our way at undreamed-of prices. And the effect of amateur experimental work was just marvellous. Your brilliant man is often hampered by lack of cash to buy the expensive gear that he needs to further his work. One of the few good results of a modern war is that its aftermath may place such things within his grasp. And once he has got them he can forge ahead like the proverbial express train. There is sure to be a similar selling-off of surplus apparatus when this war has come to its end, and I can foresee that its effects will be to produce just such another forward march by amateur experimenters and research devotees as happened in the years following 1918.

The Stimulus

It's only natural that something of the kind should take place. Here we are now, called from our labs. and our radio dens to do willingly our jobs in the Navy, the Army, or the Air Force. But aren't we all longing for the day when we can settle down again to the best of all hobbies? Don't we think over ways of improving the results that we obtained in the past and promise ourselves the joys of putting them to the test when the time comes? Aren't we thinking out the experiments that we'll try once we have the opportunity? We are. And when peace returns we'll get down to it with a will. Meantime, all honour to those, debarred from serving by age or other disability, who are keeping the experimenters' flag flying. They're seeing to it that wireless does not stand still. We've been able to read accounts of some of their good work, and so to keep ourselves abreast of the times. But a vast amount of what has been done can't be revealed till the war is over. And those revelations will provide huge new fields for experimental work.

Blast and Loudspeakers

IT was interesting to read in a recent issue of *The Wireless World* that the most common form of damage to wireless receivers subjected to the effects of blast was the destruction of the loud-speaker cone. Did you know that the waveform of a bomb-blast pressure wave was almost exactly like that of one of the most unpleasant kinds of atmospheric in shape. It rises almost vertically to its peak, then falls almost equally steeply until the "zero" line is reached. That is the "positive" or pressure part of it. Then comes the "negative" pull or suck. This takes the form of a long, shallow curve below the zero line. The effect of blast on a building—or a loud-speaker cone—is much the same as that of an atmospheric on an aerial; vibration at the natural frequency is set up. As a rule the final damage to a building is done, not by the violent-looking "positive" half of the blast wave, but by the suck of its "negative" portion. That's why the glass from windows and the bricks from walls fall outwards rather than inwards. I haven't examined any loud-speaker cones that have fallen victims to bomb blast, but I'm open to wager that most of them have been pulled rather than pushed out of shape. Any experiences from readers would be welcome.

Not So Easy

ALWAYS up to date, *The Wireless Trader* produced in its Christmas number one of those "Do You Know?" features that are so popular nowadays. One of the teasers propounded interested me greatly—and

Random Radiations—

made me think a bit. It consisted of reproductions of the symbols used in circuit diagrams of valves and other "vacuum tubes" that aren't really valves. There were 33 of them in all, and you were invited to give each its correct name. Easy enough, you say? So did I, till I tried! I got most of them right after puzzling out the electrode arrangements. But with some of the more complicated ones puzzling out was the operative word. What a difference from the valves of 20 years ago when no symbol contained more than a filament, a single grid and a single plate—not even the grid in the case of the diode! Even when the tetrode and the pentode came along, it was pretty plain sailing. But now that you've got things like the octode and the triode-heptode a little thinking *plus* a counting of grids has to be done ere you feel prepared to give a name to some complicated symbol. Could you draw, right off the reel, the conventional symbol for a triode-heptode? You can? Well, now try drawing, without reference to any book, of course, a diagram of its pins and their connections.

Colour Television

TELEVISION, somehow, seems little more nowadays than one of those pleasant memories of the past. It's just about a year and a half—and what a year and a half!—since I saw images on the screen of a television receiver, and a little less since the Alexandra Palace transmitter closed down "for the duration." Hence it's refreshing to find that, despite the war, development work on television still goes forward. Mr. Baird has produced, I read, some quite noteworthy advances in colour television, and progress in this direction is being made also on the far side of the Atlantic. I've no doubt at all that television in natural colours will come, and a welcome improvement it will be. But what I most want to see, both in the cinema and in television, is stereoscopic projection. That, too, is only a matter of time. Much progress has been made by the movie experts; I believe that stereoscopic films have been projected experimentally with no small success. When we have television and ciné pictures projected both in colour and stereoscopically each of these forms of entertainment will become inestimably more attractive. It will be an even bigger jump forward than that from the silent film to the talkie or that from sound only to sound-cum-vision by wireless. That's my view, anyhow.

Club News

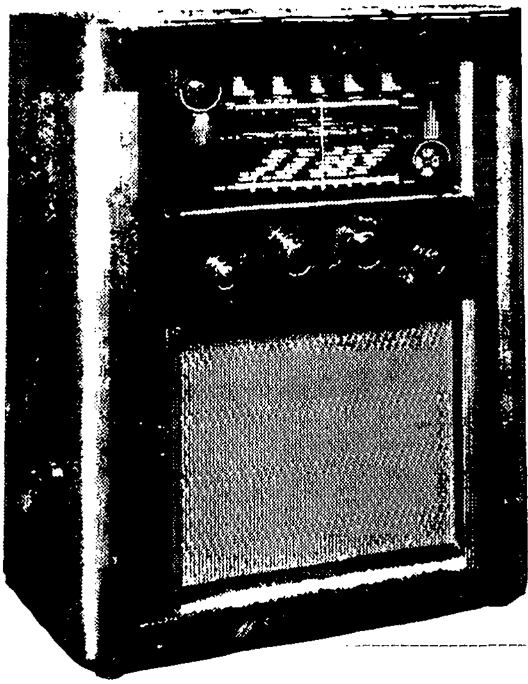
British Short-wave Correspondence Club

Hon. Sec.: Mr. A. Richardson, The Watering, Parham, Woodbridge, Suffolk.

Members are asked to note that the above club has now been divided into zones for reasons of closer control. These zones are as follows, managed by the members named:—

Scottish Zone: T. Jack, "Loanhead," Greengairs, Airdrie, Lanarkshire.
Northern Zone: T. Knight, 37, Hartington Street, Barrow-in-Furness, Lancashire.
Southern Zone: R. Nugent, Field House, Windmill Hill, Nr. Hailsham, Sussex.
Eastern Zone: D. G. Garrard, 135, Hervey Street, Ipswich, Suffolk.
Western Zone: P. Griffiths, 14, Winch Crescent, Haverfordwest, Pembrokeshire.

All overseas members should still address all communications regarding the club to H.Q.



Test Report

Cossor Model 74A

TABLE MODEL SUPERHET FOR AC MAINS (5-VALVE+RECTIFIER AND TUNING INDICATOR)

WAVERANGES

Short ...	*16-*	*52.5 metres*
Medium	*195-*	*560 metres*
Long ...	*810-2,085 metres*	

Price : £14 14s. + **£3 3s. 3d. Purchase Tax.**

FEW firms provide a wider choice of broadcast receivers in the medium- and low-priced categories than A. C. Cossor, Ltd. These are known and appreciated by a large section of the listening public. Not so many people realise that the Cossor range includes a number of receivers of more comprehensive specification for the discriminating listener who is prepared to pay a little more for a performance which will distinguish his set from the average.

The Model 74A is in every way a big set. It is fitted with an RF stage, and has a large triode output valve feeding a 10-inch loud speaker. The cabinet measures $22 \times 17\frac{1}{2} \times 10$ inches, and the performance is in every way commensurate with its appearance.

Circuit.—The aerial is transformer-coupled to the pentode RF amplifier, the long-wave coupling being provided with damping. On gramophone the input grid is earthed.

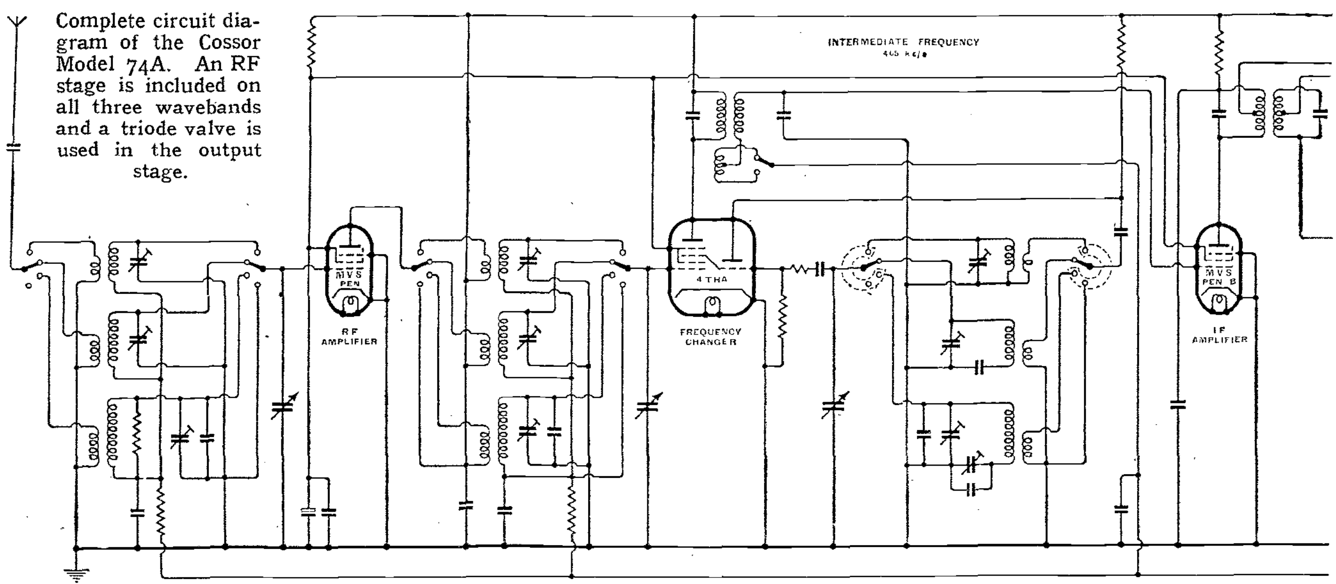
The coupling between the RF stage and the triode-hexode frequency changer is by means of transformers with tuned secondaries. Tuned-grid oscillator coils are used, and the output of the frequency changer is passed to a single variable-mu pentode IF amplifier.

