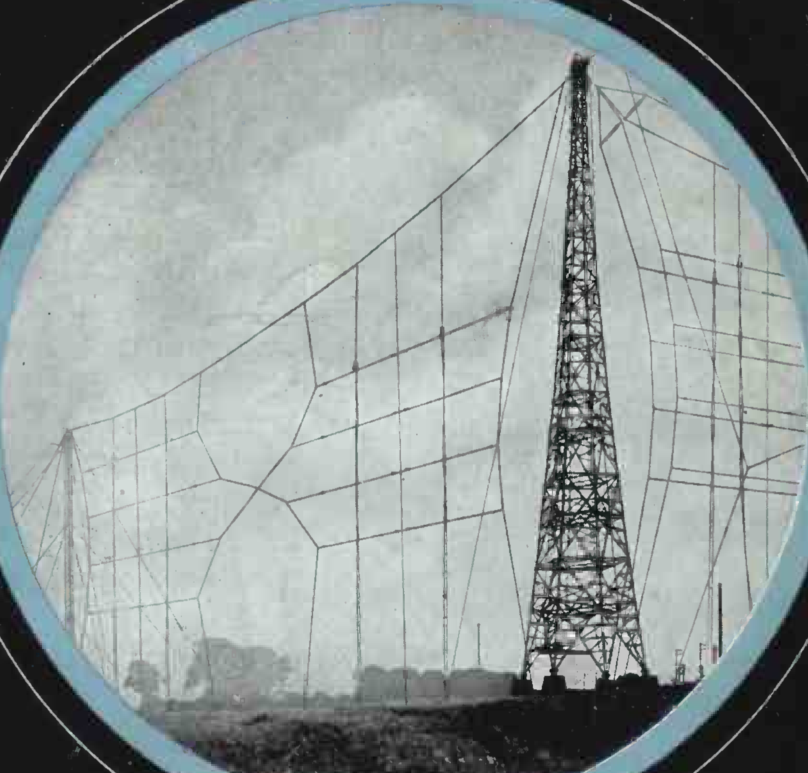
Wireless World

RADIO • ELECTRONICS • ELECTRO-ACOUSTICS



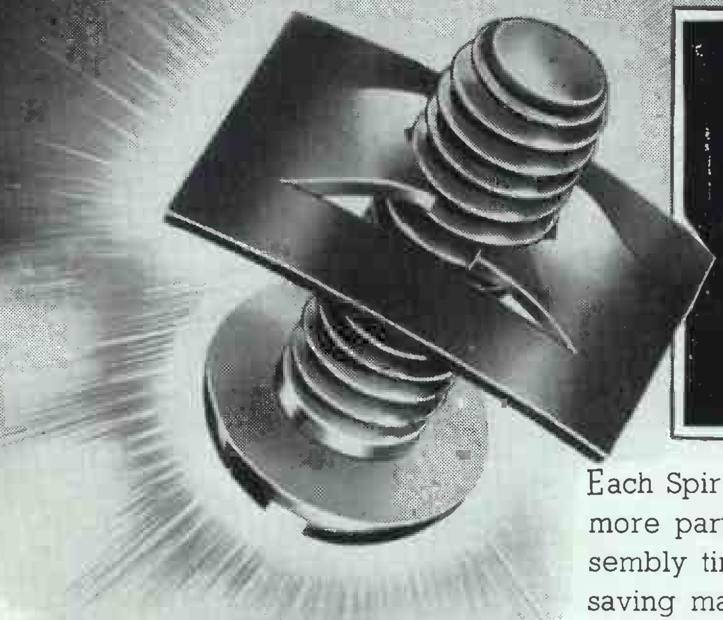
FEB. 1943

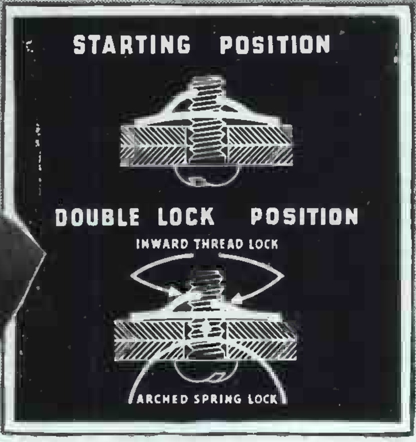
1/3

Vol. XLIX. No. 2

BASIS OF RADIO WAVE PROPAGATION

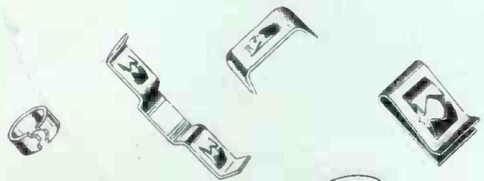
SAVE TIME—CUT COSTS
ON YOUR ASSEMBLIES

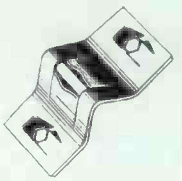




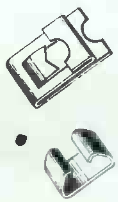
for METAL, WOOD, CERAMIC AND PLASTIC ASSEMBLIES

Each Spire Nut can replace two or more parts, thus cutting down assembly time, reducing weight and saving material. SPIRE NUTS provide a double lock that prevents loosening from vibration. The combination of an arched spring lock and an inward thread lock holds assembled parts together for the life of the product. SPIRE NUTS can be used on bolts, screws, rivets, and on metal and plastic studs





REGD. Spire TENSION LOCK Nuts



THE ONLY ONE PIECE FASTENING DEVICE WITH A DOUBLE LOCK

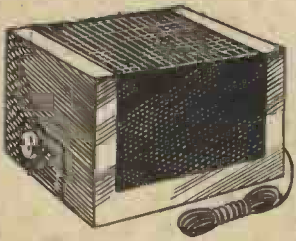
A PRODUCT OF THE SIMMONDS GROUP

SIMMONDS AEROCESSORIES LTD
GREAT WEST ROAD, LONDON.

● FOR RADIO **LONDON CENTRAL RADIO STORES** BARGAINS ●

CLARKE'S ATLAS A.C. to D.C. CONVERTERS

Type R.M. 80/150

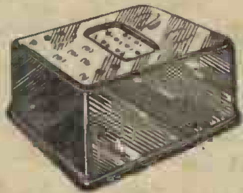


Input: 230v. A.C. 50~ Output: 80, 100, 120, 150, m.a. at 230v. D.C. Incorporating Westinghouse Metal Rectifier. In strong steel case, well ventilated. Price **5 Gns.**

Post. and packing 3/6 extra.

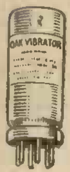
SUPREMUS H.T. BATTERY ELIMINATORS

Model E25A *for* **200-250v. A.C. 40-100~**



Tappings, 40, 60, 80, SGH, 100, SGL, 125v. These well-known H.T. Mains Supply Units are fitted in handsome bakelite cases. Here is an opportunity for battery set owners, who have A.C. mains current available, to be independent of the battery situation. Owing to post and rail conditions these are available TO CALLERS ONLY. Price **70/-**

OAK VIBRATOR UNITS



— Synchronous —

These well-known Units are fitted with 6-pin American bases. Input 6 volts. Each **15/6**

Post. & pkg. 8d. extra.

ELECTRIC SOLDERING IRONS

200/250 v. 75 watts. Post., etc., 8d. extra **12/6**

PIEZO-CRYSTAL *Hand — Table* MICROPHONES

See December issue for details. Post., etc., 2/- extra. **82/6**

EX.-GOVT. JACKS

These Jacks have powerful phosphor-bronze springs ensuring a perfect contact. Overall length, including ¼in. threaded shank, 3¼in. Supplied with nut for panel mounting. Post., etc., 3d. extra ... ... Each **3/6**

ON-OFF TOGGLE SWITCHES

Finest quality. Turn movement. 1¾in. spindle. Post., etc., 3d. extra. **2/6**

CONDENSERS with Bakelite Insulated Terminals

2.5 + 2.5 + 1 mfd. 250v., D.C. wkg. ... 6/6
2 mfd. 400v., D.C. wkg. 7/6
4 mfd. 250v., D.C. wkg. 9/6
Post. & pkg. 6d. extra.

CELESTION AMPHENOL VALVE HOLDERS

The best Quality obtainable

8-pin International Octal ... Each **1/3**

Post., etc., 3d. extra.

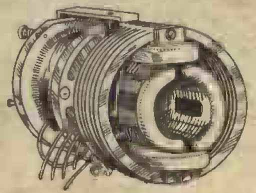
SIDE CONTACT Valve Holders

8 contacts ... ... Each **1/6**
Post., etc., 3d. extra.

T.C.C. CONDENSERS

0.1 mfd. 5,000 v., D.C. wkg. ... Each **9/6**
Post., etc., 8d. extra.

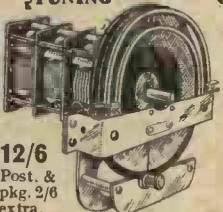
PHILIPS SCANNING & DEFLECTOR COILS



Assembled complete in metal frame, as illustrated **7/6**

Post. & pkg. 1/1 extra.

TUNING CONDENSERS



3-gang, 0.0005 mfd. without trimmers, designed for motor drive. With large diameter driving disc and reduction gear, adaptable for slow motion manual drive.

12/6 Post. & pkg. 2/6 extra.

6 PUSH-BUTTON MECHANISM only UNIT

Complete with buttons. Post., etc., 9d. extra **4/6**

SPEAKERS

CELESTION 8in. P.M. Pentode Output. New **25/6**

Post., etc., on above 2/- extra.

PHILCO 12in. Double Cone 4,000 ohms field, 5 ohms Speechcoil **5 Gns.**

Carr. 3/-, plus 5/- for packing case (returnable).

PHILCO BLEEDER RESISTANCES

In metal cans. 100, 150, 250 ohms. All 10 watts ... ... Each **2/6**
Post., etc., 3d. extra.

CHASSIS

Drilled for 9 valves, also rectangular hole 6¾ × 2¼in. Size 16¾ × 9¾ × 2in. **3/6**
Also 11¼ × 9¾ × 2¼in. and 11¼ × 7 × 2¼in. **3/6**
Post., etc., 10d. extra.

TUBULAR CONDENSERS

0.5 mfd. 500 v. wkg. **2/6**
Post., etc., 4d. extra.

See January issue for other offers

● No Pro-forma Invoices. No Price Lists ●

PHILIPS High Quality SUPER SENSITIVE P.M. SPEAKERS

These brand new speakers are fitted with concentrically mounted Hi-note Diffusers. 8½in. cone. Complete with Pentode Transformer. Price **32/6**

Post. & pkg. 2/- extra.

PHILIPS POTENTIOMETERS

Carbon: 700,000 ohms, less switch **3/6**
100,000 ohms, with 2-pole M. & B. switch **4/6**
Wire-wound: 450 ohms and 10,000 ohms **6/6**
Post. & pkg. 6d. extra.

PHILIPS CONCENTRIC SPIRAL VANE VARIABLE CONDENSERS

3-Gang 0.0005 mfd. without trimmers. As used in Philips well-known Push-Button receivers.

Price **4/6** Post. & pkg. 9d. extra.

PHILIPS WET ELECTROLYTIC CONDENSERS

50 mfd. 310v. working **9/6**
Post. & pkg. 9d. extra.

MULLARD EA50 DIODES

60 mm. × 12 mm. overall. 6.3v. heater at 15 amp. ... ... Each **10/6**
Post. & pkg. 3d. extra.

PHILIPS TRIMMER CONDENSERS

Non - drift air dielectric, 60 mmfds., suitable for S.W. work.

Price **1/3** Plus post., 3d. extra.

YAXLEY PATTERN SWITCHES

5-way, single-bank, with on-off mains switch, carrying 1 amp. at 250v., 2in. spindle with knob **5/6**
3-way single-bank, 1in. spindle with knob **2/9**
Post., etc., 6d. extra.

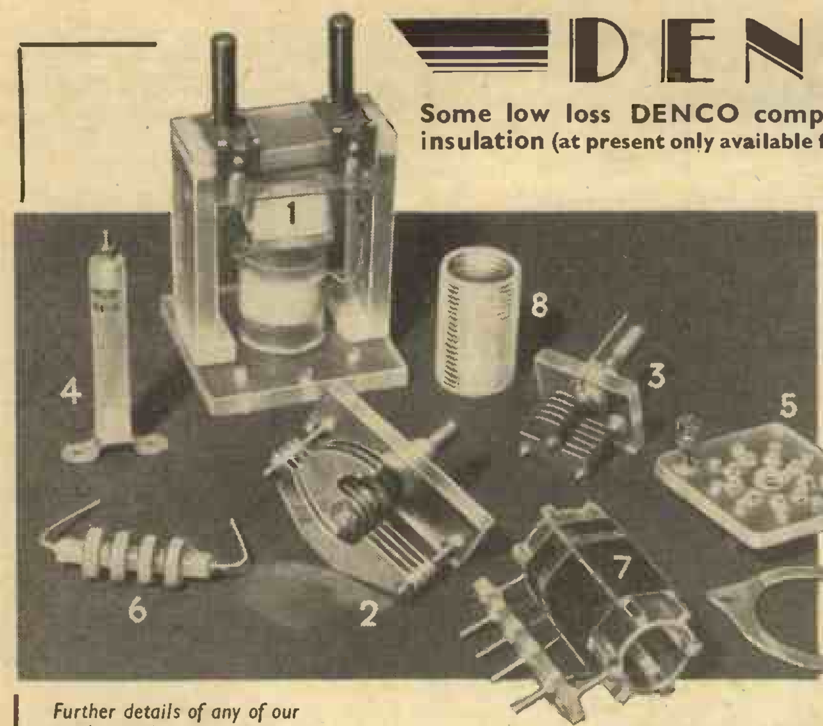
Oak Switches, 2¼in. spindle, comp. with knob.

4-way, 2-bank with connecting block ... 4/6
4-way, 2-bank 3/9
Post., etc., 6d. extra.

LONDON CENTRAL RADIO STORES, 23, LISLE ST. *GERrard 2969* **LONDON, W.C.2**

DENCO

Some low loss DENCO components, using polystyrene insulation (at present only available for Government priority orders)



1 IFT3. I.F. transformers, high Q, for 3, 5 or 10 Mc. (Square can not shown); variable coupling. **2** VCRA S.L.F. variable SW condensers in capacities from 10 to 150 pF. **3** VCRM midget variable condenser for VHF work; fixed plates measure only 1"×⅝"; in capacities from 5 to 50 pF. **4** S.O.I. 1, 2, or 3. Small stand off insulators: 1", 1½" or 2½" high. **5** VH/EF50 valve holder. **6** RFC.4. RF. choke on polystyrene rod former. **7** 4-pin receiving coils: many ranges. **8** Threaded tube formers in various diameters and t.p.i.

POLYSTYRENE: available in sheet, rod, tube, film (.001" to .01" thick) and "Denfix" low loss cement and varnish.

Further details of any of our products given on request.

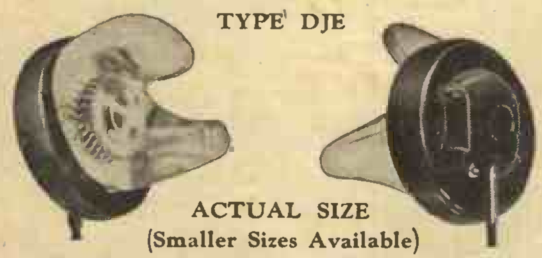
Morse Practice Oscillators; compact battery model 25/-, with valve; AC/DC mains model £4.12.6, including valves.

DENCO, Old Road, Clacton, Essex

CLACTON-ON-SEA 151

Miniature BRUSH Crystal *Earphones*

TYPE DJE



ACTUAL SIZE
(Smaller Sizes Available)

PHENOMENAL POWER SENSITIVITY
- 1 dyne per sq. cm. per 1 micro volt amp.

WEIGHS ONLY 7 GRAMMES
- Range of standard detachable mouldings

FITS INTO EAR CANAL
- Eliminates interfering sounds

EXCEPTIONALLY SMALL SIZE
- Inconspicuous and easy to wear

IDEAL FOR PORTABLE RADIO SETS

Sole Manufacturers
THE BRUSH DEVELOPMENT COMPANY
CLEVELAND, OHIO
PROMPT DELIVERIES AGAINST GOOD PRIORITIES
write for details to
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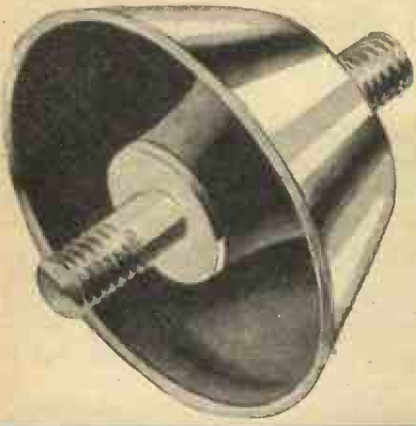
STOCKPORT
TELEPHONE: HEATONMOOR 3107

TRANSFORMER CO.

Thornley Street, Wolverhampton. *Tel.: Wolverhampton 22829*

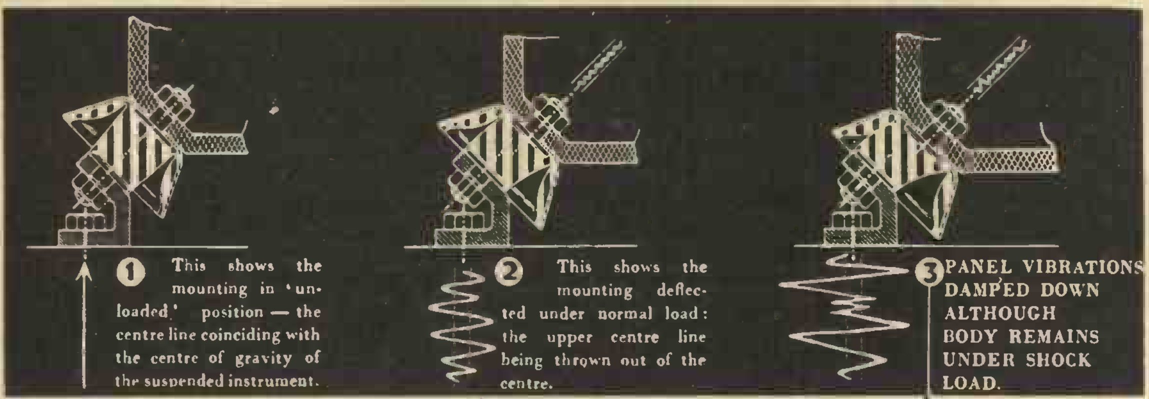
RUBBER-TO-METAL BONDING



Another very interesting problem in **VIBRATION**—and its solution.