Both IF transformers are permeability tuned, and the input transformer has a third winding which is always in circuit. It is centre-tapped to earth, and the selectivity switch reverses the sense of the coupling, thus changing the inductance of the primary and increasing the band width.

The output IF transformer is tapped down for both signal and AVC diodes. AVC is delayed, and the cathode ray tuning indicator takes its control from the signal rectifier circuits.

Resistance-capacity coupling is used between the triode amplifying portion of the second detector and the output stage.

The output valve is of the directly heated type, and the power rectifier is indirectly heated so that the smoothing condensers are adequately protected. The loud speaker field is



Complete circuit diagram of the Cossor Model 74A. An RF stage is included on all three wavebands and a triode valve is used in the output stage.

Cossor Model 74A—connected in the negative HT lead.

Performance.—On the radio frequency side the performance is everything one would expect from a receiver incorporating an RF stage. Sensitivity and image rejection on short waves are both good.

Selectivity on all three wave ranges is well up to the work in hand, and the extra band-width made available by the switch makes just that little difference between good and exceptionally good quality on the local station.

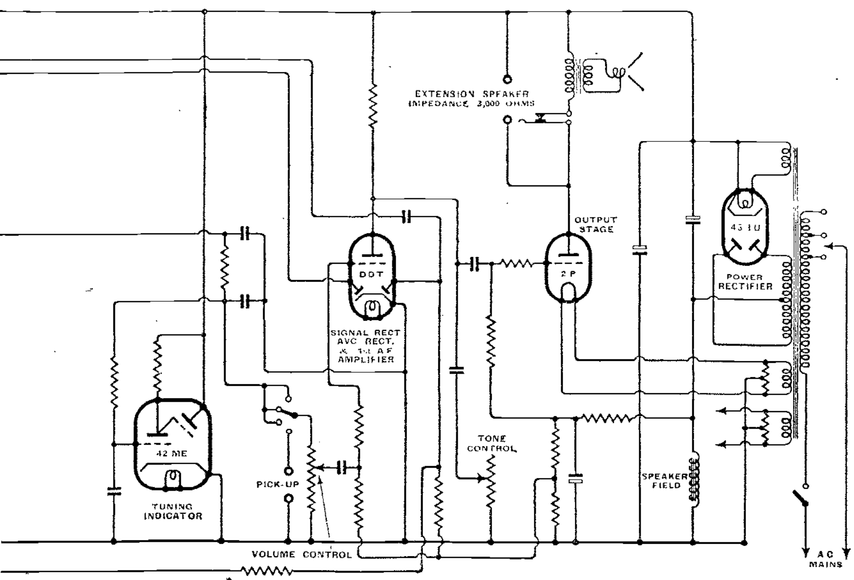
It is the quality of reproduction which is the outstanding feature of this set. The efficient loud speaker, in conjunction with the considerable baffle area provided by the cabinet, combine to give "console" volume in the bass. This is well able to carry the excellent high note response, and as far as frequency range is concerned the Model 74A is well in advance of most commercial receivers. The harmonic distortion is also extremely low, and the volume control can be tuned up to the maximum on any station without any apparent signs of overloading.

Another aspect of the quality which is worthy of note, and which is all too rare these days, is the wide-angle dispersion of the sound from the front of the set. There is less impression of the sound emanating from a "point source," and a greater feeling of expansiveness which greatly enhances the reproduction of orchestral items. With AVC applied in three stages the control is very effective, and the only fault we had to find with the performance as a whole was a slight tendency to pulling in the oscillator near the bottom of the short-wave range, under the influence of wide variations of signal strength.

Constructional Features.—The chassis is divided into two parts, the output stage and power pack being fitted on the floor of the cabinet. The main chassis, which is open at the bottom, is mounted above the loud speaker and access is readily obtained to the trimmers without dismantling the set. A really substantial stiffening bar prevents flexing of the sides of the cabinet, and also serves as a support for the back of the main receiver chassis.

The controls are five in number, the main on-off switch being mounted separately in a recess at the left-hand side of the cabinet, and the remaining four—Tuning, Volume, Waverange and Combined Selectivity and Tone—are situated just below the large rectangular tuning scale. Station names are shown on all three wavebands, and the short-wave range is calibrated in megacycles as well as metres. The scale is indirectly illuminated, and a maltese cross waverange indicator matches the magic eye.

Makers.—A. C. Cossor, Ltd., Highbury Grove, London, N.5.



Resistance-tuned Oscillator

ITS APPLICATION TO AUTOMATIC FREQUENCY CONTROL

IN *The Wireless Engineer* for September, 1937, there was described a practical form of resistance-tuned oscillator. In this type of oscillator, instead of the tuning of the circuit being achieved by varying a capacity or inductance as in ordinary oscillatory circuits, the tuning is carried out by means of a variable resistance. Such an oscillator has particular advantages when used as the local oscillator of a radio receiver. For example, in push-button receivers it is difficult to secure a stable adjustable capacity, and it is costly to secure a stable oscillator circuit by a multiplicity of adjustable inductances where the station selection is by the switching of pre-set tuned circuits. Stable adjustable resistances are, however, procurable. The resistance-tuned oscillator is also easily adapted to use in automatic frequency correction circuits as additional components are not required as in the more usual arrangements.

The following is a description of a suitable oscillator circuit as devised by D. E. Foster, an R.C.A. engineer.

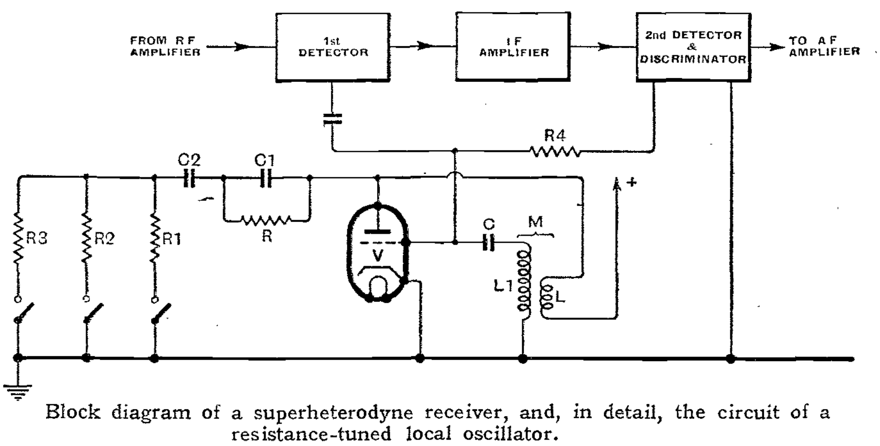
In the accompanying drawing there is shown a superheterodyne receiver system of a generally conventional type, except for the arrangement of the local oscillator network. The receiver comprises the usual signal collector, adapted to collect signals in the broadcast band of 550 to 1,500 kc/s, which feeds a tunable radio-frequency amplifier (not shown). The first detector and IF amplifier are conventional. The amplified IF energy may then be impressed upon a combined second detector-frequency discriminator network.

Briefly, it may be stated that the function of the second detector-discriminator network is to derive audio energy and a frequency-dependent direct current voltage from the IF energy. The discriminator network can be entirely independent of the second detector circuit. The direct current voltage output of the discriminator varies in polarity and magnitude with the sense and amount respectively of frequency departure of the IF energy from the assigned IF value. The variable direct current voltage, or AFC bias, is passed from the discriminator to the local oscillator V.

The local oscillator comprises the valve V, which includes at least a cathode, a control grid and anode. The anode is regeneratively coupled to the grid by means of inductive coupling between the anode coil L and the grid coil L1. Direct current voltage of the proper positive value is applied to the anode through L, whereas L1 is connected between the earthed cathode and the direct current-blocking condenser C. The anode is further connected to earth through a path which includes a frequency-dependent impedance network C1, R, a condenser C2 and any one of a plurality of resistors R1, R2, R3. The function of the impedance network R, C1, will be explained later. The resistors R1, R2, R3 function as the main tuning means for the local oscillator network. Each of these resistors has a magnitude such that when in circuit with the network R, C1, the local oscillator is tuned to a desired local oscillation frequency. Any tuning resistor may be selected by means of a push-button switch.

The local oscillation energy is impressed on the first detector network. Of course, the frequency of the local oscillations will differ from the signal frequency impressed on the first detector by the frequency value of the IF energy. It should be understood that the tunable circuits of the radio frequency and first detector may also include push-button switches, mechanically coupled to those of the local oscillator circuit, so as simultaneously to vary the signal circuits to different frequencies, so that at different adjustments of the oscillator and signal circuits the IF energy will have substantially the assigned IF value. The function of the AFC circuit is to correct for any deviation from the assigned IF value, should the oscillator or signal circuits shift in frequency. In place of the group of resistors R1, R2, R3 there may be employed a single adjustable resistor.