PROBLEM: An instrument panel requires immunisation from shock arising in any or all of three dimensions.

SOLUTION:
The R.B. Mushroom Mounting Type D.T.



This shows the mountin; deflected under shock load. The upper centre line being still further thrown out of centre. You will notice the progressive 'abutment' of the rubber profile which gives a stiffening effect that increases as the deflection increases.

Here is a problem in Vibration solved by the Rubber-to-Metal Bonding Technology of Rubber Bonders Ltd.

Vibrations are represented diagrammatically and the isolating effect of the Type D.T. Mushroom Mounting is clearly seen. This mounting is proving valuable in eliminating persistent vibration or shock.

Rubber Bonders Ltd., are successful because their scientific staff deal with every problem *individually*. Why not send a typical "vibration headache" to Flexilant Works, Dunstable for cure?

FLEXILANT

A semi-technical booklet entitled "A Short Review of 'FLEXILANT' Products" is available upon enquiry.

RUBBER BONDERS LIMITED

Engineers in Rubber bonded to metal

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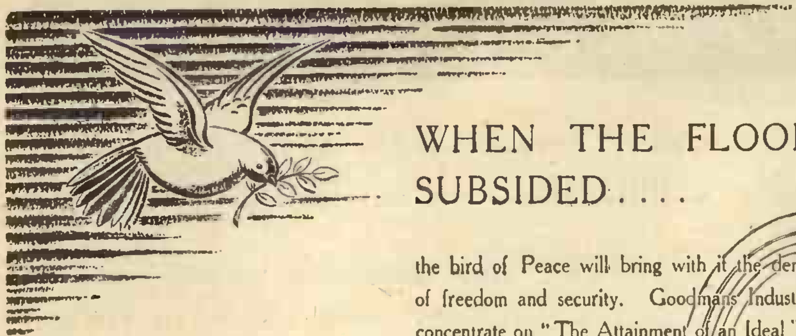
TELEGRAMS: FLEXILANT DUNSTABLE TELEPHONE: DUNSTABLE 715

R.B.9



WHEN THE FLOOD OF WAR HAS SUBSIDED....

the bird of Peace will bring with it the demand for products to assist in the enjoyment of freedom and security. Goodmans Industries then, as in pre-war days, will be able to concentrate on "The Attainment of an Ideal"—the perfect reproduction of sound.

In the meantime the whole of our organisation is devoted to the design and production of the best possible acoustic apparatus.

The best of today will in turn lead to something better still in the future, in which Goodmans Industries will maintain their reputation for establishing standards of design for high fidelity sound reproducers.

Goodmans Industries LTD.

GOODMANS INDUSTRIES LIMITED ★ LANCELOT ROAD ★ WEMBLEY ★ MIDDX.

M.R. SUPPLIES

offer from stock the following brand new **INDUSTRIAL and ELECTRO-TECHNICAL EQUIPMENT**, for which early application is essential. All prices nett cash.

HEAVY DUTY OUTPUT TRANSFORMERS for two KT66 valves in push-pull (low loaded—opt. ld. 3,500 ohms) with sec. for 7.5 and 15 ohms coils. Handling 35 watts, weight 13½ lb. Final opportunity, **72/6** (pkg. and pass. train 2/6 extra).

STEP-DOWN MAINS TRANSFORMERS. Prim. 200/250v. tapped. Sec. 12 and 17v. at full 5 amps., weight 9½ lb. For chargers, l.v. lighting, etc., **42/6** (pkg. and post 1/6).

SUPERIOR BELL TRANSFORMERS. Prim. 200/250v. Sec. tapped 3, 5 and 8v. at 1 amp. Porcelain base with bakelite cover, fully fused on prim. and sec., complying with recommendations, **13/6**.

MEASURING INSTRUMENTS by Weston, Ferranti, Elliott, etc. (We cannot undertake to select particular maker.) Housing 2½in. square flange, flush panel mtg. requiring 2in. hole, black bakelite, back terminals. **M/COIL MILLIAMMETERS,** 0/150 m.a. only left, **32/6**. **THERMO-COUPLE AMMETERS** for any frequency and D.C., same style as above, 0/2.5 amp. and 0/3.5 amp. (two models), either **39/6**. These meters are second-hand ex Govt., in good condition and lab. tested, and guaranteed accurate.

RELAYS. Londex with 200/250v. A.C. coil (2va) and 2-pole change over 6-amp. switch, size approx. 2½in. by 2½in., silver contacts, **42/6**. Also U.S.A. model, 4/12v., D.C. coil, with single pole make switch, **8/6**.

VARIABLE RESISTANCES, 100 watts, fully enclosed, approx. 3in. by 3in. by 6½in. in following range, 4 ohms 5 amps., 10 ohms 3 amps., 50 ohms 1.5 amp., 100 ohms 1 amp., 200 ohms 0.7 amp., and 400 ohms 0.5 amp., any one **21/-**. Whole range in stock at time of going to press.

TOGGLE PRESSES (by S.T.C.). Quick acting and accurate bench model exerting 1½ tons pressure. Height 32in., weight 130 lb. Many advantages over fly press—space saving, rapidity and ease of operation. A further small supply for immediate delivery from stock. Many already supplied to most important users. Price £30 nett, carriage forward.

INDUSTRIAL ELECTRIC SOLDERING IRONS. Best makes from stock. S.T.C., all voltages, 100/110, 200/220 and 230/250, 75 watt with 4in. pointed bit, **21/-** (spare elements, any voltage, 6/-). Same make, 150 watt with massive flat bit, **32/6** (elements **7/6**). Also Acru, popular bent model with interchangeable bit, good general purpose bit supplied, **28/6** (100 watt). Spare bits, 4/- each. Leave choice to us.

PIEZO-CRYSTAL MICROPHONES (Rothermel-Brush). Just arrived, 400 only. Special miniature model only 1⅜in. dia. lightweight. Made for deaf-aid but suitable for all purposes, having a fine frequency response. In aluminium housing with short screened lead but no front grille, **27/6**. Also continuation of our well-known offer of well-housed, knuckle jointed, high fidelity mikes of same make, response level to 8,000 c/s., ¼in. (26) mounting boss, as supplied to most important users, **72/6**. **FLOOR STANDS,** to suit latter model, collapsible, 2ft. to 5ft. 6in., chromium plated, **37/6**.

G.E.C. PUBLIC ADDRESS SPEAKERS. Industrial model in 9in. drum, handling 5 watts, with transformer, **45/-**. 10 watt **PROJECTOR SPEAKERS** with P.M. Unit with built-in line transf. and 42in. metal Horn, **£10.5.0.** (Carr. 7/6 extra.)

Please estimate postage where not stated; any excess refunded.

M.R. SUPPLIES, 68, New Oxford Street, London, W.C.1.

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Specialists in

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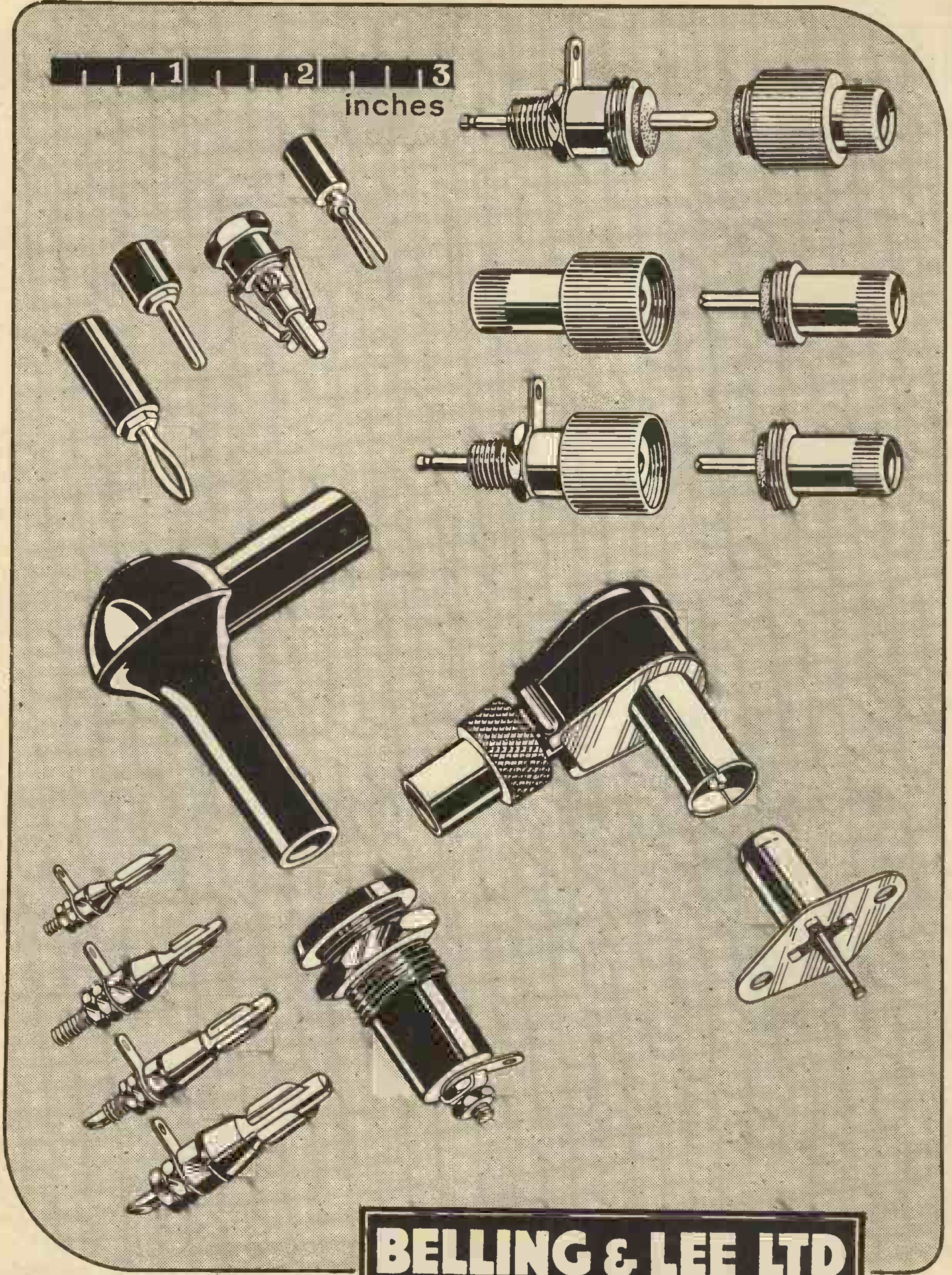

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ARE THE DESTINIES OF TOMORROW . . .

Upon the shape of events to-day, and every day, depend the fortunes of the future. Through to-day's endeavour in research and industry already are discerned new and greater benefits for the coming era.

The name Marconi, since the earliest days of Radio, stands foremost in the field of communication; and Marconi Instruments Ltd., in the specialised work of instrument production, maintain this pride of place.

Over the horizon we see a golden age for scientist and technician. As always to the fore—but in who knows what new guise?—will be the name Marconi; —accuracy and reliability, then as now, the standard by which we judge ourselves.

Meanwhile, we concentrate on the business of to-day and endeavour to meet fully all requirements.

COMMUNICATION TESTING EQUIPMENT • INDUSTRIAL, MEDICAL AND LABORATORY APPARATUS

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WHARFEDALE

GOLDEN CHASSIS

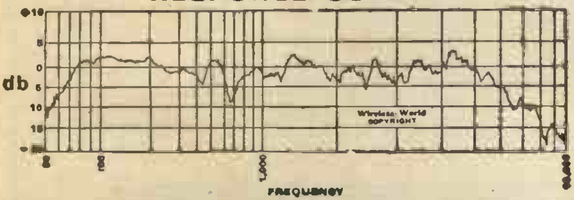
As supplied to the B.B.C.

Speech Coil 2-3 ohms: Flux Density 10,000 lines, 7-8 watts • 10" Chassis

Although we are making more than ever of this excellent Loud Speaker the output is absorbed by the B.B.C. and other Priority users.

PRICE **70/-**
(Less Transformer)

RESPONSE CURVE



WHARFEDALE WIRELESS WORKS
SOLE PROPRIETOR : D. E. BRIGGS
HUTCHINSON LANE, BRIGHOUSE, YORKS.
'PHONE : BRIGHOUSE 50. 'GRAMS : "WHARFDEL."

SPECIAL ANNOUNCEMENT ! ! !

American Lease-Lend
RADIO VALVES

International Majestic Radio Corporation Ltd. have been appointed Official Distributors of these valves, specially released by the Board of Trade.

Owners of Receivers requiring replacements are invited to obtain our list of types available. All prices controlled by Government Order.

Our allocation is very comprehensive, but there will be a large call, so place your order immediately to avoid disappointment.

Any order guaranteed to be for genuine Maintenance-Replacement will be delivered.

Write for List, and please enclose stamped, addressed envelope.

INTERNATIONAL MAJESTIC RADIO CORPORATION LTD.
6 Angel House, Pentonville Road, London, N.I.

WHY ERSIN MULTICORE

the Solder wire with 3 cores of non-corrosive ERSIN FLUX is preferred by the majority of firms manufacturing the best radio and electrical equipment under Government Contracts.

WHY THEY USE CORED SOLDER

Cored solder is in the form of a wire or tube containing one or more cores of flux. Its principal advantages over stick solder and a separate flux are :

(a) it obviates need for separate fluxing (b) if the correct proportion of flux is contained in cored solder wire the correct amount is automatically applied to the joint when the solder wire is melted. This is important in wartime when unskilled labour is employed.

WHY THEY PREFER MULTICORE SOLDER. 3 Cores—Easier Melting

Multicore Solder wire contains 3 cores of flux to ensure ffux continuity. In Multicore there Is always sufficient proportion of flux to solder. If only two cores were filled with flux, satisfactory joints are obtained. In practice, the care with which Multicore Solder is made means that there are always 3 cores of flux evenly distributed over the cross section of the solder, so making thinner solder walls than single cored solder, thus giving more rapid melting and speeding up soldering.

ERSIN FLUX

For soldering radio and electrical equipment non-corrosive flux should be employed. For this reason either pure resin is specified by Government Departments as the flux to be used, or the flux residue must be pure resin. Resin is a comparatively non-active flux and gives poor results on oxidised, dirty or "difficult" surfaces such as nickel. The flux in the cores of Multicore is "Ersin"—a pure, high-grade resin subjected to chemical process to increase its fluxing action without impairing its non-corrosive and protective properties. The activating agent added by this process is dissipated during the soldering operation and the flux residue is pure resin. Ersin Multicore Solder is approved by A.I.D., G.P.O., and other Ministries where resin cored solder is specified.

PRACTICAL SOLDERING TEST OF FLUXES

The illustration shows the result of a practical test made using nickel-plated spade tags and bare copper braid. The parts were heated in air to 250° C, and to identical specimens were applied ½" lengths of 14 S.W.G. 40/60 solder. To sample A, single cored solder with resin flux was applied. The solder fused only at point of contact without spreading. A dry joint resulted, having poor mechanical strength and high electrical resistance. To sample B, Ersin Multicore Solder was applied, and the solder spread evenly over both nickel and copper surfaces, giving a sound mechanical and electrical joint.

ECONOMY OF USING ERSIN MULTICORE SOLDER

The initial cost of Ersin Multicore Solder per lb. or per cwt. when compared with stick solder is greater. Ordinary solder involves only melting and casting, whereas high chemical skill is required for the manufacture of the Ersin flux and engineering skill for the Multicore Solder incorporating the 3 cores of Ersin Flux. However, for the majority of soldering processes in electrical and radio equipment Multicore Solder will show a considerable saving in cost, both in material and labour time, as compared either with stick solder or single cored solder. Cored solder ensures that the solder and flux are put just where they are required, and by choice of suitable gauge, economy in use of material is obtained. The quick wetting of the Ersin flux as compared with resin flux in single core resin solder ensures that with the correct temperature and reasonably clean surface, immediate alloying will be obtained, and no portions of solder will drop off the job and be wasted. Even an unskilled worker, provided with irons of correct temperature, is able to use every inch of Multicore Solder without waste.

ALLOYS

Soft solders are made in various alloys of tin and lead, the tin content usually being specified first, i.e. 40/60 alloy means an alloy containining 40% tin and 60% lead. The need for conserving tin has led the Government to restrict the proportion of tin in solders of all kinds. Thus, the highest tin content permitted for Government contracts without a special licence is 45/55 alloy. The radio and electrical industry previously used large quantities of 60/40 alloy, and lowering of tin content has meant that the melting point of the solder has risen. The chart below gives approximate melting points and recommended bit temperatures.

ALLOY Tin Lead	Equivalent B.S. Grade	Solidus C.°	Liquidus C.°	Recommended bit Temperature C.°
45/55	M	183°	227°	267°
40/60	C	183°	238°	278°
30/70	D	183°	257°	297°
18.5/81.5	N	187°	277°	317°

VIRGIN METALS — ANTIMONY FREE

The wider use of zinc plated components in radio and electrical equipment has made it advantageous to use solder which is antimony free, and thus Multicore Solder is now made from virgin metals to B.S. Specification 219/1942 but without the antimony content.