The AFC bias is applied to the grid of V through the grid leak resistor R4. The variation in bias of this grid is converted into a change in gain of V; the change in gain, in turn, is translated into a frequency shift of the oscillator network. The polarity of the AFC bias determines the direction in which the oscillator frequency is varied to compensate for the IF energy frequency departure. The direct current voltage output of the



Block diagram of a superheterodyne receiver, and, in detail, the circuit of a resistance-tuned local oscillator.

Resistance-tuned Oscillator—

discriminator rectifiers arranged in opposition will be positive or negative with respect to earth depending upon whether the IF energy has shifted to one side or the other of the assigned IF carrier value.

The local oscillator network functioning will now be described. The regeneratively coupled valve V provides negative resistance; the tuning resistor R1-R3 provides positive resistance whose magnitude is adjusted to vary the oscillation frequency. By varying the gain of V the value of negative resistance can be adjusted. Hence, at selected values of positive resistance, the AFC bias can be used to secure small frequency adjustments in order accurately to tune the oscillator to that frequency which will cause the proper IF value to be produced. The grid of V has a normal negative value by virtue of grid current flow, as the valve is in an oscillator circuit. It is desirable to maintain the grid at such a bias value as to cause the frequency shift to be substantially symmetrical with variations in applied discriminator potential about a mean value.

The Resistance Oscillator

The following detailed considerations of the functioning of the oscillator network will make the operation clearer. In a circuit consisting of a pure negative resistance which is a function of frequency, and a positive resistance in series therewith, oscillation will occur when the net resistance around the circuit is zero. The frequency of oscillation is that frequency which will make the negative resistance component equal the positive resistance component. Therefore, changing the positive resistance component will change the oscillation frequency. Now the required negative resistance which is a function of frequency can be secured by connecting across a negative resistance which is independent of frequency a reactance, and in series with that combination a reactance of opposite sign shunted by a resistance of approximately the same magnitude as the negative resistance. Therefore, small changes of the magnitude of the negative resistance will affect the oscillation frequency.

In the circuit shown inductance L is coupled to L1 and through blocking condenser C to the grid of V. The output of V is joined to L so that an oscillation circuit is formed. The anode-cathode impedance of V forms a negative resistance in shunt with L. In series with this combination is condenser C1 and positive resistance R in shunt therewith, approximately equal to a negative valve resistance. This combination L-V-R-C1 forms a negative resistance which is a function of frequency, as resistance R and the negative resistance of V are approximately equal and each is approximately equal to $\sqrt{L/C}$ where L is the inductance of coil L and C is the capacity of condenser C2.

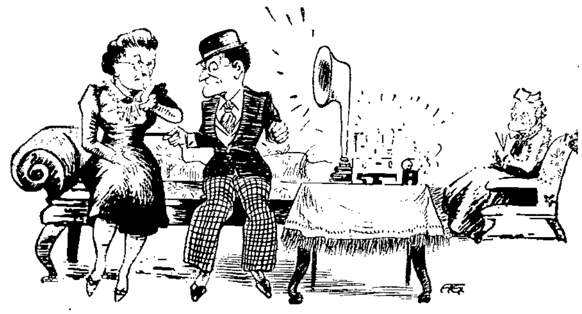
Now if the tuning resistance R1-R3 is zero, the frequency is that normal to an oscillatory circuit composed of inductance L and capacity C1. If resistance R1-R3 equals resistance R, the oscillation frequency is theoretically infinite, but is actually limited to some finite value by distributed capacity of coils. Decreasing the negative resistance a small amount so that the relationship, that negative resistance is equal to resistance R and to $\sqrt{L/C}$ still holds approximately, will likewise cause frequency increase. If the AFC bias is applied to the grid of V, through a DC amplifier if necessary to obtain a low impedance source since V, being an oscillator, will draw some grid current, it will change the operating trans-conductance of V, and hence the magnitude of negative resistance between plate and cathode. If the grid of V is made more negative its trans-conductance will decrease, and the negative resistance will increase, thereby resulting in a decrease of oscillation frequency and vice versa.

Identifying German Aircraft

NEW types of German aircraft are included in the new identification chart which has been prepared by *Flight*. Improvements introduced as a result of the use of many thousands of earlier editions are incorporated in the new chart which is printed on a card measuring 22in. by 14½in. Published by the Flight Publishing Company, Dorset House, Stamford Street, London, S.E.1, the chart costs 1s., plus 6d. postage. The postage on up to six copies is 8d. and on twelve copies 11d.

Unbiased

By FREE GRID



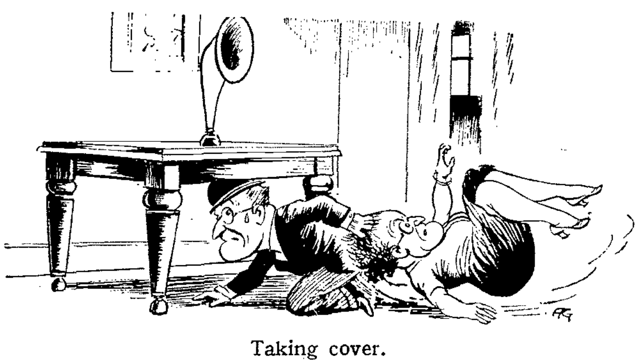
Playful prods.

Helping the Enemy

I LITTLE thought that I should raise such a hornets' nest about my ears when I mentioned last month that it was so difficult nowadays to distinguish between the whistle of a falling bomb and the whistle from the loud speaker due to oscillation from a neighbouring set that I frequently found myself dragging Mrs. Free Grid under the table with me when a particularly realistic howl came from the horn of the "old faithful" I am using in my refuge room.

Howls of protest have come from hordes of these oscillators who go completely beyond the bounds of decency by suggesting that I am in the pay of the wireless manufacturers and trying to help them line their pockets by compelling people to invest in new receivers of the non-radiating type. To these latter I can only say that no wireless manufacturer has yet made it worth my while to betray my trust.

There are quite a number of readers, however, who agree with me, and go even further and demand that a watch be kept not only on wireless whistlers but on all users of domestic electrical apparatus of the interference-producing kind, since it cannot be doubted that aircraft flying over a town pass through a veritable cloud of interference which readily tells them that they are no longer over the empty countryside. Personally speaking, I think that it would be a good opportunity to make the ether safe for post war listeners by putting pressure on manufacturers of interference-producing electrical devices to fit suppressors now.



Taking cover.

One correspondent claims that in pre-war days when he was an active member of a flying club he carried out a large number of experiments on these lines, and not only was he able to distinguish between town and countryside, but could even tell one district from another in certain cases. Over DC districts, for instance, the interference is much more pronounced owing to the use, among other things, of commutator motors, while an arc-rectified AC/DC district is readily distinguishable on a receiver equipped with a cathode-ray tube owing to the peculiar waveform emitted.

I must, however, part company with him when he suggests that, prior to the outbreak of war, German agents disguised as G.P.O. interference trackers made elaborate radio-interference charts of the whole country. Probably they were only American salesmen planning a sales campaign of suppression devices and getting the necessary data concerning the most profitable territory to operate in.

An Iron Constitution

I WAS extraordinarily interested in the report published in several newspapers about a new and homely method adopted by surgeons for finding small and elusive fragments of bombs in people's anatomy, but I must protest strongly against the suggestion that there is any novelty in it, as I used it myself many years ago soon after de Forest put the grid in Fleming's diode and made thermionic amplification possible. Actually it was not bomb fragments in my case, but shrapnel which I had picked up in the siege of Mafeking, way back in '99. I well recollect that I had so many small fragments in me that the captain of the ship on which I was returning home was compelled to request me not to visit him on the bridge as I upset the ship's compass.

It was not until many years afterwards that the final pieces of shrapnel were removed with the aid of a metal prodder attached to the aerial terminal of a home-constructed wireless set. The whole affair remains very vividly in my memory owing to a nasty passage of arms I had with Mrs. Free Grid's mother when, through my callow ignorance of women's attire, I foolishly imagined that I had discovered metal fragments in her daughter's anatomy. Mrs. Free Grid was, of course, much younger then, and, being still single, was not averse to my playful prods with a metal searching rod. What was started in fun continued in deadly earnest, however, as the loud speaker protested volubly every time I penetrated her defences. It was quite a long time before I discovered that the noise was due to her metal defences which were in those days just giving place to whalebone.

I suppose that I ought to have known better, but, after all, we are only young once, and I used my influence to get the aforementioned defences removed in order to continue my investigations further. I was considerably astonished to find that the loud speaker still indicated the presence of metal. It only shows how careful we scientists have to be not to allow ourselves to be led away into drawing false conclusions. For a long time I was seriously puzzled, and entertained all kinds of wild and far-fetched theories to account for the presence of metal in her body, only to discover in the end that it was all due to an iron tonic she was taking.

Incidentally, I may say that I have since discovered that this arrangement is an excellent test for the efficacy or otherwise of certain iron tonic patent medicines, and if any of you who have been taking any of these concoctions find on trying out this test that it fails to ring the bell, or, in other words, to make sounds from the loud speaker, you are justified in asking for your money back. No doubt before very long the vendors of some of these ferrous nostrums will include successful tests with this apparatus in some of their published testimonials.