IMPORTANCE OF CORRECT GAUGE

Ersin Multicore Solder Wire is made in gauges from 10 S.W.G. (.128"—3.251 m/ms) to 22 S.W.G. (.028"—.711 m/ms). The choice of a suitable gauge for the majority of the soldering undertaken by a manufacturer results in considerable saving. Many firms previously using 14 S.W.G. have found they can save approximately 33⅓%, or even more by using 16 S.W.G. The table gives the approximate lengths per lb. in feet of Ersin Multicore Solder in a representative alloy, 40/60.

S.W.G.	10	13	14	16	18	22
Feet per lb.	23	44.5	58.9	92.1	163.5	481

CORRECT SOLDERING TECHNIQUE

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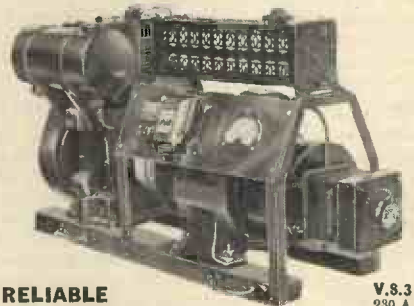

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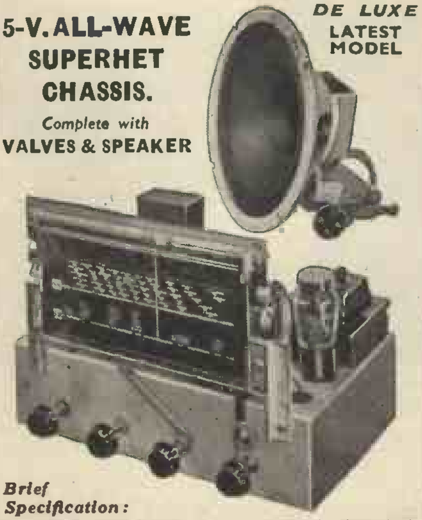

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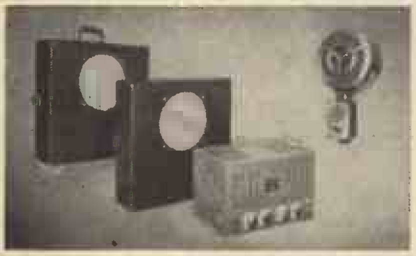

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Wireless World

Radio • Electronics • Electro-Acoustics

32nd YEAR OF PUBLICATION

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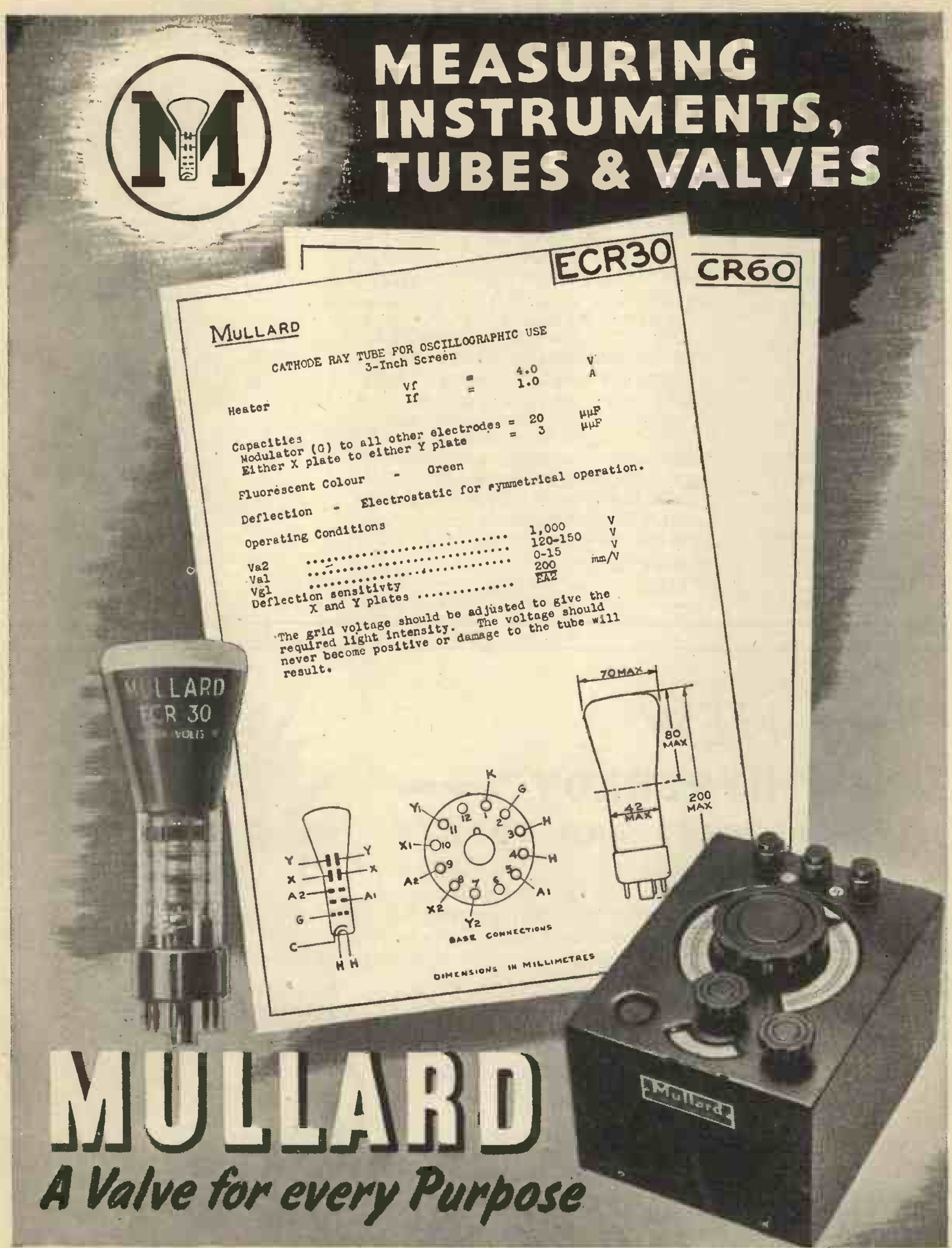

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Wireless World

Radio • Electronics • Electro-Acoustics

Vol. XLIX. No. 2 FEBRUARY 1943 Price 1s. 3d.

Technical Standards for Operators

Should They be Raised ?

A SOMEWHAT mixed reception has been accorded to an article, published in our last issue, in which the author pleaded for higher technical standards in the training of radio officers of the Merchant Navy, and also for a higher level in the qualifying examinations for the various grades of their Certificates of Proficiency, which are issued by the Postmaster-General.

As is natural, any proposal of this nature is bound to meet with some opposition, but in this case most of the objections are on the grounds not so much that a raising of standards is undesirable, but that it is impracticable, or, more precisely, inconsistent, with the pay and prospects of the service. Indeed, those who approve our contributor's proposals generally add some proviso to the effect that higher qualifications call for higher remuneration.

P.M.G's. Examination Papers

Considerations of a set of papers for the Postmaster-General's examination held just before the war confirms the opinion that, even if the standard was sufficiently high to ensure efficient operation and maintenance of typical marine apparatus, it did not call for that fuller knowledge of fundamental principles that will certainly be necessary for those who are to operate the more highly specialised gear that we all expect will come into use when peace returns. No very deep insight into basic principles was called for in answering the questions in either the Electricity and Magnetism or Technical Wireless Telegraphy papers. If, as our contributor asserted last month, at least half the questions could be predicted before the examination, its real effectiveness was still further lowered, as there was an incentive to introduce the evils of "cramming" in its worst form.

What seems to be the germ of an excellent idea is contained in a letter printed elsewhere in this issue. Our correspondent urges that a higher-grade certificate might be issued on condition that the qualifying examination reaches a standard acceptable as a technical qualification by competent examining bodies other than the Post Office. This would mean that such a certificate would serve as proof of technical training and knowledge to employers ashore in the event of the marine radio officer deciding to change the nature of his work.

There is much to be said in favour of this suggestion. Even allowing for the natural tendency towards increased specialisation, it is a matter for regret that the various branches of wireless should have divided themselves up into almost completely water-tight compartments, with comparatively few interchanges of personnel and ideas between one and another. Wireless is not yet entirely a science; it is still something of an art. The wireless operator has an unrivalled opportunity of obtaining a valuable insight into the less tangible factors involved in radio communication, especially if his basic training has been deep enough to allow him to profit from his experience. In our view, it is all to the good that a fair proportion of the technicians of the future—in all branches of wireless—should be recruited from those who have had experience of wireless operating. It would seem that in the U.S.A. the practice of using this branch as a stepping-stone to positions of greater technical responsibility is much more common than in this country.

Fuller Government Control ?

Another suggestion made in our Correspondence columns this month is that the marine radio officer should be employed by the Post Office. One of the admitted disabilities of his calling at present is that he has to please too many masters, whose interests do not necessarily coincide. Under the existing system he is responsible to the operating company (his employers), to the Master of his ship, and, in so far as observance of the Radiotelegraph Service Regulations is concerned, to the Postmaster-General. The proposed scheme would reduce this handicap, but it raises issues that can only be fully discussed in relation to the general social and economic framework within which we shall live after the war.

HEARING-AID PROBLEMS

The Biological Approach

By

A. E. RITCHIE,

M.A., B.Sc., M.B., Ch.B.

A description of the mechanism of hearing, and of the causes of its deterioration, written primarily for those who are beginning to interest themselves in the alleviation of deafness by electro-acoustic means. The author also touches on the question of mass-produced hearing-aids and their distribution to the deaf

THE question of mass-producing hearing-aids of the valve-amplifier type is not one that can be considered purely from the electro-acoustic angle. The delicacy and complexity of the auditory apparatus renders it liable to derangements of various forms, and it is the intention of this article to indicate briefly the main fields of utility for aids to hearing.

The auditory apparatus comprises four main parts, schematically shown in Fig. 1.

(1) The outer ear, collecting and directing the compression waves of sound on to the ear-drum, a membrane sensibly aperiodic over the frequency spectrum of hearing.

(2) The middle ear, comprising an air-filled chamber with a chain of tiny bones or ossicles, which transfer the vibrations of the ear-drum to a further membrane on the inner side. The mechanical layout of the ossicles is such as to be optimal for transforming vibrations in air at the ear-drum to vibrations in fluid at the inner side of the inner membrane. To compensate for changes in air pressure, due to temperature or height, the middle ear cavity is provided with a release passage known as the Eustachian tube.

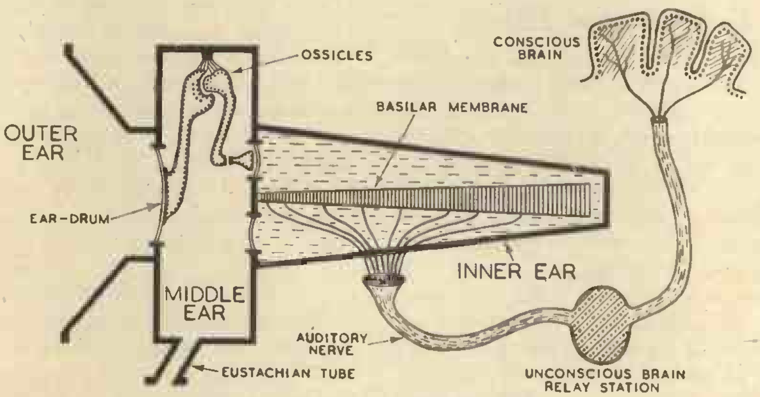


Fig. 1.—The mechanism of hearing.

(3) The inner ear, which is filled with fluid, has suspended in it a relatively long and narrow membrane made up of parallel fibres arranged transversely to the long axis of the membrane. The generally accepted theory of hearing compares this so-called basilar membrane to a miniature harp, or series of piano strings; the transverse fibres are graded from one end to the other both in length and tension, and, although very minute in comparison with harp strings, are immersed in fluid, which greatly lowers their natural frequency of vibration. Each one (or each adjacent few, for they are not quite individually free to move) may be set into mechanical resonance by a note of the appropriate frequency being applied to the outer ear. The selective resonance effect of these tuned fibres is very sharp, and where the sound heard is a complex one we must assume that the fibres corresponding to the sinusoidal components of the complex sound are in simultaneous resonance, although they may be separated by an intervening inactive portion of the basilar membrane. Microscopic and experimental evidence is in general agreement with the above conception.

(4) So far, the auditory apparatus consists of mechanical devices for translating and analysing sound waves into physical movement, represented for each component tone by the resonant vibration of the appropriate basilar membrane fibres. This fibre movement stimulates the connection of the auditory nerve which corresponds to the fibre; speaking broadly, each membrane fibre has its own insulated strand in the nerve, which collects the strands into a cable and passes them on into the brain. In the brain the auditory pathway is extremely involved, with several relay stations before the nerve impulses are recorded in the conscious part of the brain. It is important to realise for electro-acoustic work that the impulses in the auditory nerve are not electrical replicas of the sound waves applied; the general belief now is that the mechanism is not to be compared to a microphone (which transforms sound waves into electrical energy of similar form), but rather to a multiple indicator in which movement of one of the components closes an electrical circuit attached to that component only.

With regard to the electro-acoustic standards of the ear, the audio-frequency spectrum for young and healthy persons may be taken as from 20-20,000 c/s.

This extreme range is by no means essential for the clear understanding of ordinary speech, which is the criterion usually accepted as the minimum desirable for a good deaf-aid. Experiments with cut-off filters have shown that utilisation of the range 250-8,000 c/s results in only a 2 per cent. loss of intelligibility. Reduction of the upper limit below about 4,000 c/s results in serious loss of clarity in the more sibilant letters, whose waveform contains a high proportion of high harmonics. At the lower end of the scale, the ear possesses one peculiar property, made use of in telephone design; due to asymmetry in the ear-drum sounds of more than average volume produce a rectification effect, and the ear supplied with harmonics alone is able to reconstitute a bass fundamental to a remarkable degree, even if that fundamental were completely filtered off before striking the outer ear. This property, of course, does not apply to noises where the higher components are not true harmonics; the fundamental tone of piano or 'cello will be recreated to a greater extent than that of drums or xylophones. It is a very valuable phenomenon from the hearing-aid point of view, in that the majority of aids can take advantage of reduced size and weight implied by limiting the lower frequency reproduction to 200 c/s.

The sensitivity of the ear to volume is greatly dependent on frequency, with a maximum sensitivity in the region of 2,000 c/s. The threshold for all other tones is very much higher. At the other end of the intensity scale there is a definite biological limit to the amount of sound that the ear will stand; intensities exceeding that produce discomfort, pain, and ultimately damage to the inner ear and nervous mechanism. This threshold intensity is also dependent on frequency.

Causes of Deafness

The possible sites of damage causing deafness may be considered from the above explanation and diagram. Conduction of sound may be impaired in the outer ear by blockage or perforation of the eardrum; in the middle ear by stiffening of the joints of the ossicles, by pressure developing through obstruction to the release tube, by inflammation and swelling of the soft lining of the middle ear cavity, or, not uncommonly, by loss of movement at the inner membrane of the inner ear.

In such conditions localised to the outer or middle ear, the analytical powers of the inner ear and their registration in consciousness remain unimpaired; and although the normal path of vibration conduction is not available, the use of bone-conduction, whereby the skull bones transmit the vibrations directly to the inner ear, is still possible, though less efficient. This provides the hearing-aid designer with the problem of producing an output device which will work when tightly applied to the bones of the skull.

Damage to the inner ear may be local or widespread. Portions of the basilar membrane may degenerate if subjected to continual strong stimulation of restricted frequency, as occurs in some of the noisy occupations such as boiler-making. In many cases of congenital deafness the inner ear is partially or wholly absent. Accidental damage may injure the inner ear, and a number of pathological processes cause its progressive deterioration in whole or in part. In the case of defects in the basilar membrane, the hearing-aid problem is quite different, for in such instances the resonant machinery is destroyed, and no amount of amplification conducted either through air or bone, can produce the sensation of the missing tones in the absence of the mechanical transformer. Damage to the auditory pathway may occur in the course of the auditory nerve, in the relay centres of the brain, or in the conscious part of the brain itself. On account of the inaccessibility of the auditory apparatus as a whole, and its complexity, the tracking down of the cause producing the damage in any of these portions is a matter of the most refined diagnosis and long experience.

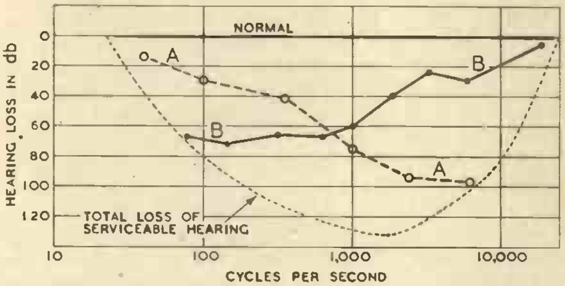


Fig. 2.—Typical audiometer curves for two types of deafness.

Investigation of the frequency spectra of various forms of deafness can be done with precision with various types of audiometer. Elaborate precautions have to be taken in regard to the exclusion of outside noises, which are liable to distort the true spectrum. Speaking generally, defects in conduction tend to depress the low-frequency end of the scale (Fig. 2, curve B), whereas one of the common types of damage to the basilar membrane results in a loss of the higher notes (Fig. 2, curve A).

Knowing an individual's sensitivity in this way, a good hearing aid ought readily to be adjustable to have a compensatory rising or falling characteristic as the case might demand, and the production of such an aid with a really wide range of tone control would be of the greatest value. It is not absolutely necessary to employ an audiometer; in careful and well-instructed hands a good set of tuning-forks can give much of the necessary information, though precautions about external noise are even more necessary in this case. There are one or two standardised speech tests which if employed intelligently can give vital practical information. Some of the correspondents whose letters have appeared in *Wireless World* have raised the question as to whether a maladjusted aid can do damage without the user being aware of discomfort. There is no doubt that damage can be done to the basilar membrane by continued stimulation at an intensity considerably below the level of discomfort, but the possibility of this in practice is not very likely, with a good instrument, as it represents a very decided peak in the spectrum in a region to which the patient must necessarily be sensitive, and the majority of deaf persons are very intolerant of this, as of excessive background noise and cracklings. There are exceptions to this general finding, but the great majority of hearing-aid users could probably safely be left to adjust the tone-controlling device for themselves.

Medical Diagnosis

But that is by no means the whole tale. The basic biological argument against the mass-distribution of deaf aids is not that the aid may do damage, but that the possible resort to the aid without systematic medical examination may allow a pathological process to progress beyond repair, while early detection might have the possibility of arrest or cure. This is not the place to discuss pathology, but one must bear in mind that the most precise

Hearing Aid Problems—

audiometer curve tells only the result of the damage and not the underlying cause. A great number of the conditions causing deafness are progressive; some are not obviously connected with the air, but are reflections of some generalised disorder, and the correct diagnosis is often dependent on a lifetime of specialised experience in otology.

It has been suggested that wireless technicians might well be trained to "fit" deaf persons with hearing aids, and the term "otician" has been used to describe those so trained. This suggestion may have been prompted by the analogy of the optician. It is not altogether a sound analogy. The majority of the refractive errors measured and corrected by the trained optician are relatively superficial and stable in character, and are more accessible to examination. They correspond rather to the hearing variations in acuity level of from plus to minus 10 db. which are found in average persons, but which in everyday life go uncorrected because we do not use the ear normally for the fine discrimination that we require from the eye under modern conditions. The basic pathology is widely different, and the refractive errors tend to be much less progressive than many of the common causes of deafness. Moreover, one must remember that many deaf persons will not be benefited at all by the use of aids. The "otician" may, indeed, if he is doubtful as to the cause of the deafness, recommend the client to seek medical advice; the difficulty is that the honest "otician," despite audiometer or fork tests, will nearly always be doubtful as to the cause, without a knowledge of which no form of treatment, hearing-aid or anything else, can wisely be employed.

Potential Dangers

The mass-distribution project bears this potential danger, all too common in medical matters—palliative self-treatment until some progressive damage has gone too far. The production in quantity of a standardised device, of knowledgeable design, reasonable price, and flexibility in adjustment of tone and intensity range, is quite another matter. A medical diagnosis made, and the possibility of hearing-aid use established, the wireless specialist is the competent authority to supply, maintain and adjust such a device, and service of this nature would be of the greatest value both to the otologist and to great numbers of deaf persons.

Those who wish to read more about the subject of hearing are referred to the following books and articles:—

Beatty, R. T., "Hearing in Man and Animals." Bell, London, 1932.

Beatty, R. T., "How We Hear." *Wireless World*, Dec. 11th and 18th, 1929.

Fletcher, H., "Speech and Hearing." Macmillan, London, 1929.

GRAMOPHONE NEEDLE POINTS

Blunt or Sharp?

IN our last issue we published an article dealing with the use of gramophone points of large radius. John Brierley, who recently described the construction of a moving-coil pickup in this journal, comments as follows on this subject:—

"I do not think it is quite correct to say that it has been generally accepted that for optimum results the tip of the reproducing point should be of as small radius as possible. That is not altogether a reasonable conclusion unless the cutting stylus is included in the specification as well.

"The downward pressure of a pickup is often determined by calculating the maximum force between the point and the groove wall and assuming, for practical purposes, that the groove wall is inclined at an angle of about 45° to the vertical; this latter assumption is most important and if it is effectively erroneous the result can be rather similar to that obtained by having an insufficient downward pressure. For instance, when the point reaches to the bottom of the groove (or nearly so) it is most unlikely, in the average case, that it will at the same time make good contact with the upper part of the groove wall. A little consideration will show that unless the downward pressure is infinitely large, a certain amount of lost motion must occur, and, owing to various considerations, its effect increases with frequency. It is noteworthy that matters are improved by recording at a *higher* level—providing, of course, that the downward pressure of the pickup is proportionately increased.

"My experiments with various shapes and sizes of points have had to be carried out with points made in comparatively soft steel, which rendered exact observation rather difficult, but two conclusions were clear:—

"(1) That for the reproduction of the higher frequencies with a minimum of "fizziness" it is absolutely essential that the point should make good contact with the upper part of the groove wall.

"(2) Needle and record wear increases very rapidly as the contact with the bottom of the groove is reduced.

"For optimum results, in so far as high-quality reproduction is concerned, at any rate, it would seem that the point should fit the groove at the bottom as well as the sides, but preference should be given to good contact with the upper part of the sides. At the same time, if this is carried too far, the fact should not be ignored that considerably greater wear will result."

OUR COVER

The cover illustration this month shows 35- and 31-metre aerials used for the B.B.C. Oversea Service. On the right is part of a 25-metre aerial with reflector for Africa.

LATE NIKOLA TESLA

WE record with regret the death in New York on January 6th of Dr. Nikola Tesla, whose name will go down to posterity because of his early experiments in the wireless transmission of electrical energy, to which reference was recently made by one of our Brains Trustees.

Born on the Austro-Hungarian border in 1857, he was educated at Prague, and at the age of 27 went to America and soon afterwards adopted American citizenship. For some time he was employed in the Edison works, but his experiments in the generation of alternating currents by the rotating field principle, which conflicted with Edison's theory of direct current, necessitated his leaving.

In the non-wireless field Tesla is best known for his work on high-voltage discharges and for his invention of the "Tesla coil."

Electromagnetic Fields in Radio—1

FARADAY-MAXWELL BASIS

By

MARTIN JOHNSON

D.Sc.

IT is hoped in this and subsequent articles to build a bridge between two attitudes of mind which have often been disastrously separated. On the one side is the familiarity with circuits and apparatus accompanying the radio experimenter's skill at controlling electron streams; on the other side is the familiarity with theoretical operations upon electric and magnetic vectors, claimed by physicists and engineers whose training has included differential equations. The self-taught experimenter tends to feel debarred from exploring the ultimate reasons why his apparatus should work, because the electromagnetic field cannot be discussed without advanced mathematics. We do not propose here to shirk all the mathematics, but to attempt the novel experiment of facing it and explaining every stage of it in physical terms accessible without any previous formal training. We believe that the use of mathematics as a valuable and even essential language in radio need not remain a sealed prerogative of the academic or professional, and that the subject can be "started from scratch" and carried up to the point at which much of the matter in standard books and papers on electromagnetism becomes readable.

What is a Field?—By "field" we shall imply the property of space which can be detected and measured in terms of the force felt by some test-charge, the nature of the field depending on whether the charge is stationary or in motion. The test-charge might reasonably be a single electron but has usually been taken as a "unit" charge. The size of this unit is derived from the mechanical measure of the force it experiences at a given distance from a similar charge, so that "field" is ultimately describable in mechanical terms. This is convenient because the practical use of an electric field is so often its exploitation as a working mechanism in dynamos and motors, although in radio it serves for communication of intelligence rather than of power. Our fields are analogous to the gravitational field which decides the weight and free fall of all material bodies, though with a difference, since we can alter electric and magnetic fields by redistributing the molecular charges in a body, while for gravitation we can only move about bulk masses without altering their properties by any atomic adjustment.

In radio the field of importance is the electromagnetic, and it is unfortunate that much of technical instruction has pictured more readily the electrostatic field around fixed charges and the magnetostatic field around magnetic poles. Actually, isolated poles do not occur, though it is often convenient to imagine a magnetic field as measurable in terms of the force on a fictitious unit pole just as an electric field is "felt" by a unit charge: the main line of our argument, however, will be to regard magnetism as due to the motion of electricity, a change in location of electric charge producing "magnetic" effects and a change in magnetic intensity producing or "inducing" EMF and hence currents.

Force experienced by a moving charge in a magnetic field.—Radio experimenters are more familiar with a unidirectional beam of electrons than are most official students of science: Fig. 1 would fit any device such as a cathode ray tube which provides a stream of negative charges each of magnitude e moving with velocity v. This velocity will be given by the driving voltage V since the kinetic energy of a mass m at velocity v is $\frac{1}{2}mv^2$ and can be equated to a loss of potential energy eV. Then if a magnetic field of strength H, for instance, across the poles of a permanent magnet, is perpendicular to the stream, each charge as it moves will find itself deflected by a force F perpendicular to its original motion and to H. In our diagram it bends up or down according to the direction of H to right or left. Then the fundamental connection between electricity and magnetism can be expressed by "F is proportional to the product $e\,v\,$H."

The proportionality factor covers the choice of units on which the quantities are measured.

Electric and Electromagnetic Units and the Velocity "c."—(i) The above relationship may be made the basis of an *electromagnetic* unit of charge, by turning the proportionality into an equality, thus $F = e\,v\,H$.

The unit then becomes the charge which at a speed of 1 cm. per sec. perpendicular to a field of unit strength (the Gauss) experiences a force of 1 dyne, the absolute mechanical unit of force. (ii) Alternatively, if the *electrostatic* unit of charge is used for e, that is, the charge which at 1 cm. is repelled with a force of one dyne by a similar charge, then $F = \frac{e\,v\,H}{c}$ where

$$c = \frac{\text{electromagnetic unit of charge (e.m.u.)}}{\text{electrostatic unit of charge (e.s.u.)}}$$

This ratio is worth scrutinising as to its "dimensions," that is to say, the extent to which Length, Mass, and Time, enter into it as multiplying or dividing factors or powers. Since e in e.s.u. is defined through a force, while a unit magnetic pole (p) may similarly be defined as repelling a companion pole, e and p have similar dimensions. But E (an electric

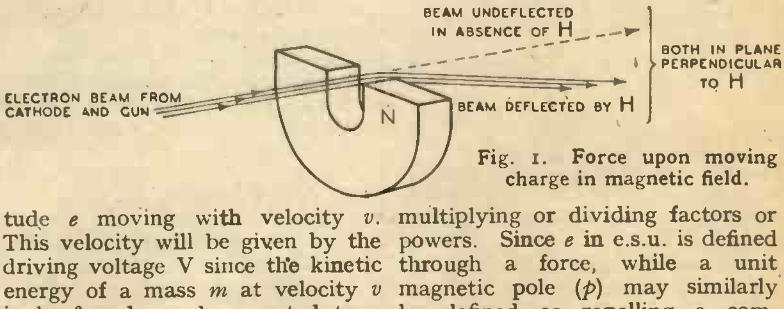
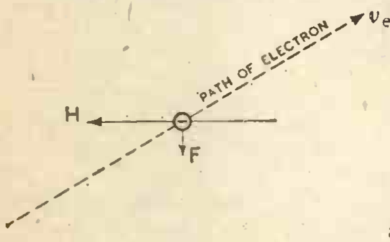


Fig. 1. Force upon moving charge in magnetic field.

Electromagnetic Field—

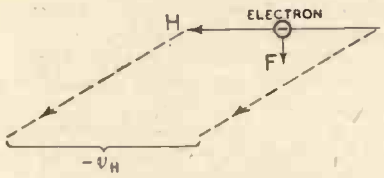
field) and H are also interrelated through similarity of dimensions. Hence eH has "force" dimensions as surely as eE. Therefore, in the above equation, the two factors v and c together make no further contribution to the dimensions, so that c must be of the same dimensions as a velocity since v is a velocity.

This provides the first hint that there must be some quantity, of the dimensions of a velocity, connecting electric and magnetic phenomena: actually it turns out that "c" is, in fact, the speed of free-space propagation of radio waves, light, X-rays, and all other manifestations of field motion.



(a) CHARGE MOVING PAST STATIONARY MAGNETIC FIELD

Fig. 2. Two possibilities of relative motion between charge and magnetic field.



(b) MAGNETIC FIELD MOVING PAST STATIONARY CHARGE

Moving Magnetic Field and Moving Electric Field.—A feature of modern science is that *relative* motion is the only sort which has physical significance, so that to move the magnet backwards along a stationary column of charge would have the same effect as to let the cathode ray traverse the magnetic field. If the velocity of the magnet and its field is v_H and that of the charge is v_e, forward motion of the one is equivalent to backward motion of the other (Fig. 2). The equation becomes, with this reversal of sign,

$$F = \frac{1}{c} e\, v_e\, H = -\frac{1}{c} e\, v_H\, H$$

But F/e defines an electrostatic field intensity E, so that

$$E = -\frac{v_H}{c} H$$

This is a way of stating the remarkable fact that a charge "feels" the *moving* magnetic field as an electric field.

Electrostatic and magnetostatic fields both depend upon the inverse square of distance from their source, the magnetic instance involving the rather fictitious "pole strength p" justified by analogy with charge e, so that

$$H = \frac{p}{r^2} \qquad E = \frac{e}{r^2}$$

If the fields are orientated so that the distance r from pole or charge is perpendicular to the velocity v, our law for F in terms of H becomes

$$F = \frac{1}{c} e\, v_e \frac{p}{r^2} \text{and}$$

$$F/p = H = \frac{1}{c}\left(\frac{e}{r^2}\right) v_e$$

The right-hand side is seen to include (in brackets) a term equivalent to an electric field, so that

$$H = \frac{1}{c} E\, v_e$$

Corresponding to the previous case, the pole "feels" the *moving* electric field as a magnetic field. If the charge and its accompanying electric field move together, we have therefore relations connecting fields and motions,

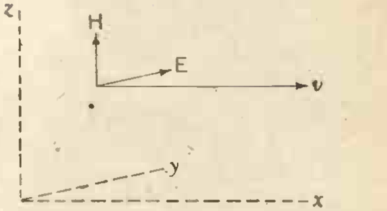
$$H = \frac{1}{c} v_E\, E \quad E = -\frac{1}{c} v_H\, H$$

Electric and Magnetic Fields mutually Generating each other and Moving Together in Radio Transmission.—For the transmission of electromagnetic effects which we call radio, the above relations give rise to one important particular case. Consider (Fig. 3) a framework of three mutually perpendicular axes x, y, z, with H in the z direction, E in the y direction, and the motion of *both* fields in the x direction with velocity v. Then the above equations become

$$H_z = \frac{v}{c} E_y \text{ and } E_y = \frac{v}{c} H_z$$

These are incompatible unless $v/c = 1$ or the speed of the moving fields as they generate each other must be equal to c, the ratio between electromagnetic and electrostatic systems of units. For an electromagnetic field to be self-propagating, the electric and magnetic components of it must be perpendicular to each other and to the direction of travel. That this is fundamentally true of radio waves is the foundation of our understanding of their nature.

Line Integral and Flux.—These connections between magnetism and electricity, derived from the facts of behaviour of a radio experimenter's cathode-ray beam, can be transformed into the more old-fashioned statements of induced voltages and the magnetic effects of currents, if we define "flux" and "line integral." We shall throughout utilise two shorthand conventions from the differential and integral calculus: firstly the symbol dx, dt, ds, etc., denoting any very small element of a "variable" x, t, s, etc. These "infinitesimals" become necessary when any physical quantity ceases to be crudely regarded as remaining constant during any given change of circumstance. "Differentiation" or obtaining the "derivative" such as dx/dt, is therefore the study of rates of change of any quantity x during its continuous dependence upon some controlling factor t. "Integration," written $\int$, is the gathering or summing up of the results which are true for the collection of infinitesimal elements in a finite stretch of any physical quantity. This is all the



PLANE CONTAINING H AND E IS PERPENDICULAR TO THE DIAGRAM

Fig. 3. Transmission of magnetic and electric fields together, with common velocity.

knowledge of calculus needed in these discussions, as multiple integrals $\iint$ and $\iiint$ may be looked on simply as denoting summing up in two or three dimensions when the variable concerns an area or a volume instead of something expressible as a line.

In these terms, if s is a path of any shape along which a test charge may travel, and ds is any infinitesimal element of the path so small that the direction is momentarily constant,

E ds = electromotive force (EMF)
= work done upon unit charge

H ds = magnetomotive force
= work done upon unit pole

For the whole path, summed over all elements however diverse in direction, a difference of potential between two, points A and B, is made up of infinitesimal contributions dϕ to an integral ϕ,

$$d\phi = -E\,ds \text{ and } \phi_A - \phi_B = \int_A^B E\,ds$$

where A and B indicate the limits of integrating.

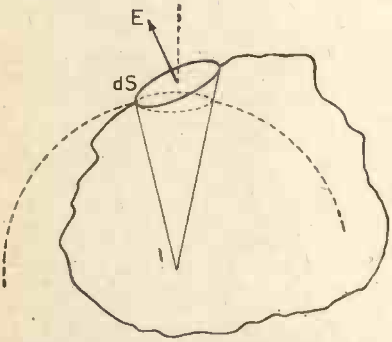


Fig. 4. Flux through an area as a product of the field's component with an element of surface from which it emerges perpendicularly.

With a circle at the foot of the integral sign, $\int_O E\,ds$ becomes the "line integral round a closed path" measurable as total work in the complete journey out and home for the electric charge when it ultimately returns to its starting point. EMF and potential difference are here analogous to water pressure driving a flow of electricity as the corresponding mechanical quantity would drive the material fluid.

We now define "flux" (electric or magnetic) as the product of E or H with an element of *area* dS (Fig. 4). The component perpendicular to each element of area is the quantity of significance. The conception applies to various "directional" quantities and in a later article will be expressed in terms of vectors; for the moment the best illustration is the flow of a fluid again. If the latter's velocity is v, the flux is vdS, and the total flux or volume of fluid passing per second through a whole area is $\iint v\,dS$, the double integral denoting the two dimensions of an area.