Recent Inventions

Brief descriptions of the more interesting radio devices and developments disclosed in Patent Specifications will be included in these columns

TONE CONTROL

A COMBINATION of positive and negative feed-back is utilised to improve the tone of a low-frequency amplifier. In a two-stage amplifier, voltage from the output transformer of the second stage is fed back through a condenser to the grid of the first stage. This applies reverse reaction, the discrimination of the condenser in favour of the higher frequencies giving the effect of a low-frequency boost.

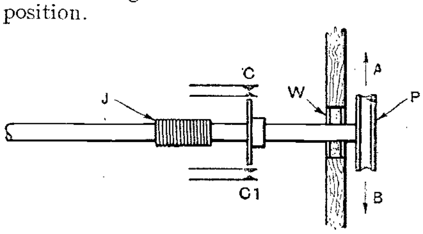
A tapping is also taken from a resistance in the same feed-back circuit to the grid of the same second stage. This gives positive reaction, and a shunt condenser is provided to by-pass the higher frequencies so that the lower tones are again favoured. Any desired range of frequencies can similarly be boosted by inserting suitable impedances in the feed-back circuit.

E. K. Cole, Ltd., and A. W. Martin. Application date October 19th, 1938. No. 520350.

o o o o

PUSH-BUTTON TUNING

EACH button on a switch-tuned set is given a multiple duty so that it can be made to select a given station on each of, say, four available wavebands without the necessity of having to operate any separate switch. As shown, the shaft of the push button P is made in two parts, which are flexibly jointed at J. The outer part of the shaft is enclosed in a washer W of spongy rubber or similar yielding material, where it projects through the cabinet casing, so that, in addition to the usual direct or plunger motion, the button P can be moved slightly upwards or downwards, as indicated by the arrows A, B. It has also a similar slight freedom of movement to right or left of its centre position.



Multiple-duty push-button system.

An upward movement closes the pair of contacts C and so changes the waveband switch to a given position, whilst a downward movement will bring another waveband range into operation through the contacts C1. Other waveband changes can be effected by moving the push button against similar contacts arranged at right angles to C and C1.

Kolster-Brandes, Ltd., and W. A. Beatty. Application date November 11th, 1938. No. 521209.

INTERFERENCE FROM THE MAINS

IN addition to the usual mains "hum," a further interference is sometimes caused by the production of "harmonics" of the supply frequency in the rectifier unit. Another source of trouble, particularly in a superhet. receiver using a high intermediate frequency, is due to higher harmonics of the IF, which get through by capacity coupling into the heater circuits of the amplifying valves, and so back through the primary winding of the supply transformer into the input of the receiver. If any of these harmonics happens to lie near to the signal frequency, it will be considerably amplified.

All such types of disturbance are eliminated, according to the invention, by electrostatically screening from one another not only the primary winding and the secondary winding supplying the anode voltage, but also the secondary winding connected to the heating circuits of the amplifiers, and the primary supply winding. This prevents the transfer by capacity coupling of any of the parasitic frequencies in question.

Philips Lamps, Ltd. Convention date (Germany) June 3rd, 1938. No. 520622.

o o o o

"QUIET" TUNING

THERE is a certain amount of difficulty in applying a clear-cut muting action to a receiver which is fitted with automatic tuning as well as automatic volume control. The object of the invention is to ensure "quiet" tuning, in such a case, when changing-over from one programme to another, even when frequency separation is small.

For this purpose the normal muting bias is arranged to be opposed by a second bias, which is set up across an impedance in series with a glow-discharge tube, both these being included in the anode circuit of a control valve. The valve is subjected to a triggering voltage from one of the IF stages—so that the voltage varies in accordance with the incoming signal strength. The voltage in question passes through a highly selective piezo-electric filter so that it has a clear-cut action in removing the muting bias whenever tuning is changed from one station to another.

Marconi's Wireless Telegraph Co., Ltd., and O. E. Keall. Application date 12th January, 1939. No. 523697.

o o o o

"BEAM" VALVES

THE invention relates to valves of the kind in which the electron stream is first formed into a definite beam, more or less as in a cathode-ray tube, and is then controlled by deflecting it to one side or other. The object is to produce a tube capable of handling a stream, say, of the order of 400 milliamps at from 1,000 to 2,000 volts, and to control it by comparatively small deflecting fields.

A feature of the invention is the use of a single electron lens both for producing and deflecting the stream, this being contrasted with the ordinary cathode-ray tube practice of using one electrode system for producing the beam, and a different electrode system for deflecting it. Also, according to the invention, the deflecting fields are applied to the electrons before they reach the beam-forming unit, this again being in contrast with ordinary CR tube practice.

J. H. O. Harries. Application dates November 9th and December 1st, 1938. No. 521199.

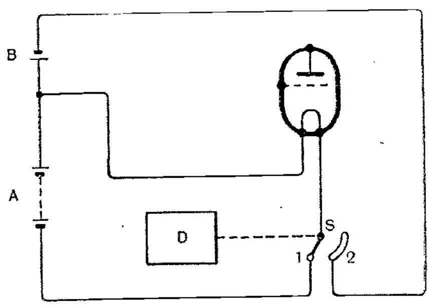
o o o o

FILAMENT SWITCHING ARRANGEMENTS

RELATES to means for bringing the cathode of a valve more quickly than usual to the temperature at which it emits a full stream of electrons. The same idea can also be used to maintain a valve relay of the kind employed for intermittent or "watchdog" duty at a "threshold" temperature so that it can be brought into action with the least possible delay.

If the switch S is moved in an anti-clockwise direction, it first makes a momentary contact at 1 and so "flicks" the full voltage of the battery A across the filament. This rapidly heats it up, but, because the contact is only momentary, no harm is done. The switch then passes on to the contact 2, where the low-voltage battery B is brought permanently into circuit.

By using a circular group of contacts, across which the switch is constantly driven by a clockwork or other motor D,



Circuit for quick filament heating.

it is possible to maintain the filament normally at a point just below the temperature of full emission, and to bring it up to full activity only once per revolution. This economises battery consumption in the case of a valve relay which is only intended to keep watch for a possible emergency or "calling" signal. At the same time the relay is kept ready to respond promptly, and

Recent Inventions—
without any time-lag, when such a signal arrives.

A. A. Thornton (communicated by Philco Radio and Television Corporation). Application date August 26th, 1938. No. 521942.

o o o o

PA LOUDSPEAKERS

IN order to protect the loudspeakers, used in out-of-doors public-address systems, from the effects of bad weather, the sound-reproducing box is arranged above, and substantially at right-angles to, the tapering neck of the horn, the latter being mounted horizontally. A curved tube connects the reproducer box to the throat of the horn, and is fitted with a drainage plug. The arrangement is designed to prevent rain from driving in along the horn and so damaging the delicate diaphragm of the sound-reproducing unit.

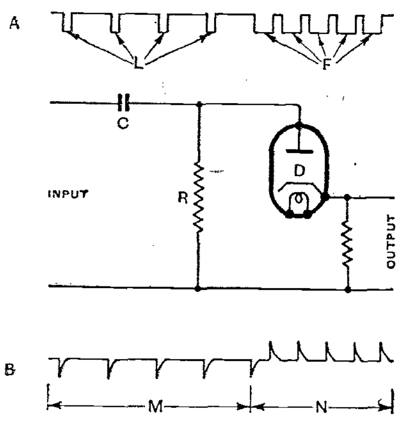
Standard Telephones and Cables, Ltd., and J. C. Curry. Application date November 15th, 1938. No. 521408.

o o o o

SYNCHRONISING IN TELEVISION

THE line and frame scanning impulses used in television are separated by passing them through a differentiating circuit which imposes a phase difference of 180 degrees between the two sets of signals The synchronising signals are radiated in the form shown at A, where L represents the short line-impulses and F the longer frame-impulses.

Both are applied to a condenser C in series with a diode D, the input to the latter being shunted by a resistance R.



Separating line and frame impulses.

The discharge period of the condenser C is such that it reaches a steady state corresponding to the curve M in the lower line B of the figure until the frame impulses reach it, whereupon the wave front "reverses" to give out-of-phase impulses of the form shown at N. The frame pulses can now be easily separated from the line impulses by the rectifying action of the diode D, which passes them on to the time-base circuit.

W. Jones and Pye, Ltd. Application date January 25th, 1939. No. 524286.

TUNING ADJUSTMENTS

IF it is desired to alter the semi-fixed tuning elements associated with one of the push-buttons on a set which, in addition to being switch-tuned, is also fitted with automatic frequency control, a certain difficulty arises. This is due to the fact that so long as the AFC is operative it tends to obscure the accuracy or otherwise of the new adjustment, since no matter what alteration is effected, it will appear to be correct. No calculated allowance can be made, since the "pull" of the AFC is variable and only ceases to act when the true adjustment has actually been made.

Such adjustments are not often necessary, and, in practice, one usually has to remove the escutcheon plate from the set in order to get access to the components concerned.

It is now arranged that the screws which fix the escutcheon plate in position normally complete the circuit of the automatic frequency control. When they are withdrawn the AFC circuit is automatically broken, and the required adjustment can then be made accurately and without trouble.