Faraday Induction and Maxwell Circuit Law.—The integral notation we have introduced can exhibit our fundamental connection between electricity and magnetism as the origin of all applied electrical sciences. Putting together two of our previous results,

$$E ds = -\frac{1}{c}(v_H H)ds = -\frac{1}{c}H(ds\,v_H)$$

But ds v_H, product of line element and velocity, is the area of field crossing line ds per second, so that its product in turn with H is a flux according to our definition. Hence E ds $= \frac{1}{c}\times$ magnetic flux crossing line per second.

Generalising to a finite path whose curvature if summed up in the integration, $\int_A^B E\,ds = \frac{1}{c}\times$ magnetic flux crossing path AB per second.

In terms of the particular circular integral which we defined, we have the EMF round a closed path p, $\int_O E\,ds = \frac{1}{c}\times$ magnetic flux crossing p per second (Faraday's Law). There is also the analogous law for H similar to that for E, giving by similar argument $\int_O H\,ds = \frac{1}{c}\times$ rate at which electric flux is crossing path (Maxwell's Law). The understanding of all electromagnetism, including dynamos, motors, and other machinery, rests upon these two laws.

Application to Ampere Current Law.—The laws of electromagnetism have been derived in these paragraphs from the notion of moving magnets and moving electron streams such as are used in radio. The next step is to recollect that "flux crossing a path" may be replaced by an equivalent "time rate of change of flux." For example, in the transformer of a radio set, the AC periodicity provides the fluctuation which in our simplified derivation was provided by actually moving either of the fields. This turns our equations into the more familiar form of the Faraday Law "EMF equals rate of decrease of magnetic flux." Since rates of change are expressible in the differential notation as d/dt where t is a time, the two laws become,

$$\int_O E\,ds = -\frac{1}{c}\frac{d}{dt}\iint H\,dS$$

and

$$\int_O H\,ds = \frac{1}{c}\frac{d}{dt}\iint E\,dS.$$

The double integral recalls that dS is an element of surface as ds is an element of length. For the empty vacuum through which radio is transmitted, these equations are complete; but it is useful to see where they can be extended to a field containing charges, for example in the current-carrying wire of our material circuits. In the latter case, as each charge e crosses a given area the flux over the adjacent region changes abruptly from $+2\pi e$ to $-2\pi e$. This fact can be seen by considering the angle subtended at a point by an imagined surface (Fig. 5), the maximum total angle being 4π. Alternatively the result can be accepted from the theorem of Gauss which we discuss in a later article: from either argument the total change of the contribution to the above double integral is $4\pi_e$*. An element of flux change dϕ becomes then

$$d\phi = d\iint E\,dS + 4\pi(de).$$

$$\int_O H\,ds = \frac{1}{c}\times \text{rate of flux change}$$

$$= \frac{1}{c}\frac{d\phi}{dt} = \frac{1}{c}\left(\frac{d}{dt}\iint E\,dS + 4\pi\frac{de}{dt}\right),$$

but de/dt = i, defining a current in

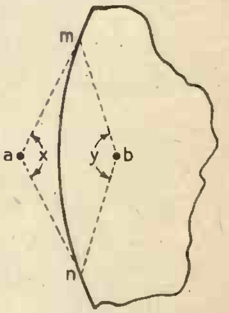


Fig. 5. Change of flux as charge crosses area is 4π times charge. a, b, are positions of charge before and after crossing surface; m n is element of boundary; x, y, are angles bounding the view of element of area seen from a, b, and reach magnitude 2π each, when a and b approach the surface.

e.s.u. as time rate of growth of charge. Remembering that c connects e.s.u. with e.m.u., we have alternative expressions for this: the usual statement of "current

* This often-used property depends on the fact that a sphere's surface area is 4π times the square of its radius; the "solid angle" of a cone is the ratio "area cut off by this cone on sphere centred at its vertex (compare Fig. 4), divided by square of sphere's radius": so that the maximum possible solid angle is $4\pi r^2/r^2$ or 4π. Then, since $E = e/r^2$, any contribution to flux is this quantity multiplied by an area, or e multiplied by a solid angle. Hence the surface integral of flux over a whole sphere is e multiplied by 4π.

density" crossing given *area* is j dS in e.m.u.) and if "charge density" is ρ e.s.u. per unit *volume* moving with velocity v cm. per sec., $j = \rho v/c$. In these notations the portion of the above equation which survives in a steady state, i.e., when there is a conductor current but no average change in E, is

$$\int_0 H ds = 4\pi \frac{i(\text{e.s.u.})}{c} = \frac{4\pi}{c}\iint \rho\, v\, dS = 4\pi \iint j(\text{e.m.u.})dS.$$

This is equivalent to Ampere's law connecting mechanical work and current in a conductor.

Application to Dielectric Currents.—Our connection between electricity and magnetism has been applied to the free space in which radio waves travel, and also to conducting material. But these alternatives of "no charge" and "freely flowing charge" do not exhaust the possibilities, and Maxwell himself foresaw the "dragged anchors" of stationary charge as equivalent to a current in the molecules of a material dielectric. This equivalent, for instance in the field between the plates of a condenser, will be discussed in a later article.

Application to Current-carrying Wire.—Since a current is actually a flow of n charges per unit length of conductor moving at v, $i = nev$. Hence our original law of force for a single charge, $F = evH$, becomes for the multitude of charges in any length element ds of a wire, in e.m.u., $dF = ds(nev)H = i\,ds\,H$. If the element of wire length is displaced through dl there is work done

$$dW = F\,dl = i(ds\,H)dl$$
$$= i(dl\,ds)H$$

Thus if a wire carrying current is moved relative to a magnetic field, the expression upon which we have based the whole of our field theory also gives the work done by field upon current-carrier as flux cut by wire multiplied by current, since $dl\,ds$ is an area. This is the basis of dynamo and motor action and much electric power generation and utilisation: its common ground with the fields of radio can thus be shown by the way our sequence has developed.

These laws provide the whole physics of fields for radio: but to evolve from them the propagation of radio waves they must be re-expressed in a form more convenient for practice though less obvious in origin. We proceed to this in a further article.

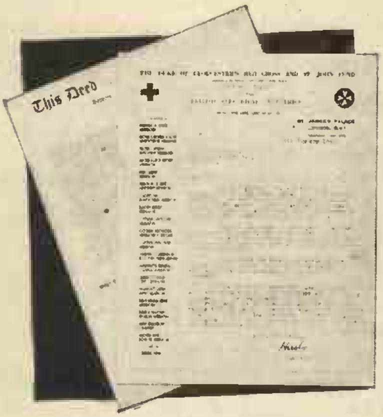
The somewhat unconventional methods which we have been using owe much to discussion with colleagues, in particular to association with Mr. Young and to the stimulus of Professor Oliphant's original methods of introducing electromagnetism to elementary students. So far as I am aware, the late Mr. H. F. Biggs is the only author to develop the subject along these lines in book form. Debts are gratefully acknowledged without claiming that any of these gentlemen would necessarily agree with all of the present treatment.

APPEAL TO THE RADIO INDUSTRY

Electrical Industries Red Cross Fund

MANY of our great national industries have already responded with gratifying results to the appeal of H.R.H. the Duke of Gloucester for the Red Cross and St. John Fund by organising appeals within their industries.

It was felt that the electrical industries should take part in this scheme, and an appeal is now being launched with the widest support of the associations representing all branches of electrical activities, including radio manufacturers, wholesalers, and retailers.



Lord Hirst's appeal letter and the form of covenant.

At the joint invitation of the associations, Lord Hirst of Witton has consented to act as chairman of the appeal, and a personal letter from Lord Hirst is now being sent out to all units of the industries.

The initial working committee was formed under the chairmanship of Mr. V. Watlington, M.I.E.E. (director of B.E.A.M.A.), with Mr. V. W. Dale (business manager of E.D.A.) and Mr. H. S. Pocock, M.I.E.E. (who initiated the appeal), acting as joint secretaries.

Lord Hirst's appeal letter is accompanied by a statement of the purpose and aims of the appeal, and particular attention is drawn to the advantages of entering into a covenant to subscribe annually for seven years *or the duration of the war*. By this means whatever sum is contributed is doubled (at the present rate of income tax) because the Red Cross are able to recover the tax. The gross amount is credited to the subscriber as his contribution. Single or occasional donations are, of course, welcome, but they have not this special advantage and do not give the Red Cross the same assurance of a regular annual revenue. The official form of covenant is being sent with each appeal letter.

It is stressed by Lord Hirst that the present appeal is directed to employers. Workers throughout the country are already contributing £50,000 a week to the Red Cross, and he is confident that employers will be equally generous.

Wireless is the youngest of all the branches of the electrical industry with which it is associated in this appeal, but we feel sure that its contributions will not be the least. Though young in years, wireless has already established a fine tradition of service to humanity; applications of its technique have contributed more than any comparable scientific development to the well-being of mankind. The industry will welcome this further opportunity of relieving the sufferings of those who are making the greatest sacrifices in this momentous struggle.

Contributions should be sent to the Electrical Industries Red Cross Fund, St. James's Palace, London, S.W.1, and other correspondence to the Joint Secretaries, c/o The E.D.A., 2, Savoy Hill, London, W.C.2.

"PAPER IN BATTLE DRESS"

THOUSANDS of examples of paper economies which have been effected in industry, offices and other spheres of activity are to be seen in the exhibitions, "Paper in Battle Dress" and "Waste Paper Goes to War," which are combined in one show at the Royal Exchange, London. It will be opened on Thursday, January 28th, and will remain open from ten to four daily, except Saturdays and Sundays, for three weeks.

THE WIRELESS INDUSTRY

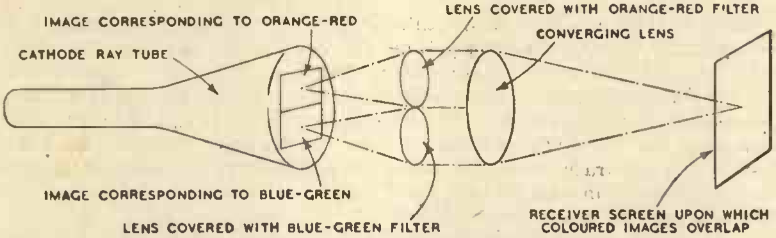
CORRESPONDENTS of Communication Engineering Pty., Ltd., of Australia, are asked to note that the firm's address is now 55, Carter Street, Cammeray, North Sydney, N.S.W.

COLOUR TELEVISION DEVELOPMENT

Receiver Without Moving Parts

STEREOSCOPIC television employing the anaglyphic* principle and colour television viewed on a receiver which employed no moving parts was recently demonstrated by John Logie Baird at his private laboratory at Sydenham.

The former achievement was demonstrated early last year and described in the February, 1942, issue of this journal. It is therefore not considered necessary that the system should be fully described here, but it may be pointed out that the anaglyphic principle is based on the use, by the viewer, of spectacles fitted with colour filters in place of lenses, for the purpose of left- and right-eye discrimination, the stereoscopic pair being produced at the receiver screen in corresponding colours to the red and blue filters. Each component of the stereoscopic pair will then be seen only by the eye covered by its particular filter, so that each component will be viewed in turn. As the pictures on the screen are slightly displaced, according to the left- and right-eye viewpoints at the transmitter, and superimposed, a resultant picture in stereoscopic relief is obtained.



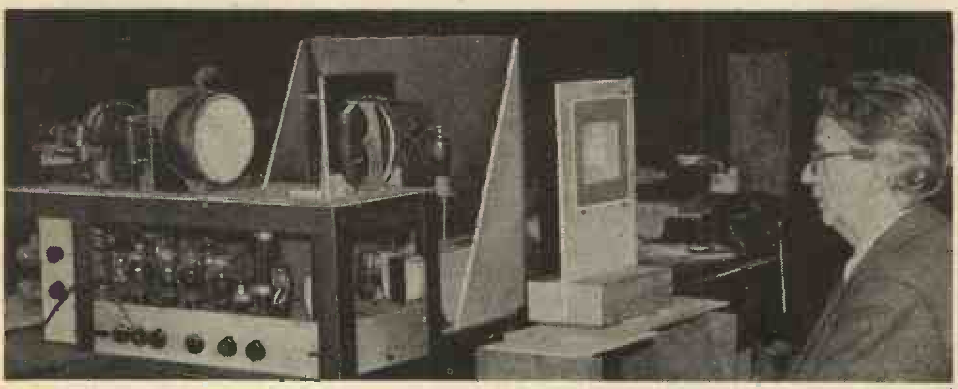
Optical system of the new Baird colour television receiver.

In the February, 1941, issue of *Wireless World* there was described a 600-line colour television system employing a two-colour process of red and blue-green making use of a rotating disc carrying the colour filters.

Stationary Filters

Baird has realised for some time that the use of moving parts in a receiver constitutes a very real drawback, particularly to the non-technical user, and therefore decided to develop a receiver employing stationary colour filters. The apparatus, shown diagrammatically in the accompanying drawing, employs the principle of superimposing, by optical means, coloured images representing the primary colours. For the sake of simplicity, Baird uses the same colour combination as was employed in the above-mentioned partially mechanical system; that is, a two-colour combination of orange-red and blue-green.

Images corresponding to the primary colours employed are reproduced side by side in sequence on the cathode-ray tube. Two lenses, one covered with an orange-red and the other with a blue-green filter, are arranged with their optical centres on perpendiculars through the centres of each of the images, and at a distance from them equal to the focal length of the lenses. It is arranged that the lenses project parallel beams on to a large lens situated at a distance from the receiving screen equal to its focal length. The resultant coloured picture is obtained from this superimposition of the two coloured pictures. One of the accompanying photographs indicates the general layout of the optical system; the other shows the lens system, with the colour filters in front of the lenses.



An experimental model of the new receiver, with Mr. Baird seated in front of the viewing screen. The arrangement of lens and colour filter system is shown in the small photo above.

* Anaglyphic: having the appearance of an ornamental carving or embossing done in low relief.

RADIO DATA CHARTS—4

Attenuation of Transmission Lines

By
J. McG. SOWERBY,
B.A., Grad. I.E.E.
(By Permission of the Ministry of Supply)

CALCULATION of the characteristic impedance of different types of transmission lines is facilitated by abac No. 3 in the present series, so the designer can choose the type of line most suitable for a given purpose, and can find the termination—equal to the characteristic impedance—required to give the minimum attenuation. To find the attenuation it is required to determine the attenuation constant, which is in turn part of the propagation constant. This propagation constant γ is of the form $\alpha + j\beta$, and is given by the equation

$$\gamma = \sqrt{(G + j\omega C)(r + j\omega L)} \qquad (1)$$

Where G = conductance/unit length; C = capacitance/unit length; r = resistance/unit length; L = inductance/unit length; $\omega = 2\pi \times$ frequency.

This equation is well known, and is given (for instance) by Hund ("Phenomena in H.F. Systems," p. 412). If G is so small that it may be ignored, then (1) reduces to

$$\gamma = j\omega\sqrt{CL}\sqrt{1 + r/j\omega L} \quad .. \quad (2)$$

Making the further assumption that $r/\omega L$ is small compared with $(r/\omega L)^2$—which is justified in RF lines—equation (2) reduces to

$$\gamma = j\omega\sqrt{CL}\{1 + r/2j\omega L\} \qquad (3)$$

The propagation constant of RF lines may be expressed to a good degree of approximation by

$$\gamma = \frac{r}{2}\sqrt{\frac{C}{L}} + j\omega\sqrt{CL} \quad .. \quad (4)$$

It will be seen that this is of the form $\alpha + j\beta$, and since $\sqrt{C/L} = 1/Z_0$ the attenuation constant of a RF line may be written

$$\alpha = r/2Z_0 \quad .. \quad .. \quad .. \quad (5)$$

Also the velocity of transmission of a wave along such a line is given by $\omega/\beta = 1/\sqrt{CL}$ and this is nearly the velocity of light at high frequencies as was shown by experimental evidence quoted last month.

Of course "r" is not the DC but the RF resistance including the skin effect, and in calculating the actual attenuation of a real line this effect must be allowed for. Unfortunately not only must the skin effect of a single wire be taken into account, but also the proximity effect of one wire of the line on the others, and this means in practice—as will become clear later—that an abac for finding the attenuation of a line must have a separate scale for the characteristic impedance of each line configuration. In the last abac for the characteristic impedance a separate curve for each line configuration was drawn, but six separate Z_0 scales—in addition to the three required for the resistance—would make the abac unduly complicated to use. For this reason only the two commonest lines have been considered in constructing this attenuation abac; namely the two-wire and the co-axial.

RF Resistance

Considering first the two-wire line, the RF resistance—taking account of the skin effect—is given by the relation

$$r = \sqrt{\frac{r_0}{1 - (d/D)^2}} \quad .. \quad .. \quad (6)$$

Where r_0 = DC resistance, d = wire diameter, D = spacing between wires.

In e.m.u. the resistance per centimetre length is therefore

$$\sqrt{\frac{16\rho f}{d^2\{1 - (d/D)^2\}}} \quad .. \quad .. \quad (7)$$

Where ρ = specific resistivity of wire material; f = frequency in c/s.

Since the resistivity of the conducting material comes into this expression the abac can only be correct for one material—in this case copper. If other line materials are used the answer given by the abac must be multiplied by a factor depending on them. The requisite factors were given in the form of a table in *Wireless World* for Nov. 1942, p. 254. These factors will seldom be used but it is worth noting here that the value for aluminium is 1.28. It should be noted that if magnetic materials are used (iron wire for instance) other factors become important and the abac is no longer applicable.

By combining equations (5) and (7) the attenuation constant of the line may be found immediately; and the actual attenuation introduced by the line is given by

$$A = 8.686\,\alpha l \quad .. \quad .. \quad (8)$$

Where A = power attenuation in db. and l = physical length of line.

Putting in the appropriate numerical values for the constants, converting to practical units, etc., the following relation for the attentuation of a two-wire line is arrived at:—

$$A = \frac{2.6\sqrt{f}\,l}{d}\left\{\frac{1}{Z_0}\sqrt{\frac{(D/d)^2}{(D/d)^2 - 1}}\right\}10^{-5}\text{db} \quad .. \quad (9)$$

where d is in inches and l is in yards.