G. D. Barraclough. Application date December 22nd, 1938. No. 522975.

o o o o

GENERATING MICRO-WAVES

CENTIMETRE waves are generated in a magnetron valve which is stabilised by means of a Lecher-wire "resonator." The resonator consists of two strips which run the length of the tube, inside the glass bulb, and may be bent over to form a short-circuited "loop" at one end, the HT supply then being tapped to the midpoint of the loop.

Four anodes, arranged in two pairs, are set at right-angles to the resonator, one pair being welded to the upper strip, and the other pair to the lower strip, a gap being left at the opposite end of the welding point in both cases. The cathode is arranged in the centre of the anode system, along the line where the two pairs of anodes would normally intersect each other.

The electron-discharge path is from the cathode towards the rear edges of the four anodes. Under the influence of the applied magnetic field, oscillations build up along the Lecher-wire resonator. For a discharge path of 0.5 millimetres, the tube will generate waves from 4 to 5 centimetres long.

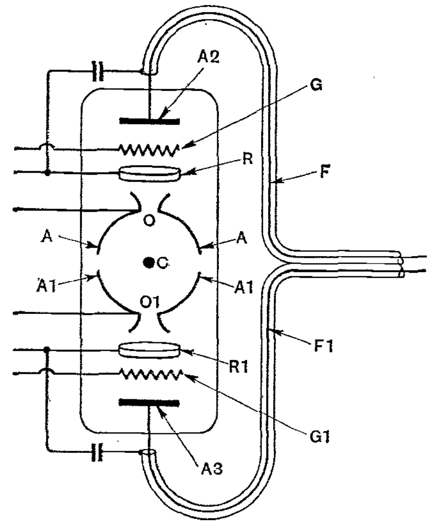
Telefunken Ges. für Drahtlose Telegraphie m.b.h. Convention date (Germany) December 20th, 1937. No. 522905.

o o o o

SHORT-WAVE MODULATION

THE figure shows a valve, of the magnetron type, for signalling on ultra-short waves so that the output is a pure amplitude-modulated carrier, free from any superposed frequency modulation. The underlying principle is to separate the oscillation-generator stage electrically from the modulating stage, so that any interaction between the two is avoided.

The cathode C is surrounded by two anode segments A and A1, with apertures O, O1, from which some of the oscillating electrons in the anode-cathode space pass, through positively biased ring electrodes R, R1, into the modulating space containing signal grids G, G1 and anodes A2, A3. The whole arrangement



Design of magnetron for pure amplitude modulation.

forms a push-pull system, the modulated output being taken off by co-axial feeders F, F1 from the anodes A2, A3. The method of the invention is comparable with the known system of using a space-charge grid to modulate a constant electron current from a virtual cathode.

Telefunken Ges. für drahtlose Telegraphie m.b.h. Convention date (Germany) February 11th, 1938. No. 525022.

o o o o

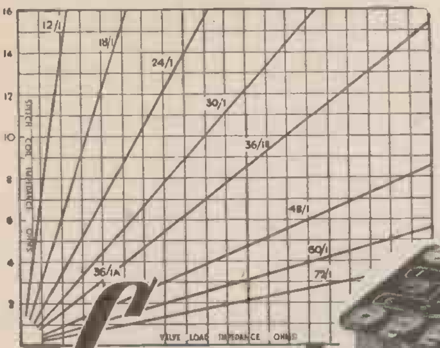
SCREENING

A NUMBER of insulated wires, forming, say, the RF leads or conductors of a wireless receiver, are threaded through the meshes of a wire-gauze sheet. They are thus held in any desired "run" or position, and at the same time are effectively screened from each other by the wire-gauze foundation, which can be earthed.

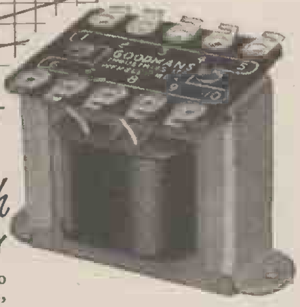
The combination can conveniently be used as a wiring sheet or panel for the chassis of a wireless set, or as a method of carrying and screening the RF cables used for remote control.

Marconi's Wireless Telegraph Co., Ltd., and J. S. Swift. Application date January 6th, 1939. No. 523484.

The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.



**This Chart makes matching with ONE transformer simplicity itself. Send for details including this chart.*



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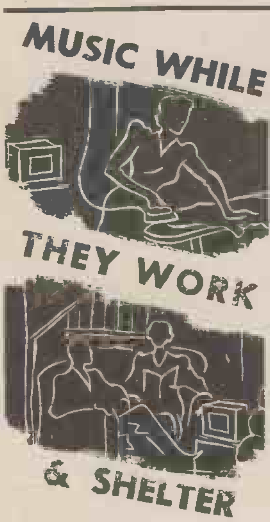

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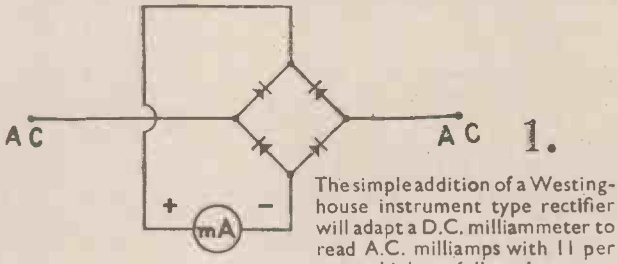
HOW TO MAKE an A.C.-D.C. TEST SET



1.

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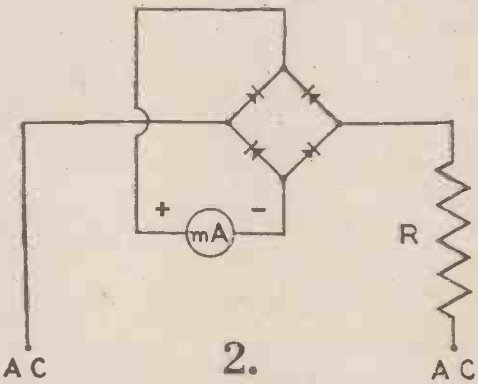
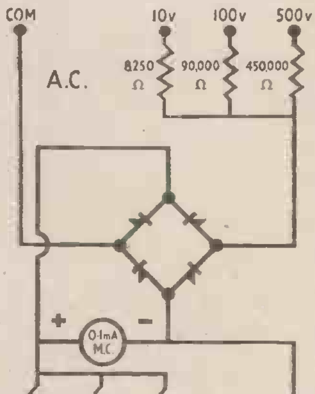


2.

By adding a series resistance "R" the A.C. milliammeter is easily converted into an A.C. voltmeter. The value of "R" depends on the full scale reading required.



3.

Descriptive pamphlet No. 11-B contains full details for the construction of a simple and robust A.C.-D.C. test set, suitable for reading D.C. and A.C. volts, and for measuring L.F. voltages in radio receivers. It also describes how the meter may be calibrated to read watts or decibels and also deals with the design of current transformers to enable high ranges of alternating current to be measured. Use the coupon and get your copy now.

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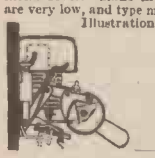

SINGLE POLE, HEAVY IRON CASE 250/400 Volt

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6 ,,	S 11/1Z*	13/6
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2 ,,	S 11/2Z*	20/-	6 ,,	S 11/2	23/-
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3 ,,	S 11/2Z*	22/-	10 ,,	S 11/2	30/-
4 ,,	S 11/2	22/-	12 ,,	S 11/2Z*	36/-
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22 TRIPLE POLE, 3 TRIPS Light Iron Case 300/500 Volt			TRIPLE POLE, 3 TRIPS Heavy Iron Case 300/500 Volt		
Rating	Type	Price	Rating	Type	Price
800 m/a.	S 11/3Z*	25/-	500 m/a.	S 11/3Z*	26/-
3 amps.	S 11/3	21/-	800 ,,	S 11/3Z*	27/-
3 ,,	S 11/3Z*	24/-	1 amp.	S 11/3Z*	24/-
4 ,,	S 11/3	21/-	2 ,,	S 11/3Z	32/-
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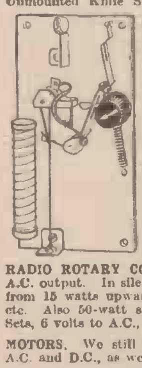
Small 7-stud on ebonite with plug, 1/9. Yaxley, wave-change, 2-gang with knob, one hole, 1/2. Reyrolle PowerPlugs, 15 amps., shrouded panel wall, two pairs on box, unused, 10/-. SNAP Indicating on-off and change-over Switches, carry 250 volts, 5 amps., 1/2; 10 amps., 1/6. Single-pole Change-over 10 amp. Switches, porcelain, 1/6. Double-pole, ditto, 3/6 R.A.F. 80B Series Parallel Barrel Switches, 5 amps., 2/-.

CHANGE-OVER. Send-Receive Switches on Ebonite. 2/-. Unmounted Knife Switches, S.P., 10 amp., 4/9. D.P. C.O. 25 amp., 14/-. Triple-pole Change-over, 30 amp., 22/6. D.P. Linked, 10 amp. G.E.C. Tumbler, in iron box, 2/6. G.P.O Tumbler D.P. C.O., on mahog. base, 1/6.



A SPECIAL DESIGN IN AUTO-SWITCHES with time-lag tripping on 2 to 3 amps. Safety thermo switch with quick-break auto overload trip, for back of panel with front indicating knob, compact, 4in. × 2in. × ¾in. deep. Any voltage up to 1,000 v. (as illus.) Only 5/6. Worth a Guinea.

SWEET AIR IN YOUR SHELTER, with a Lesdix Neron Ozonizer, cost almost nothing to run on A.C. mains and can be hung on the wall; 10 watts, 17/6; 25 watts, 25/-.

RADIO ROTARY CONVERTERS. For D.C. mains to 230 v. A.C. output. In silence cabinet, with filter. All sizes in stock, from 15 watts upwards, 30, 50, 100, 200, 400 and 800 watts, etc. Also 50-watt size 12 volts and 50 volts input. T.V.T. Sets, 6 volts to A.C., 25/-.

MOTORS. We still have a stock of fractional H.P. motors, A.C. and D.C., as well as large machines of all sizes and types.

A SELECTION OF RELAYS

2 m.a. Table Relay. For Radio Work. Compact vertical type, enclosed. Screened 3,000 ohm coils, platinum contacts, single-pole change-over, ½ amp. contacts, wood base, metal case, size 2½in. diam., 3½in. high. Price only 8/-. G.P.O. glass top B. Relays are larger, twice the size, have massive platinum contacts, 15/-. Some chipped, 10/-. A few without contacts, 5/-. 6d. postage.

TELEPHONE TYPE RELAYS. SINGLE BLADE RELAYS. No. 1a is a new special high resistance, 42,000 ohm, works on 1 m.a. Price 12/6.

No. 1 type 80D, 1,000 ohms, "on-off," s.p. 6 volts, 8 m.a., 7/-. No. 2 type 832 s.p., 2,000 ohms, "off" only, 10 volts 5 m.a., 8/-.

L.R. SERIES RELAYS. No. 13 type L.A., 1 ohm, 2 on 1 off, 12/6. No. 14 type L.B., ditto, 10 ohms, 12/6.

STAYPUT RELAYS. No. 15 type 1,950 coil, 1,300 ohms, trip contacts "on" hand reset, 12/-. No. 16, ditto, but reverse, contact set "on" by hand, trip-off coil, 1,500 ohms, 14 volts, 10 m.a., 12/-.

SUPERSENSITIVE MOVING COIL RELAYS. Work on tiny currents from photo-cells, etc. (1) The famous Weston Relay, open type, Model 30, 50/-. List price, 50 dollars. Mounted in mahogany case with glass top, 60/-. For panel, the 2in. meter type W1 works on 50 micros. with 150 mils. on main contact, 63/-.

ELECTRO-MAGNETS for 250 volts 30 m.a., holds 14 ozs., 2/6.

SOLENOIDS for remote work or relay, 4 and 6 volts, ½in. stroke and 1 oz. pull, silk-covered coil, metal frame, 3/6. Magnetic key, 10 amp. contacts, 6 volt, coil, 15/-. Auto Cut-out and Cut-in Battery Switches, 15/-.

LIGHT AND RAY CELLS. Selenium, 10/6. Electro-cell, Self-generating, 25/-. Raycraft outfit with relay and amplifier, 55/-. Photo-Cells for sound on Film, Television and Ray work, R.C.A., 25/-. Beck, Angle Prisms, mounted in carrier, 5/6.

VOICE RECORDING

VOICE-RECORDING MACHINE. Illuminated pedestal type, fitted automatic, motor, disc recording gear and amplifier, by the Amusement Equipment Co., Ltd. Put 6d. in the slot and 125 words are recorded on 5in. disc, plays back to earphones. For voice letters to friends and relations, an acquisition to a canteen or entertainment depot; earns good fun fair money, only £22. Cost £90.

TWO DOMESTIC BARGAINS

AEROFRIGE DOMESTIC REFRIGERATOR. Cabinet size, 46in. high × 22in. × 20in., 3½ cu. ft. capacity, white enamelled, New condition, £14.

UNIVOLT ELECTRIC DOMESTIC WASH MACHINE. 230 volt A.C./D.C. mains, 16in. dia., 25in. high, 6/8 gal., £4/10/-.

WORKS EQUIPMENT

230 Volts A.C. 2½ kW. **RECTIFIER EQUIPMENT,** with 5 kW. transformer and Philips valve, D.C. output, 230 volts 10 amps., £15.

TEST PANEL, with 4 meters for full-range works testing. Ranges 5 m.a. to 12 amps. D.C. or A.C., with rectifier and transformer, 5 volts to 500 volts, 7in. dial meter on steel panel, 27in. × 30in., £12.

4-RANGE A.C. WORKS AMMETER SWITCH, by Elliott, for 5, 25, 100 and 400 amps., with selector knife, £6/10/-.

DISTRIBUTION BOARDS. Polished Hardwood, glass door, clip fuses, D.P., four of 12-way, one 8-way, two 6-way, six 5-way, all at 2/- per way.

ELECTRIC ENGRAVER AND TATTOO MACHINES. A.C. mains, 75/-.

VACUUM CLEANERS. "Pulvo" Large Hall Cabinet Type on wheels, fitted ½ h.p. motor exhauster, 200 v. or 100 v. Cost £22. Sale, £5.

ZET OZONIZERS for air purification. 1 Tube Units, 10/6. Complete in white enam. wall case, 9in. × 3in. × 3in., with flex and plug, 12/6; 2 Tube Units, 15/-.

WAX HEATERS. Electric Automatic Wax Sealers, all brand new and copper clad, 7/6.

ELECTRIC CLOCK. Movements 230 volts A.C., less hands, 10/-.

ELECTRO-MAGNETS. Powerful 2 lb. model, 18 gauge bobbin 110 v., lift 7 lbs., 3/6; 220 v. D.C., lift 12 lbs., on A.C. 1½ lbs.. 3/6. ¼ h.p. Morse Chain and Wheels, 5/- set. Skewgear Boxes, ¼ h.p., 10/-. Gear Boxes, 2-1 for ¼ h.p., 4/6. Electric Governors, 7/6. Bowden R.A.F. Remote Controls, 18 points, 7/6.

ELECTRIC DRILL STANDS. Massive Wolf rise and fall with counterweight; suitable large or small machines, 10/6, carriage forward.

LENS GRINDING MACHINE. Oscillating movement for motor drive, £3/10/-.

200 TRUE-TWIN CAMERASCOPES, 2 lens viewers, 1/- post free.

COMPRESSORS ONLY for Refrigerators or Tyre Pumping, £3. Brass Unions, 1/-. Stop Valves for refrigerators, 2/6.

ELECTRIC GOVERNORS. Centrifugal control, 1,500 r.p.m. contacts, brushes, slip rings for auto speed regulation. 7/6.

PUMP FLOAT SWITCH, 45/-. Double-pole, 55/-. Foot Valves, ¾in., 2/6. Welded Steel 1 pint H.P. Containers or Surge Pots, 2/6.

TRAINING AIDS FOR NAVY, ARMY AND R.A.F.

L.R. SOLO PHONES. For buzzer morse. Single Earpiece, 40 ohms, with cord, 1/3. Ditto, D.3, 60 ohms, with cord, 1/6. W.E., 1,000 ohms, with cord, 2/-. 2,000 ohms Earpiece, with cord, 2/6.

L.R. DOUBLE HEADPHONES Pilot Signallers 120 ohms Phones. All leather headbands with slide adjustment chin strap and 4ft. cord, 3/6. Sullivan 120 ohms, Aluminium Headbands, 3/9.

RADIO PHONES. Browns, 'A' Reed Phone, aluminium headband, 4,000 ohms, 35/6. 1,500 ohms 21/6. 120 ohms, 17/6. Cords, 1/6. Various Makes: Second-hand Headphones in good order. 2,000 ohms and 4,000 ohms, 4/6 and 6/6, with cords. Western Electric, 2,000 ohms, 4/6.

TAPPER KEYS for Morse Signal Transmission. Service Silent Practice Keys, 3/-. T.X. Practice Key, front contact, on black moulded base, a good small key, 3/6. Long bar Type Practice Key, T.X.2, with cranked bar, 5/6. Superior Model B2, with back contact, a well finished key on polished wood base, 7/6. Operators' P.F. plated pivot bar and terminals, mahogany base, 9/6. Type I.V. Superior ditto, nickel-plated pivot bar and fittings, on polished base, 10/6. Panel Keys to fold up flat, 6/6. Fullerphone double acting Morse Key, solid brass on heavy base, 7/6. Three-colour light Switch Box, with morse key for code signals, 4/6. S.G. Brown totally enclosed type, 42/-.

LEARNERS' MORSE PRACTICE SET. Special Duplex with Key Buzzer and Lamp for sound and visual, 10/-. Heliographs and tripods.

BUZZERS, small type, with cover, 1/6. Power Buzzers, with screw contact and adjustable armature, 2/6. Heavy Buzzers, in Bakelite case, 3/6. Siemens Morse Line Transmitters, with key and brass-cased Power Buzzer, 17/6. Magneto Exploders, 25/-.

PORTABLE FIELD PHONES FOR LISTENING POSTS AND A.R.P. Leather cased W.D. Type 135. Service Field Phones are difficult to get at the present time. Soiled but serviceable. Cases, morse keys, mike and phone.

EXCHANGES, Plug type, 5-line and 20-line. Wire and cables cheap.