This is the relation on which the chart is based. The expression in the bracket at the end of equation (9) can be written as a function of Z_0, and this function has been calculated over the range 100 to 1,000 ohms and incorporated as the Z_0 scale.

An exactly parallel approach for the air dielectric co-axial cable leads to the expression for the attenuation as follows:—

$$A = \frac{1.301\sqrt{f}\,l}{D}\left\{\frac{D/d + 1}{Z_0}\right\}10^{-5}\text{db.} \quad (10)$$

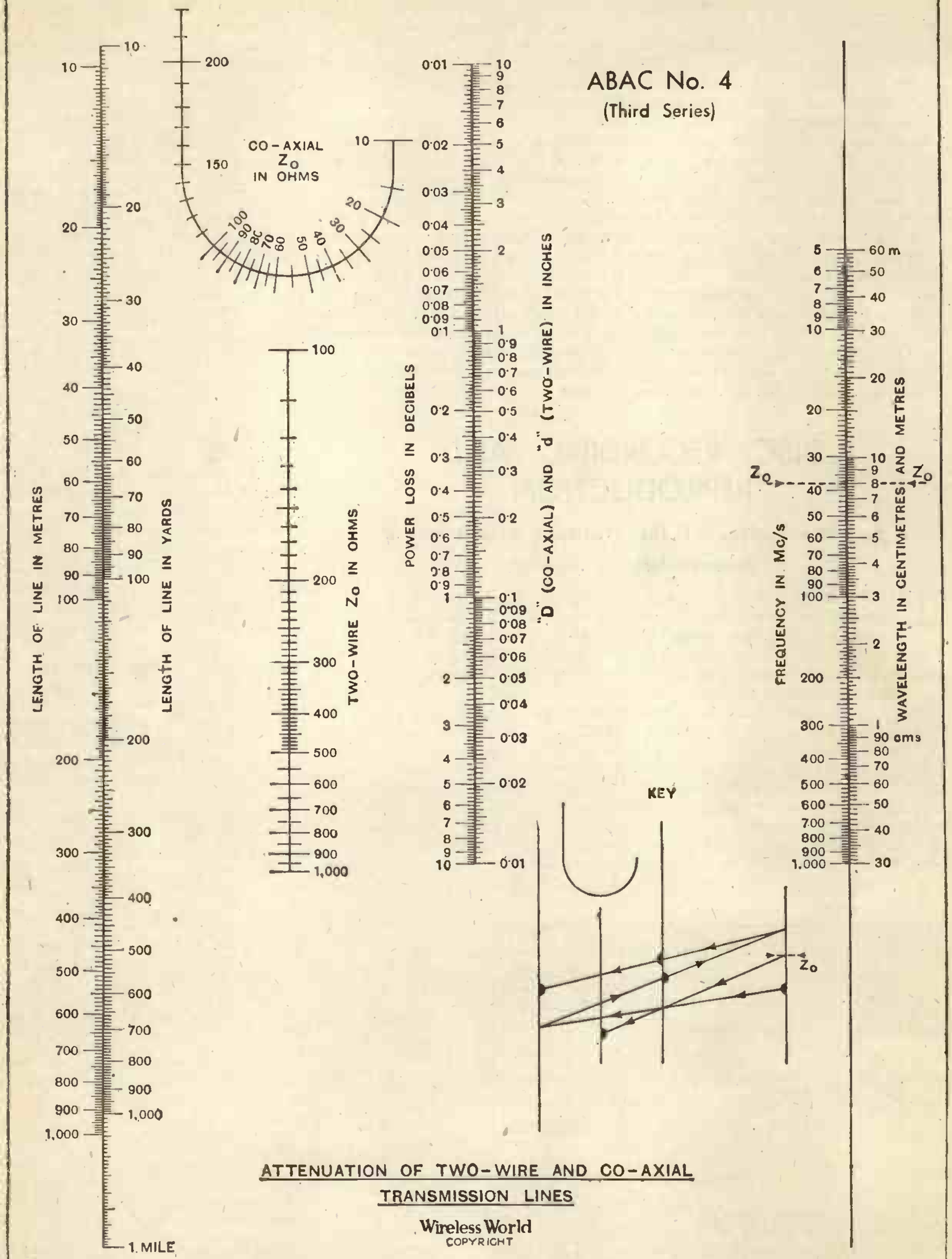
Again the bracketed term has been calculated in terms of Z_0 and incorporated on the abac as the Z_0 scale.

Turning to the chart itself, the mode of operation should be clear from the key. A few points are worth mentioning: (1) the D scale has two meanings; in the case of the two-wire line it means "d" the wire diameter, and in the case of the co-axial it means sheath diameter or "D"; (2) insulation losses have been neglected; (3) conductance between "go" and "return" leads has been neglected; (4) for the answer to be right the line must be long compared to the wavelength—say, by at least a factor of five.

Example: A two-wire line is made of 0.08in. diameter wire and Z_0 is 600 ohms. It is used to transmit the output from an amateur transmitter working at 56 Mc/s to the aerial 220 yards away. What is the attenuation introduced by the line? How does this line compare with a co-axial

(*Concluded on page 44*)

ABAC No. 4
(Third Series)



ATTENUATION OF TWO-WIRE AND CO-AXIAL TRANSMISSION LINES

Wireless World COPYRIGHT

Radio Data Charts—
line whose attenuation is known to be 0.2 db./100ft. ?

Starting at the gauge point on the right-hand scale marked Z_0, place the ruler on 600 ohms on the two-wire Z_0 scale. Note the point of intersection with the centre line. Join this point to 56 Mc/s on the frequency scale, and note the point of intersection on the length scale. Join this point to 0.08 on the diameter scale ("*d*" in this case); a point of intersection is found on the frequency/wavelength scale. Join this point to 220 yards on the length scale; the ruler cuts the loss scale at 0.892 db. Also join this point to 33⅓ yards; the ruler cuts the loss scale at 0.135 db. Hence the required loss is 0.892 db, and the two-wire line has a lower loss than the co-axial line quoted; 0.135 db/100ft. as against 0.2 db/100ft.

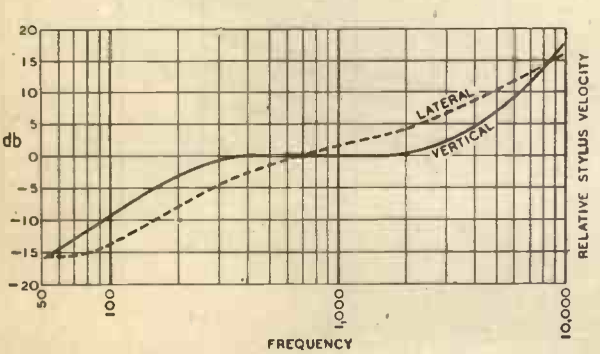
It will be found that the two-wire line often gives a lower attenuation as calculated by the abac than the more expensive co-axial line. But the open-wire line is exposed to the elements if out-of-doors, and rain may well result in appreciable conductance between the wires which might very materially increase the attenuation. On the other hand, the centre conductor of the co-axial line is completely shielded from the weather, and if the ends can be sealed and the sheath earthed, there is no reason why the attenuation should not remain constant under all normal atmospheric conditions.

DISC RECORDING AND REPRODUCTION

Recommendations of the National Association of Broadcasters in America

THE general absence of standards for electrical transcription, i.e., disc recording and reproducing for broadcasting, has resulted in the use of as many as ten equalising networks by some U.S. radio stations. The National Association of Broadcasters in America has co-ordinated the work of a special committee, consisting of representatives of all interested organisations, which has prepared a series of standards, the first sixteen of which have already been adopted and submitted to the industry. diameters of outer and inner grooves, limits for eccentricity, number of starting grooves, etc., are matters which are not likely to interest the majority of readers. There are, however, several recommendations containing figures which are of direct interest to those who design pick-ups, and which throw light on factors essential to good quality of reproduction.

The recommendations with regard to frequency characteristics are given in the form of curves for both lateral and vertical ("hill and dale") which are reproduced here-



Recording characteristics for vertical (full line) and lateral (dotted line) transcriptions. Permissible tolerance ± 2 db.

It is not proposed to give full details of all the points dealt with in the report, as many of these, such as dimensions of centre hole, with. It is interesting to note the marked lift at the high-frequency end of the scale, a measure which seems to have been taken to give a lower surface noise after tone correction in the reproducing amplifier.

It is worth while repeating the main text of the sections covering noise and programme levels, which are as follows:—

"17. That the programme level measured by the standard volume indicator shall be the same as the level required to record a 1,000 c/s note at a velocity of 5 cm./sec. This allows for the 10 lb. margin usually present between signal and reading of volume indicator. This standard contemplates peaks running as high as 15 cm./sec., which is the maximum velocity that can be traced without distortion in the inner radius of a 33⅓ r.p.m. record.

"18. That the noise level measured when reproducing a record over a frequency range of 500-8,000 c/s shall be at least 36 db. below the level obtained under the same conditions when using a 1,000 c/s note at 5 cm./sec. This measurement is intended to give a fixed reference level for measuring noise, and does not take into account programme level actually recorded or programme dynamic range. Pre-emphasis, i.e., equalisation, will improve S/N ratio a further 8 db."

It is also stated that the maximum vertical force required by the pick-up shall be 1½ oz. (42 gm.). This downward pressure is determined as much by the pick-up as by the record, but the limit set will have a bearing on the shape of the record groove and the angle its walls make with the vertical.

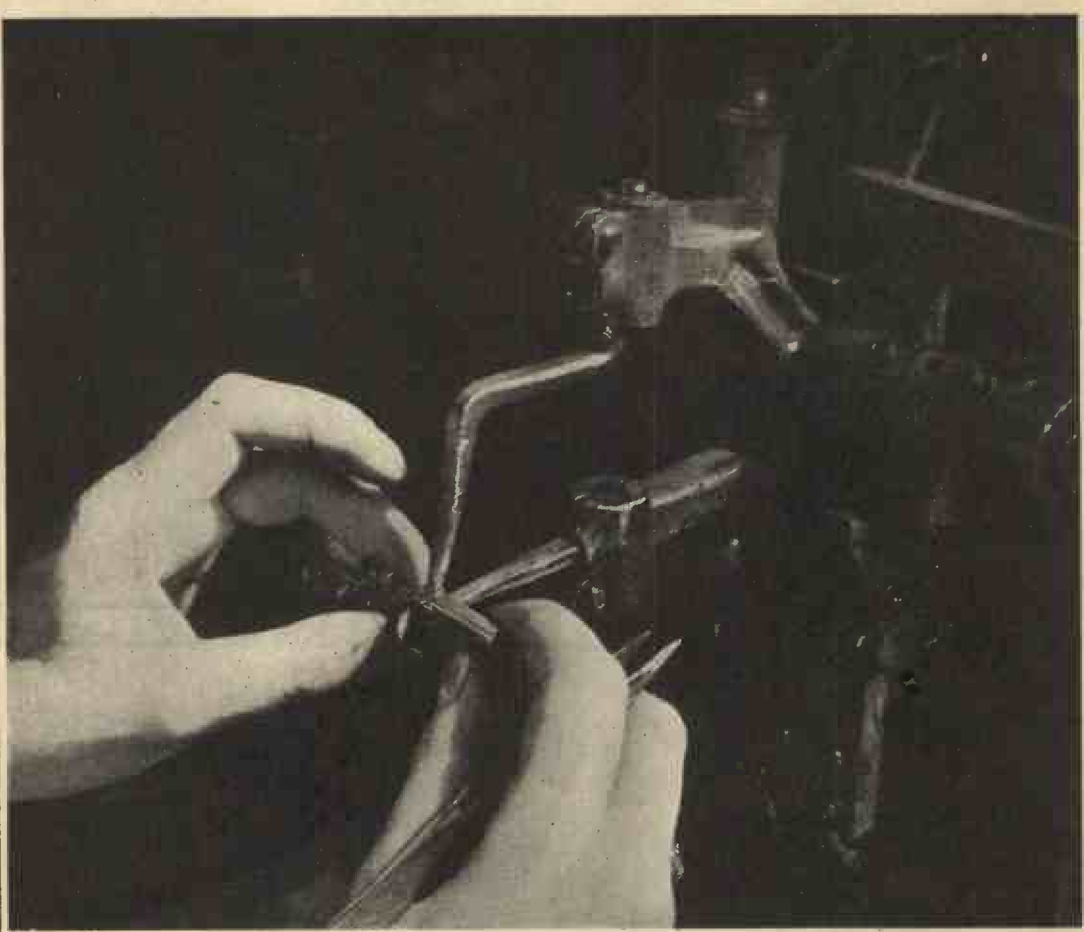
The label of the record is required to contain information regarding speed and type of recording, inside or outside start, and last, but by no means least, the recording frequency characteristic. Is it too much to ask that this might be printed on records issued to the public? What a help it would be to those who really take the trouble to get the best out of records of varying types.

A VALUABLE INDEX

THE annual index to the Abstracts and References published month-by-month in *Wireless Engineer* will, it is hoped, be on sale on February 15th. This 40-page index to authors and subjects, which covers the abstracts published in our sister journal during 1942, will cost 2s. 8d. (including postage). Early application should be made to our publishers, as supplies will be limited.

In addition to the regular monthly quota of abstracts from, and references to, articles on wireless and allied subjects recently published in the world's technical journals, two articles dealing with the behaviour of the diode when employed as a frequency changer are included in the January issue of *Wireless Engineer*.

Assembly Welding



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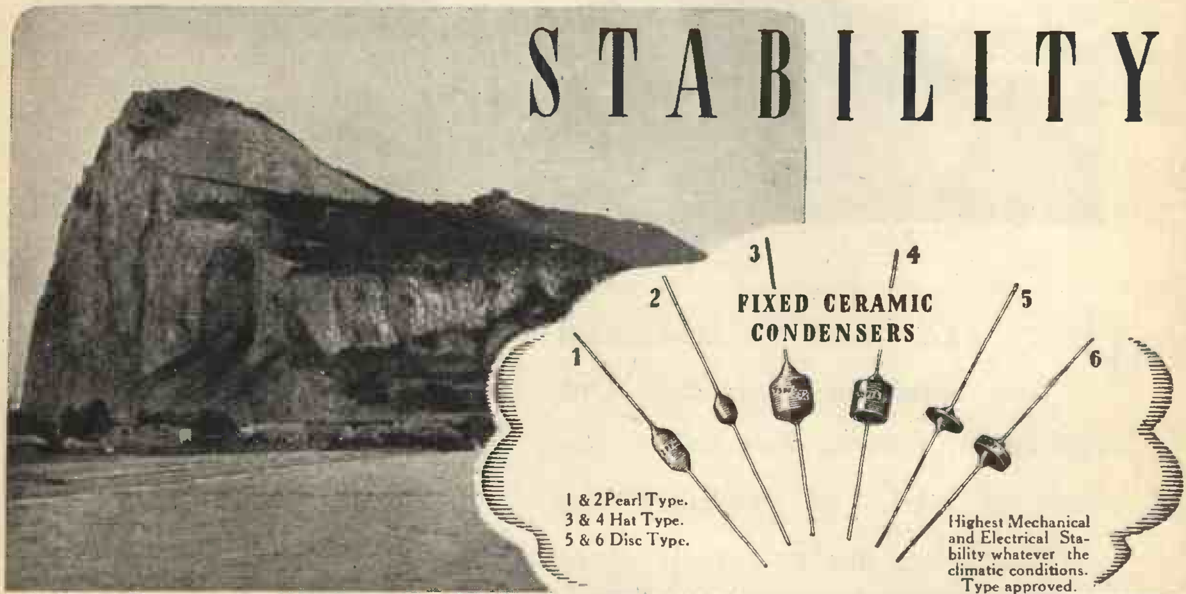

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Is Wave Propagation "Two-way"?

Plan for a National Radio Commission

Question No. 9.—I have always thought of long-distance wireless communication as a strictly "two-way" affair. In effect, if I hear a distant station calling me, he should be able to hear my reply (of course, assuming that such things as efficiency of equipment, power, wavelength, etc., are sensibly equal). But now, increased experience of short waves makes me think that propagation conditions may not always be equal in "forward" and "reverse" directions. Will the Brains Trust say if point-to-point communication is in fact strictly reciprocal?

J. HARMON.

"T.W.B." is a specialist on the subject of short-wave propagation, and has already dealt with questions on similar problems. He writes:—

THE reciprocity theorem states, in effect, that if a certain voltage in one aerial causes a certain current at a certain point in a second aerial, then the same voltage applied at this point in the second aerial will produce the same current (both in magnitude and phase) at the point in the first aerial where the voltage was originally applied. It is strictly true only in the case of ground-wave propagation, i.e., it is modified when—as in the case of long distance short-wave transmissions—the waves are propagated through an ionosphere which lies within a magnetic field.

The exact nature of the effects which occur to upset the reciprocal condition is rather obscure, but what follows will indicate the possibilities.

Some time before the war American workers found that during an ionosphere storm short waves arriving in the U.S.A. from Daventry came in on a bearing which was many degrees south of the Great Circle bearing of Daventry from the receiving point. This implied that the waves had been deflected from the Great Circle path, presumably by a horizontal gradient of ionisation in the refracting layer. This would cause the waves to be refracted, not straight downwards from the ionosphere, but downwards in a "sideways" direction. Such a condition could give rise to non-reciprocity, for the "sideways" effect might vary over the whole transmission path, thus causing waves going in one direction to follow a somewhat different path to those going in the other.