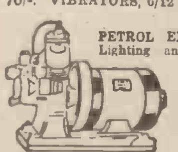
TELEPHONES for all purposes. House Shelter and Office.

COMPASSES. W.D., Marching Compass, jewelled, course setter, etc., mahogany case, 3in. × 3in. × 1in., 10/-. W.D. Prismatic Watch type, brass case, floating card-folding prism, 35/-. Mariner's 6in. Binnacle Boat Compass, portable, gimbal bases, etc., 45/-. Kelvin Ship Compass, pattern 14, liquid type. Mahogany case, 10in. × 10½in. × 7½in., 60/-. Plain 1in. Pocket Compass, 1/-.

MORSE RECORDERS. Ex W.D. Standard G.P.O. Paper Tape Inkers record morse signals automatically. Work direct on line or through relay on radio, mahogany base drawer contains reel All are in good order, £7. Super Type, £8.

H.T. BATTERY SUPERSEDERS. 85 v. at 6 m.a. for H.T. from your 2-volt battery, no H.T. batteries. 7in. × 4½in. × 3in. Bakelite finish. Vibrator and Metal Rectifier, by S. G. Brown. Sale 37/6. Full guarantee. Type 8, for larger sets. Can be supplied for either 2-volt, 4-volt or 6-volt battery. Model 10, output D.C. 120 volt, 10 m.a., 2 taps, 65/-. Model 20, output D.C. 135 volt, 20 m.a., 3 taps, 70/-. **VIBRATORS,** 6/12 volt car type, 4 amp., 10/-.

PETROL ELECTRIC GENERATING SETS for Lighting and Charging. Half h.p. DIRECT COUPLED, 150 watts D.C., 1,300 r.p.m., 2-stroke water-cooled 1-cyl. Engine, magneto ignition. On bedplate with 30 volts 5 amps. Dynamo, £12. 75 Larger size, ½ kW. Petrol Electric Sets, 500 watts, 2-stroke water-cooled 1 h.p., 1 cyl. engine on bedplate, direct-coupled to 50/70 volts 10 amps., D.C. dynamo, magneto ignition, fuel and oil tank, £16



Stamped envelope must be enclosed for Free Bargain List "W" or for replies to enquiries.

ELECTRADIX RADIOS

LONDON'S LARGEST SUPPLIERS OF BARGAINS IN RADIO, ELECTRICAL, MECHANICAL AND SCIENTIFIC INSTRUMENTS,
218, UPPER THAMES ST., LONDON, E.C.4. *Telephone: Central 4611*

Wireless World

CLASSIFIED ADVERTISEMENTS

THE CHARGE FOR ADVERTISEMENTS in these columns is

12 words or less, 3/- and 3d. for every additional word.

Each paragraph is charged separately and name and address must be counted.

SERIES DISCOUNTS are allowed to Trade Advertisers as follows on orders for consecutive insertions, provided a contract is placed in advance, and in the absence of fresh instructions the entire "copy" is repeated from the previous issue: 3 consecutive insertions, 5 per cent.; 6 consecutive, 10 per cent.; 12 consecutive, 15 per cent.

ADVERTISEMENTS for the March issue are accepted up to First Post on Monday, February 10th, at the Head Offices of "The Wireless World," Dorset House, Stamford Street, London, S.E.1, or one day earlier at the Branch Offices, 8-10, Corporation Street, Coventry; Guildhall Buildings, Navigation Street, Birmingham, 2; 260, Deansgate, Manchester, 3; 26B, Renfield Street, Glasgow, C.2.

Advertisements that arrive too late for a particular issue will automatically be inserted in the following issue unless accompanied by instructions to the contrary. All advertisements in this section are subject to prepayment.

Cheques and Postal Orders sent in payment for advertisements or deposits should be made payable to ILIFFE & SONS Ltd., and crossed. Notes cannot be traced if lost in transit. They must therefore be regarded as being despatched at sender's risk. Alternatively, they may be sent per registered post.

All letters relating to advertisements should quote the number printed at the end of each advertisement and the date of the issue in which it appeared.

The proprietors are not responsible for clerical or printers' errors, although every care is taken to avoid mistakes. They also retain the right to refuse or withdraw advertisements at their discretion.

For the convenience of private advertisers, letters, other than circulars, etc., may be addressed to numbers at "The Wireless World" Office. When this is desired, the sum of 1/- to defray the cost of registration and to cover postage on replies must be added to the advertisement charge, which must include the words Box 000, c/o "The Wireless World." All replies should be addressed to the Box number shown in the advertisement, c/o "The Wireless World," Dorset House, Stamford Street, London, S.E.1. *Remittances should not be sent through the post to Box Numbers.*

☛ DEPOSIT SYSTEM

Readers who hesitate to send money to advertisers in these columns may deal in perfect safety by availing themselves of our Deposit System. If the money be deposited with "The Wireless World," both parties are advised of its receipt. Notes and Money Orders save time. Cheques should be made payable to Iliffe & Sons Ltd., and are acknowledged to seller when "cleared."

The time allowed for decision is three days, counting from receipt of goods, after which period, if buyer decides not to retain goods, they must be returned to sender. If a sale is effected, buyer instructs us to remit amount to seller, but if not, seller instructs us to return amount to depositor. Carriage is paid by the buyer, but in the event of no sale, and subject to there being no different arrangement between buyer and seller, each pays carriage one way. The seller takes the risk of loss or damage in transit, for which we take no responsibility. Details of any arrangement made between parties which does not concur with any of the above conditions must be advised to us when the deposit is made. For all transactions whether a sale is effected or not a commission of 1 per cent. is charged on and deducted from the amount deposited (minimum charge 2/-). All deposit matters are dealt with by Iliffe & Sons Ltd., Dorset House, Stamford Street, London, S.E.1.

NEW RECEIVERS AND AMPLIFIERS

A NEW 200-watt A.C. Amplifier, with provision for gramo. and microphone input, 2 Tungsram P.100/1,000 valves; bargain.—Box 2562, c/o *The Wireless World.* [9380

£13/10 Only, usual price £22.—*Wireless World* 2 R.F. Receiver with push-pull quality amplifier, 10 valves, including tone control stage, 8 watts triode output, ideal for quality reproduction from radio and gramophone; limited number.—Bakers Selhurst Radio, 75, Sussex Rd., South Croydon. [9344

RECEIVERS AND AMPLIFIERS
SECOND-HAND, CLEARANCE, SURPLUS, ETC

PETO Scott Preselector, little used, offers; 23- or 27-valve Scott chassis and speaker wanted.—Box 2561, c/o *The Wireless World.* [9379

EDDYSTONE E.C.R. Communication Receiver, nearly new; £33.—Cooknell, 38, Prior Deram Walk, Canley, Coventry. Tel.: 60512 Cov. [9395

W.W. Type Quality Amplifier, Vortexion 500-500 transformer, S.S. chokes, new valves, 2 P.X.4s, 2 M.H.4s, M.H.4, M.U.12-14, Magnavox L.S., £3; radiogram cabinet, walnut, 30/—101, The Avenue, Pinner 5101. 9398

BANKRUPT Bargains.—Genuine offer; brand new 1939-40 fully guaranteed models, makers' sealed cartons, at 25 to 40% off present prices; also portables, midgets; send 1½d. stamp lists.—Radio Bargains, Dept. W.W., 261-3, Lichfield Rd., Aston, Birmingham, 6. [9362

Wanted

R.M.E.69 and D.B.20; cash.—Tregunna, High Cross St., St. Austell, Cornwall. [9375

WANTED, pre-tuned Quality Receiver or similar Quality Receiver, prefer less amplifier.—3, Kirby Rd., Blackpool. [9392

SOUND SALES Tri-channel Amp. (1939 or later), excluding 346 amplifier and speaker; also wanted Voigt corner horn (not home constructed), excluding speaker unit.—Write 113, Kingsfield Ave., Harrow, Middx. [9399

AMPLIFIER, 200 volts, 50 cycles, output about 10 watts, gram. and microphone switching; state price.—Box 2559, c/o *The Wireless World* [9376

WANTED, first class R.F. unit with short waves, to plug into W.W. 12-watt quality amplifier.—J. D. Davies, Lyth Hill, near Shrewsbury. [9369

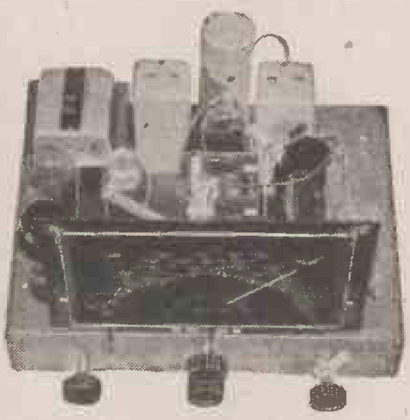
ARMSTRONG

STRIVING

We are still striving to give our customers every satisfaction with regard to delivery and service. Actually the endeavour is greater than ever because the difficulties are greater than ever.

We know our old friends will realise that, through no fault of our own, lack of supplies have prevented us from accepting many of the orders received for various models of Armstrong Chassis.

As mentioned last month our Service Dept. is in full operation. This affords an opportunity for customers' old type chassis to be brought up to their original efficiency.



To readers who have a real need of a new wireless set, we have a few of our latest EXP48 Chassis so favourably reviewed in the October issue of "The Wireless World." Briefly, the specification is :—

SPECIAL OVERSEAS MODEL EXP48
8-v. 4-BAND ALL-WAVE SUPERHET CHASSIS
(13-160m. continuous & normal Broadcast bands)
6 Watts Push-Pull Output.

Send for Illustrated Specification which fully describes this chassis with prices, etc.

ARMSTRONG MANUFACTURING CO.
WARLTERS RD., HOLLOWAY, LONDON, N.7, ENGLAND
'Phone: NORth 3213

ACOUSTICAL MANFG CO.

SPECIALISTS IN

Amplifiers, Transformers, and all Sound Equipment

have (owing to enemy action) removed to:

138-140, WARDOUR STREET, LONDON, W.1,

where our full services are available.

RECEIVERS AND AMPLIFIERS
SECOND-HAND, CLEARANCE, SURPLUS, ETC
Wanted

WANTED Immediately, new and used sets, radiograms, record players, automatic record changers, electric gramophone motors, etc.; quote make, model, type or catalogue number (see rear), and whether working or not; definitely best prices paid.—Snell, Arcade, Swansea. [9383

PUBLIC ADDRESS

V

VORTEXION P.A. Equipment.

IMITATED, but unequalled.

WE Invite You to a Demonstration.

A.C.-20 15-20-watt Amplifier, 38-18,000 cycles, independent mike and gram., inputs and controls, 0.037 volts required to full load, output for 4, 7.5, and 15 ohms speakers, or to specification, inaudible hum level, ready for use; 8½ gns. complete.

C.P. 20 12-volt Battery and A.C. Mains Model, as used by R.A.F., output as above; 12 gns.

A.C.-20, in portable case, with Collard motor, Piezo pick-up, etc., £14; C.P.20 ditto, £17/17.

50-WATT Output 6L6s, under 60 watt conditions, with negative feed back, separate rectifiers for anode screen and bias, with better than 4% regulation level response, 20-25,000 cycles, excellent driver, driver transformer, and output transformer matching 2-30 ohms impedance electronic mixing for mike and pick-up, with tone control, complete with valve and plugs; £17/10.

COMPLETE in Case, with turntable, B.T.H. Piezo pick-up and shielded microphone transformer; £22/10.

80-WATT Model, with negative feed back; £25, complete.

120-WATT Model, with negative feed back; £40, complete.

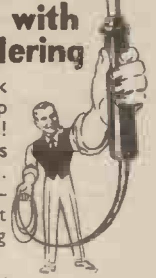
250-VOLT 250 m.a. Full Wave Speaker, field supply unit; 25/-, with valve.

WE are Compelled Through Rising Costs to Increase our Prices by 10%.

ALL P.A. Accessories in Stock; trade supplied.

SEE Our Display Advertisement on page 57 (Edit.).

VORTEXION, Ltd., 257, The Broadway, Wimbledon, S.W.19. 'Phone: Lib. 2814. [9232



You just plug in with Solon *Electric* Soldering

With the Solon you can work wherever there's a lamp holder—and do better work! Solon Electric Soldering is easy, neat, strong and clean. No stopping to heat up—constant heat maintained at point. 15 hours soldering uses only 1 unit.

Made for following standard voltages:—200/220, 230/250.

SOLON *Electric* SOLDERING IRON

Handyman model supplied complete with Resin-Cored Solder, Flex and Lamp Adaptor **9/4**

Solon Resin-Cored Solder **6D.** per reel.

W. T. HENLEY'S TELEGRAPH WORKS CO. LTD.

(Dept. 23/E), Engineering Sales Dept., Milton Court, Westcott, Dorking, Surrey.

WORK OF

NATIONAL IMPORTANCE

Skilled W/T Operators are required in practically every branch of the Services—Navy, Army, Air Force as well as for the Mercantile Marine, Commercial Companies and other work of National Importance.

Many who would like to become W/T Operators are located too far away from the few schools which they might attend, whilst others cannot spare the time taken, or are too tired after a day at business to travel to and from classes

THE CANDLER SYSTEM OF CODE TRAINING IS CARRIED OUT IN YOUR OWN HOME

The excellence of Candler Code Courses has accounted for the success of many thousands of present-day operators. Many readers of "The Wireless World" are taking Candler Courses. There are courses for the absolute beginner, and for those who want to improve their technique or bring up their w.p.m. speeds.

If you will fill in the Coupon below and post it in an unsealed envelope (postage 1d.) I will at once send you a copy of the "Book of Facts" and other essential information.

Courses supplied on Cash or Monthly Payment terms.

COUPON

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

NAME ....

ADDRESS ....

....

Post Coupon in 1d. unsealed envelope to London Manager

CANDLER SYSTEM CO. (Room 55.W.), 121, Kingsway, London, W.C.2.

Candler System Co., Asheville, North Carolina, U.S.A.

241

NEW MAINS EQUIPMENT

V

VORTEXION Mains Transformers, chokes, etc., are supplied to G.P.O., B.B.C., L.P.T.B.; why not you?

WE are Compelled Through Rising Costs to Increase our Prices by 10%.

VORTEXION, Ltd., 257, The Broadway, Wimbledon, London, S.W.19. 'Phone: Lib. 2814. [9233

NEW LOUD-SPEAKERS

BAKERS Brand New Surplus Speaker Bargains.

EVERY Music Lover Interested in Realistic Reproduction should write for free descriptive leaflet now.

£5; usual price £10.—Brand new permanent magnet infinite baffle speaker, complete with beautifully finished cabinet in polished walnut.

£2/10; usual price £5.—Brand new super quality triple cone speaker, permanent magnet model; exceptional bargain; limited number.

£1/12/6; usual price £3/5.—Brand new permanent magnet infinite baffle extension speaker, in rexine covered cabinet, the ideal extension speaker.

SECURE One of These Exceptional Bargains Now.

BAKERS Triple Cone Conversions Will Immensely Improve Reproduction of Your Present Speaker. ("For a few shillings you have converted a speaker scheduled for the scrap heap into one worth pounds.—W. E. Darby, Grad I.E.E.") Write for details.

BAKERS SELHURST RADIO, 75, Sussex Rd., Sth. Croydon. [9345

SECOND-HAND LOUD-SPEAKERS

ROLA G.12, 2,500 ohms field; £2; wanted P.M. model.—Dawson, Jeweller, Halesworth. [9385

SHORT-WAVE EQUIPMENT

G5NI for Short Wave Equipment; largest stocks in the country; communication receivers; National agents; American and British Valves, etc. See advertisement on page 3.—44, Holloway Head, Birmingham. [0531

"H.A.C." Short-wave Receivers, famous for over eight years; latest model one-valver now available; complete kit of precision components, accessories, full instructions, requiring no soldering; only 16/-, postage 6d.; illustrated catalogue free.—A. L. Bacchus, 109, Hartington Rd., S.W.8. [9322

CABINETS

A CABINET for Every Radio Purpose.

SURPLUS Cabinets (Undrilled) from Noted Make.

WE Have Hundreds in Stock (no Catalogues); send measurements of chassis, etc., and say what kind of cabinet required; stamp for reply.

INSPECTION Invited.

H. L. SMITH and Co., Ltd., 289, Edgware Rd., W.2. Tel.: Pad. 5891. [9331

DYNAMOS, MOTORS, ETC.

ALL Types of Rotary Converters, electric motors, battery chargers, petrol-electric generator sets, etc., in stock, new and second-hand.

A.C. D.C. Conversion Units for Operating D.C. Receivers from A.C. Mains, 100 watts output, £2/10; 150 watts output, £3/10.

WARD, 46, Farringdon St., London, E.C.4. Tel.: Holborn 9703. [0518

BARGAIN.—110 volt, 0.8 amp. D.C. semi-enclosed, ball bearings, 1,850 revs., weight 15lb., size 6in.×5in.; no tax; cheap, 10/6, carriage forward.—L. Dixon, 218, Upper Thames St., E.C.4. [9400

VALVES

Wanted

25 B8GT Valve.—Lee, Wireless Depot, Pocklington, York. 9397

TAX-FREE STOCKS HAVE ALMOST GONE

New supplies will be 25% higher.

ORDER *FREE OF TAX* NOW!

L.R.S. EASY TERMS ON REQUEST.

RADIO RECEIVERS, &c.	£	s.	d.
VIDOR all-dry ARP receiver 320	7	7	0
EVER READY all-dry Superhet	8	10	0
ULTRA Model 70	8	10	0
Part carr. 2/- extra on receivers.			
HEAYBERD MODEL A 0·5 Battery Charger, Westinghouse 2-12 v. at 2 a.	5	0	0
AVO Universal AC/DC Test Meter	6	10	0
AVOMINOR Test Meter	2	17	6
VORTEXION AMPLIFIERS (see advt. page 57. Edit.). Now available from us on Easy Terms. Write for quotation!			
W.B. LOUDSPEAKER UNITS (Junior)	1	15	6
DOMESTIC ELECTRICAL GOODS			
MORPHY RICHARDS IRONS, Auto-control Safety Model, post 1/-	1	5	0
MORPHY RICHARDS FIRES—			
Tubular Major, 1 kW	1	7	6
Tubular Twin Beam, 1 or 2 kW	1	16	0
Cray Twin Beam, ¾ or 1½ kW	1	1	0
Senior Twin Beam, 1 or 2 kW	1	7	6
ORMOND HAIR DRYER	1	12	6
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