Even with undisturbed conditions some degree of non-reciprocity can exist, depending upon the direction of the transmission path relative to that of the earth's magnetic field. The behaviour of a wave in the ionosphere is governed by the fields of the free electrons there, which the wave itself has set in motion. The direction of motion of the electrons depends upon the direction of the flux lines of the wave. The earth's magnetic field exercises a twisting effect on the paths of the vibrating electrons—greater or less according to the direction of the field with regard to the paths of the electrons. The relation between the direction of the field and the paths of the electrons may be different for a wave going in one direction from that going in the other, and thus the magnitude of the twisting effect may be greater in the one case than in the other. The behaviour of the wave is therefore modified by the action of the earth's magnetic field, and this modification may be somewhat different in the two cases.

Ionosphere measurements show that the *virtual height* of the refracting layer varies at any one time in different parts of the world, even under undisturbed conditions. If this is so, a wave entering the ionosphere at a certain angle, and travelling a long way through it before emerging, will emerge at a different angle from that at which it entered. This may occur several times over a long path, i.e., at the "top" of every hop. This means that, in order to reach the receiving aerial, a wave must leave the transmitting aerial at a different elevation angle when going in one direction from that at which it must leave when going in the other direction. Bearing in mind the nature of the aerial polar diagrams it would thus appear that conditions may not be strictly reciprocal.

As to the magnitude of these effects, it is perhaps a fair conclusion to say that conditions *approaching* those of reciprocity usually do exist, except during ionosphere storms.

Still more views on Question No. 6.

(Would not the control of all wireless matters be better vested in some independent body, such as the F.C.C. in U.S.A., rather than in the G.P.O.?)

"RADIATOR," after surveying the extent to which our National wireless activities are actually controlled by the G.PO., evidently decides that more impartial control is needed:—

IN this country the Government has a monopoly in the exploitation of radio services, which is vested in the Postmaster-General, who presumably carries out the wishes of the Government as to the conduct of the services. The Postmaster-General may, through his department, operate the services himself, or he may delegate the operation of certain of them to public corporations or to private companies, as, in fact, he does in the case of the marine wireless companies, the B.B.C., etc. These bodies operate their services, therefore, under licence granted by the P.M.G., who retains in his own hands the responsibility for the good government of *all* the services. The Post Office thus has control over all matters affecting the licensing of sets and stations, regulation as to their operation and as to the handling of their traffic, allocation of wavelengths to the various services, inspection of the stations, examination and control of the operators, etc. In all these matters the G.P.O. is subject, of course, to any International Convention which deals with the control of radio, and to which this country has been made a contracting party by the action of the P.M.G.'s own representatives, who would represent Great Britain at the conven-

Wireless World Brains Trust—

tion. The main objections to this system would appear to be:

(a) As the Post Office itself is one of the chief exploiters of radio, and presumably exploits it on a profit-making basis, it can hardly be expected to adopt a completely impartial attitude in the exercise of its controlling functions over other exploiters of radio services. In other words, where the interests of its own services conflict with those of other concerns, it would tend to exercise its control to the benefit of its own and to the detriment of the other services.

(b) The Post Office would tend to get out of touch with the requirements of the actual users of some of the services, especially of those which it does not itself operate. If this is so then the Post Office is not really competent to exercise a governing function over these services.

In these circumstances it does seem desirable that the government of radio services in this country should be in the hands of a more independent body than the Post Office—a body which is in touch with the requirements of the users of *all* the services and which is able to exercise its governing function in a completely impartial manner, having regard only to the way in which the requirements of the majority may most efficiently be met.

It is to be noted that the setting up of such a body would not deprive the Government of their monopoly in radio communications, the operation of which would still be largely in the hands of the Post Office. The Post Office—as the State civil communications service—would, in fact, operate all those services which the Government saw fit to grant to it, other services being let out to other bodies as at present.

But the responsibility for the government and control of all the services—whether Post Office operated or not—would rest with the new body, who would, in addition, make recommendations to the Government as to who should operate any particular service. The new body—which might well be called the National Radio Commission—would therefore carry out all the governing functions listed above, and would be given complete legal power to do so.

As to the constitution of the Commission, it is obvious that it should represent all branches of the radio services, and this would probably mean that at least nine Commissions would be required. Not all of these, or indeed many of them, would need to be full-time Commissioners, though probably one or two of them would. They would not necessarily be technical men, although, because of the nature of the problems with which they would deal, they would have to have some technical understanding.

There would probably be one Commissioner from each of the three fighting Services, and these, together with one from the Post Office, would be the "Government members." One Commissioner would be appointed by the B.B.C., and another would be elected by the Marine and other radiotelegraph operating companies. In order that the impartial engineering and scientific viewpoint might be presented, the seventh Commissioner should be an engineer or scientist elected jointly by the Wireless Section of the I.E.E. and other engineering and scientific associations of appropriate status. Manufacturing interests ought also to be represented, and the eighth Commissioner might well be appointed by the R.M.A. or similar body. The interests of the listening public would, no doubt, be brought forward by the B.B.C. Commissioner, but, as they form the vast majority of the "users" of the radio services it seems desirable that they should have more direct representation on the Commission. Unfortunately, however, no representative organisation of radio listeners exists in this country. The simplest way of electing a listeners' representative would therefore appear to be to entrust the duty to a Committee of the House of Commons, who would elect one M.P. as the ninth Commissioner. He might also represent the amateur transmitters.

The Commission would, as has been said, have the full legal power necessary to carry out its governing functions, but it would be prohibited from operating any sort of radio service itself. It would necessarily require a full-time staff to carry out its work, comprising engineering, legal and inspectorate departments, and the heads of these would be the Commissioners' chief executive officers.

So much for the control of radio in this country. We must bear in mind, however, that changes which may take place after the war may result in all nations surrendering some of their sovereign rights. It may well be that the control of radio may be made an international or perhaps a Federal concern—in Europe at any rate. If this is so then it would appear that a Federal instead of a National Radio Commission might be formed, constituted somewhat in the manner described, but on a much larger scale, and working on an international instead of a national basis.

SOUND REINFORCING is employed in one of the rebuilt broadcasting studios of the National Broadcasting Company in Radio City, New York. The small console incorporating the controls is located in the seating section. The sound reinforcing system is used to permit studio audiences to hear those broadcast artists who perform close to the microphone, and would, therefore, be inaudible to a large section of the audience.

Frequency Modulation—2

FM TRANSMISSION, PROPAGATION AND RECEPTION

In this instalment the two most popular frequency modulators are described, and the rest of the transmitter circuit is given in outline. The turnstile aerial and UHF propagation are briefly dealt with, while an introduction is given to the receiving circuit.

By CHRISTOPHER TIBBS, *Grad.I.E.E.*

IN America the band between 42 Mc/s and 50 Mc/s has been allocated to experimental and commercial frequency modulation transmissions. Transmission is confined to the ultra-high frequencies, which permit the use of the required band width and do not employ the ionosphere as a part of its transmission medium. On all the lower frequencies a proportion of the energy radiated skywards is reflected back to earth.

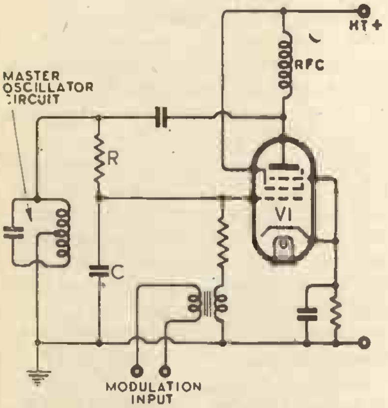


Fig. 1. Basic circuit of a frequency modulator of the variable reactance valve type.

This results in selective fading and distortion due to phase differences occurring when the reflected and direct rays are received simultaneously. If frequency modulation is employed under these conditions, distortion is far more serious than is the case with a corresponding amplitude - modulated transmission. As a general rule it can therefore be stated that FM only gives satisfactory results on the ultra short wave band.

An FM transmitter is both simpler and more efficient than its AM counterpart. Unlike an amplitude modulated transmitter, frequency modulation can be applied directly to the master oscillator or at a stage where the power being handled is still small. The modulated carrier is then amplified and fed to the final power output stage which is normally operated under Class C conditions. This highly efficient method of working is rarely possible with an AM transmitter and is one of the many points on which FM shows an improvement over amplitude modulation. An example often cited is that of a 50 kW amplitude-modulated transmitter, which when 100 per cent. modulated has to produce a peak output of 100 kW. An equivalent FM transmitter requires no such power reserve and can therefore be operated as a 100 kw station. A frequency-modulated transmitter will require only about half the current drawn by an amplitude-modulated station of the same rating.

The Reactance Valve Modulator.—Although a wide variety of methods are employed for the actual frequency modulation of a transmitter the differences are not fundamental, and in most cases, are primarily concerned with the achievement of the highest possible frequency stability. The frequency modulator circuits at present employed fall into two main groups—the variable reactance valve modulator, and the modulation circuit due to E. H. Armstrong.

The operation of the variable reactance modulator valve, the circuit of which is shown in Fig. 1, can be summed up as follows. The master oscillator circuit has a resistance R and a condenser C

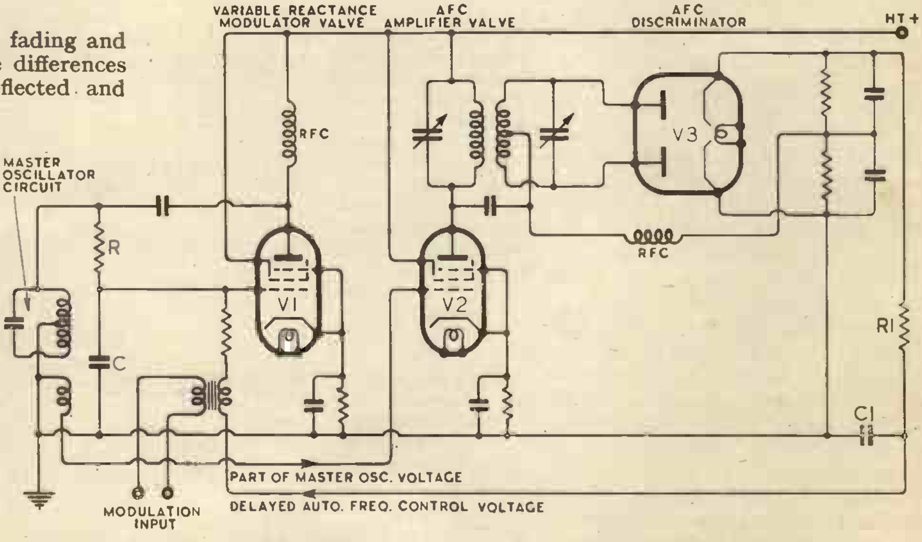


Fig. 2. Circuit showing how AFC is used to stabilise a variable reactance frequency modulator valve. Stability can be further increased by using the AFC amplifier valve to mix the output from a crystal-controlled oscillator with the signal from the master oscillator The control voltage is then derived from the beat signal.

connected across it. Their values are arranged so that the resistance is high in comparison with the condenser's impedance. Under these conditions the voltage across the condenser lags 90 degrees behind that across the tuned circuit. This lagging voltage is applied to the grid of the valve V_1. The 180-degree phase shift taking place through this valve, results in its anode voltage leading that across the oscillator circuit by 90 degrees. This valve can therefore be regarded as an inductance shunted across the tuned circuit. The value of this "inductance" can be varied by altering the valve anode current. The application of an audio signal to the valve's grid will therefore cause fluctuations in anode current, which, in effect are alterations of the "inductance" it shunts across the tuned circuit. It follows therefore that the master oscillator is frequency modulated as a result of the signals applied to the grid of the reactance valve.

A transmitter using this circuit has to include means for the correction of frequency drift, caused by changes in the reactance valve and oscillator. The usual method of obtaining this correction is by means of a conventional automatic frequency control circuit. The general arrangement of such a stabilised modulator is shown in Fig. 2.

Stabilisation is produced by supplying part of the master oscillator's output to an amplifier valve (V_2). The output from the AFC discriminator in this valve's anode circuit is arranged so that the variable reactance valve bias is increased when it presents too large an inductive shunt across the oscillator circuit. An increase in the bias supplied results in the reactance valve applying a smaller effective shunt inductance and so allowing the master oscillator frequency to fall. Should the oscillator frequency be low the discriminator will supply the reactance valve with less bias, so causing the oscillator frequency to increase.

The degree of stability obtained from this circuit can be still further increased by mixing the signal from the master oscillator with that from a crystal controlled oscillator. Under these conditions the AFC discriminator operates off the resultant beat note. In this way the effect of any drift in the discriminator circuit constants is greatly reduced. The long time constant due to R_1 and C_1 ensures that the changes due to normal frequency modulation do not influence the control voltage.

In order to maintain the highest possible frequency stability the master oscillator is operated at a comparatively low frequency. It

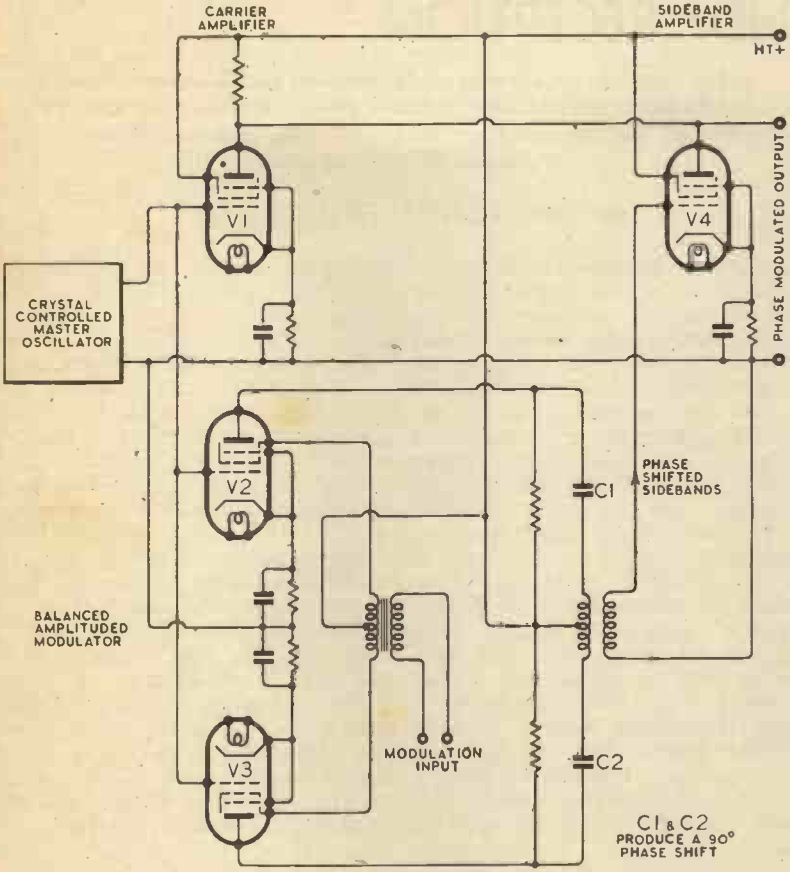
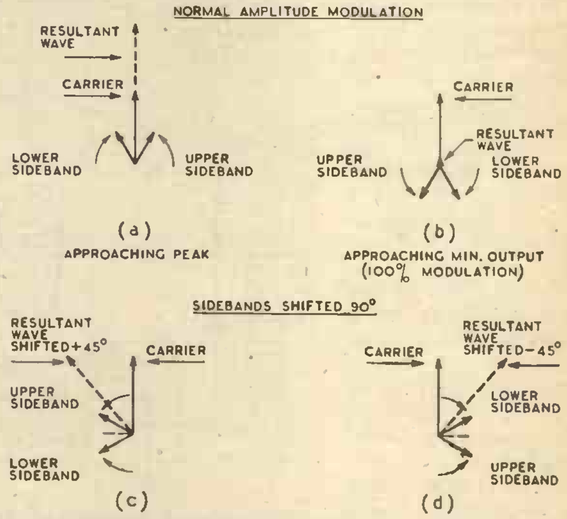


Fig. 3. Major Armstrong's phase modulator. The audio input is fed through a filter which reduces the modulating signal amplitude directly as its frequency is increased. The phase-modulated output is therefore, in effect, frequency modulation.



(Right) Fig. 4. Vector diagrams (a) and (b) show the normal phase relations between the sidebands and carrier of an amplitude modulated wave. Diagrams (c) and (d) show that by shifting the sidebands 90 degrees relative to the carrier, phase modulation is produced. The resultant "by product" frequency modulation is used in Armstrong's modulator.

has therefore to be followed by a number of frequency multiplying stages before it can be supplied to the final power output stage.

Armstrong's Modulator. — Major Armstrong has developed an original method of frequency modulation[2,3]. Its chief advantage is that, being based on a crystal controlled oscillator, it has a higher inherent frequency stability than any other type of frequency modulator.

The circuit of Armstrong's modulator is shown in Fig. 3. Although this arrangement actually phase-modulates the carrier, the overall result is frequency modulation. This outcome is produced by first passing the audio signal through a filter with a characteristic which increasingly attenuates the audio input from the lower up to the higher frequencies. In this way the " by product " frequency modulation[4], which is produced by the phase modulator, and which is a minimum at the low audio frequencies, is corrected so as to produce a constant frequency deviation characteristic over the audio band.

In Armstrong's modulator the output from a crystal controlled oscillator is fed through two channels. The first consists of a pair of valves (V_2 and V_3) operating as a balanced amplitude modulator. The carrier is cancelled out across the output transformer, leaving the AM sidebands only. By feeding these sidebands through the small condensers C_1 and C_2, a phase shift of 90 degrees is produced. The output from the oscillator, after being amplified by V_1, is combined with the phase-shifted sidebands on the anode of V_4.

The effect of combining a carrier with AM sidebands which have been shifted in phase by 90 degrees, is shown in Fig. 4. These vector diagrams show, first how the sidebands normally combine with the carrier to produce amplitude modulation and secondly, how, when 90 degrees out of phase, they produce phase modulation.

After the input has been corrected to produce an FM deviation characteristic which is level over the audio range, Armstrong's modulator results in a maximum FM of some 20 to 25 cycles. This is actually the " by product " of the phase modulation. If the transmitter is to operate at a maximum deviation of say 75 kc/s, the frequency changes will have to be multiplied some 3,000 times.

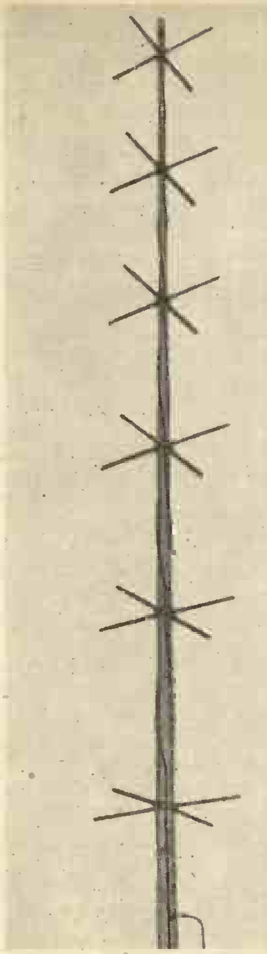


Fig. 5. The turnstile aerial is very popular and is frequently used for FM broadcast stations. The example illustrated is a product of the R.C.A. Manufacturing Co.

The large amount of frequency multiplication required is one of the principal objections raised against Armstrong's modulator. In the case given above the oscillator frequency might have to be multiplied from 100 kc/s to perhaps 10 Mc/s, at which frequency it could be heterodyned to a lower value, before being multiplied to the final transmission frequency. The bank of frequency multiplier valves is always a prominent feature in an FM transmitter employing Armstrong's modulator.

Propagation.—By far the most popular type of transmission aerial is known as a " turnstile "[6,7]. Its general construction can be seen from the photograph in Fig. 5. In America standard designs are available in power ratings up to 50 kW, and with any number of bays between two and ten. This type of aerial produces the horizontally polarised field which is used by practically all FM broadcast stations. In this connection it may be remembered that tests have shown motor car interference to be mainly vertically polarised.

Among the reasons for the popularity of the turnstile aerial are its high efficiency and almost perfect polar diagram, an example of which is given in Fig. 6. An important practical advantage attending this type of aerial is the ease with which heating elements can be inserted in the actual RF radiators, an important point in localities where there is liable to be ice formation.

The presence of a phenomenon called the " improvement threshold " places a definite maximum to the service range of an FM station. The improvement threshold occurs at a distance from the transmitter, such that the carrier and peak voltage due to any local interference are equal. So long as the carrier voltage is greater than the noise, FM shows an improvement over amplitude modulation ; once the signal drops below the noise level the signal-to-noise characteristic of an FM receiver is approximately the same as that of an AM receiver. This comparison between the relative amplitudes of the interference and signal should be made at the end of the IF amplifier, if the noise produced by the early receiver stages is to be included. In districts where impul-

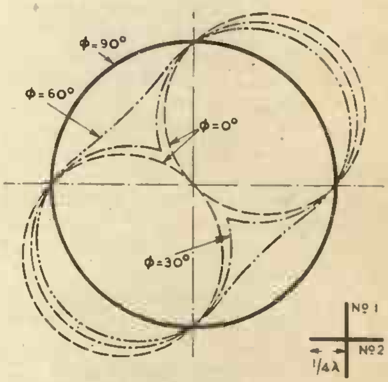


Fig. 6. Diagram showing the horizontal radiation pattern for a turnstile aerial. Currents in arms one and two are equal, and the dotted lines indicate the polar diagrams obtained with current phase differences other than 90 degrees.

sive noise is negligible, the improvement threshold will be reached when the signal drops below the receiver noise level. This noise, resulting from valve emission irregularities and thermal agitation, can be taken as 1 microvolt peak, for a well designed RF stage. Crosby[5] has developed a method of calculating the distance at which the "interference threshold" occurs. In one worked example (based on the figure of 1 peak microvolt of set noise) he shows that it is reached at between 90 and 100 miles, from a 100 kW station operating under normal conditions.

An FM receiver will not respond to amplitude modulation, and therefore interference has to be in the form of frequency modulation before it can be demodulated. When the carrier level is above that of the noise, interference will take the form of spurious frequency modulation of the carrier. If, however, the noise is the greater, then the carrier will appear as a frequency modulation of the noise, a condition in which the desired signal is very rapidly smothered.

Receiving Equipment.—In America FM has been introduced to the public as something that can only be incorporated in higher priced receivers. It is being sold on its high fidelity performance, with interference freedom as an essential requirement of quality reproduction. From both the technical and commercial standpoints this policy is sound, and has met with the success which it warrants. It is estimated that in January, 1942, FM receivers were being purchased at the rate of 30,000 a month.

A block schematic diagram of a modern wide-band FM broadcast receiver is shown in Fig. 7. The circuit follows conventional superhet lines up to the limiter stage and no problems are introduced which have not been previously encountered in receivers operating in the UHF band. The IF channel has, of course, to be wide enough to pass the largest frequency swing transmitted. A deviation of ±100 kc/s is the maximum so far employed; this necessitates a receiver response which is substantially flat for some 200 kc/s. An IF frequency in the region of 5 Mc/s is normally employed, this is high enough to ensure that the second channel will fall outside the FM band.

A diagram of that part of the receiver circuit which differs from the normal amplitude modulation receiver is given in Fig. 8. The last IF stage is followed by the limiter, which suppresses all amplitude modulation. It commonly takes the form of an overdriven pentode, which is arranged to have a short grid base.

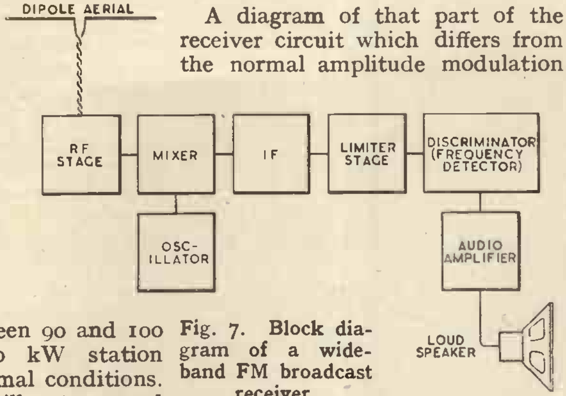


Fig. 7. Block diagram of a wide-band FM broadcast receiver.

It is sometimes suggested that the limiter "planes off" the interference; this is not strictly correct. It actually converts all forms of amplitude modulation, whether static, second station interference or valve hiss, into corresponding frequency modulations superimposed on the incoming carrier. It is the favourable relation which this frequency modulation bears to the original amplitude interference, which is mainly responsible for the remarkable high signal to noise ratio achieved.

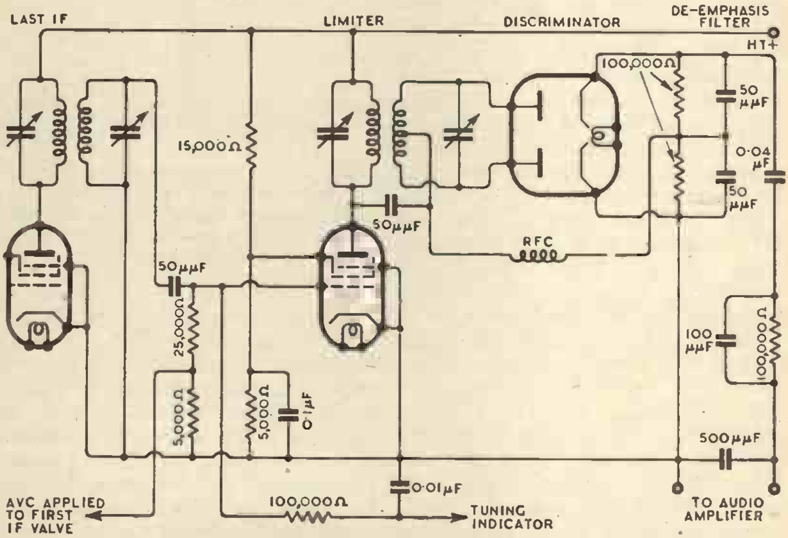


Fig. 8. It is not until the limiter and discriminator stages are reached that an FM receiver differs materially from its AM counterpart. A typical circuit for this part of the receiver is shown above.

Following the limiter is the discriminator or demodulator stage, which converts the carrier—frequency changes into corresponding variations in amplitude, which can then be rectified. Its performance determines to a very large extent the response obtained from the whole receiver. Both this stage and the limiter stage will later be subjects for special articles.

While there is nothing specifically new about either the audio-frequency amplifier or the loud speaker system, they should both be of the highest possible quality. Due to the inherently low distortion of an FM system, it is all too easy for the loud speaker to become the weakest link in the chain. It is for this reason that a number of American manufacturers are only marketing console and radiogram FM models. This makes it possible to ensure, in some cases with the aid of an acoustic labyrinth, that there is adequate loading for the loud speaker.

The advances made possible by frequency modulation are not confined to broadcasting alone. The system is ideally suited for short distance mobile transmitter-receivers. During the last few years it has been widely used in America for such purposes as police mobile

Frequency Modulation—

communication equipment, sports broadcast commentaries, communication with forest rangers and repair gangs working on railways, powerlines, etc. Under conditions such as these the saving in battery power is of considerable importance. The prime advantage is, however, the tremendous reduction in noise level. The sharp boundary to the service area and the discrimination against weaker stations, on the same or near-by channels, places FM in a class by itself for mobile communication.

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RANDOM RADIATIONS

By "DIALLIST"

Frequencies and Wavelengths

LAST month I suggested a method of classifying the wavelengths and frequencies used in radio work which combined to some extent the system backed in 1937 by the C.C.I.R. and that put forward in *Wireless Engineer* for May, 1942, by B. C. Fleming-Williams. The former is primarily a classification by wavelengths; the latter, primarily a classification by frequencies. What really is needed is a system which buttons up the two methods in a logical way and provides a classification that is as much by wavelengths as by frequencies. This can, I believe, be achieved by a small modification of the system worked out last month in these notes. The "powers of ten" method has a great deal to recommend it and a useful key is provided by using, not just simple powers of ten but powers of ten multiplied by three for the frequencies. If we work in kilocycles and not in cycles the formulæ for the conversion of frequencies into wavelengths and *vice versa* become $f = \frac{3\times10^5}{\lambda}$ and $\lambda = \frac{3\times10^5}{f}$. The bands, numbered from 1 to 7, thus run in frequencies from below 3×10^1 (may I write 10^1 for the sake of clarity?) to 3×10^7. The corresponding wavelengths range from above 10^4 meters for band No. 1 to 10^{-2} metres at the lower end of the band No. 7. All this is shown in the accompanying table.

Easy to Remember

The suggested classification is easy to fix in one's mind when some of its points are noted. First of all the band number is given by the highest frequency in kilocycles that it contains. It can also be found by subtracting the power of ten of the shortest corresponding wavelength from 5, which follows from the fact that the conversion formula that we are using is: $\frac{3\times10^5}{f\,(\text{kc/s})\times\lambda\,(\text{metres})} = 1$. Thus in band 1 the shortest wavelength is 10^4 metres and $5-4=1$. The lower limit of band 3 is 10^2 metres: $5-2=3$. In band 7 the shortest wavelength is 10^{-2} metres and $5-(-2)=7$. The waveband names show the respective powers of ten of the wavelengths concerned: thus, Myria- means $10{,}000 = 10^4$; Kilo- means $1{,}000 = 10^3$; Hecto- means $100 = 10^2$; Deca- means $10 = 10^1$; we have 10^0 for one metre; Deci- means $\frac{1}{10} = 10^{-1}$; Centi- means $\frac{1}{100} = 10^{-2}$.

Naming the Frequencies

You will notice that I have changed the names originally adopted by the C.C.I.R. for bands 4, 5, 6 and 7. I don't like the sequence High, Very High, Ultra-High and Super-High, particularly the last two; in the ordinary way Ultra-High and Super-High would mean the same thing. Medium High, High, Very High and Ultra-High is better, but it isn't completely satisfactory. Can any reader offer improved names for the frequencies of these bands?

□ □ □

Lease-Lend HTBs

IN *The Wireless Trader* for January 2nd, 1943, I see that a certain number of Lease-Lend radio high-tension batteries have been imported from the U.S.A. and that some of them are now making their way into the shops. Good news, that, for battery users, who have recently found some kinds of HTB at any rate rather hard to buy. But I'm afraid that the number of American batteries is not large, so that we must not expect to find that the shortage has completely disappeared. Nor will these batteries suit all sets. So far as I can make out, all are of the 120-volt type, though what size of cells they contain I don't yet know. They have spring-clip connectors instead of the plug-sockets with which we are familiar, and I expect that they probably have but two clips labelled 0 and 120 volts, for Americans don't make much use of tappings, and always regard our many-socketed HTBs with amazement. When you are using clip-fitted batteries there's no need, as a rule, to remove the wander plugs; with a little persuasion they can be manœuvred under the tongues of the clips.

Why the Shortages ?

It's curious to notice how battery shortage seems to go in cycles. In the winter of 1939-40 almost all types of dry battery were as good (or as bad!) as unobtainable for a spell. Then came plenty for a long time; then a period of shortage, and so on. At the time of writing, some flash-lamp refills—particularly those that fit bicycle lamps—are rare in the shops, though they were easy enough to get before Christmas. So far as I know, the makers' output does not fluctuate violently; it is the popular demand that seems to do so. What is rather mystifying is that the shortage of flash-lamp refills should become most marked *after* the shortest day is past.

Band	f in kc/s	Frequency Name	λ in metres	Waveband Name
1	Below 3×10^1	Very Low	Above 10^4	Myriametre
2	3×10^1—3×10^2	Low	10^4—10^3	Kilometre
3	3×10^2—3×10^3	Medium	10^3—10^2	Hectometre
4	3×10^3—3×10^4	Medium High	10^2—10^1	Decametre
5	3×10^4—3×10^5	High	10^1—10^0	Metre
6	3×10^5—3×10^6	Very High	10^0—10^{-1}	Decimetre
7	3×10^6—3×10^7	Ultra High	10^{-1}—10^{-2}	Centimetre

SQUEGGING OSCILLATORS

Explaining Their Operation

By
EDWARD HUGHES,
D.Sc., M.I.E.E.

IT is well known that in a valve oscillator of the type shown in Fig. 1 the oscillations may, under certain conditions, be continually starting and stopping, a phenomenon known as "squegging." Although this effect is sometimes turned to practical account—for example, in crude modulated oscillators—it does not seem to be satisfactorily explained in text-books. It is not sufficient to say that the time constant, C_2R_2, of the grid condenser and leak must be large, since it is found that, with a given time constant, a triode may generate oscillations of constant amplitude when the coupling between L_1 and L_2 is loose, but may squeg when the coupling is tightened.

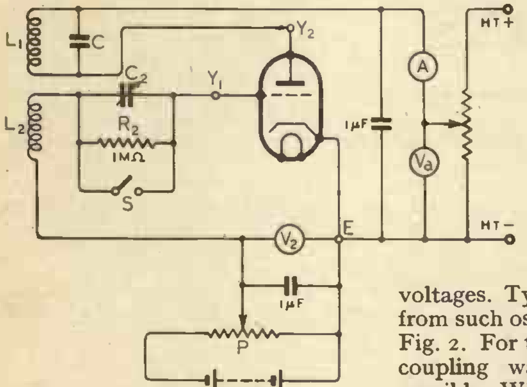

Fig. 1. Circuit of a squegging oscillator. The provision of meters and of means for fine adjustment of operating voltages is of course incidental to the investigation of the behavious of the oscillator, and not essential to its operation.

The double-beam cathode-ray oscillograph is particularly convenient for investigating the action of a squegging oscillator, as it enables the grid-cathode and the anode-cathode voltages to be observed simultaneously. In the actual oscillator investigated, C_2 was a 3-dial decade condenser having a total capacitance of about 1 microfarad; and points E, Y_1 and Y_2 were connected to the corresponding plates of the CRO, so that the oscillograms represented the DC as well as the AC components of the voltages.

With switch S open, zero grid bias from P, and C_2 adjusted to, say, 0.05 μF, suppose the coupling between L_1 and L_2 to be tightened. The first effect is to generate continuous oscillations; but when the coupling exceeds a certain value, the amplitude of the oscillations is modulated, and further increase in the coupling produces pulses of oscillations spaced relatively far apart.

With the time base of the CRO set to a low speed, it is possible to trace the envelopes of the RF voltages. Typical envelopes derived from such oscillograms are shown in Fig. 2. For this particular series the coupling was made as tight as possible. With slightly less coupling the initial tips M and N in the anode-cathode PD disappear. Curve (c) in Fig. 2 was obtained by connecting the oscillograph across grid condenser C_2; and the dotted line in Fig. 2 (b) indicates the phase relationship between this curve and that of the grid-anode voltage.

At instant B the negative potential of the grid relative to the cathode has decreased to a value that is found to be the cut-off bias of the valve under static conditions with anode voltage oA. Anode current begins to flow, and the oscillations increase quickly in amplitude. The amplitude of the EMF induced in L_2 increases sufficiently to send the grid considerably positive during each positive half-cycle. The corresponding grid currents charge C_2 so that the PD across the latter follows curve BE, and the positive peaks of the grid-cathode voltage follow curve CD. The pulses of grid current decrease in amplitude so quickly that they are soon only just sufficient to compensate for the leakage through R_2. These positive peaks of grid voltage produce pulses of anode current and thereby help in maintaining the oscillations in circuit L_1C.

Fig. 3 (b) has been drawn (but not to scale) to indicate what is going on inside the envelope of Fig. 2 (b); and the zig-zag line between B and F represents the PD across C_2 during the squeg. The fact that the PD across C_2 does tend to be a saw-tooth wave can be demonstrated by using relatively low values of R_2 and C_2 with the oscillator generating continuous waves. It is seen that during CD there are pulses of anode current of decreasing amplitude as in Fig. 3 (a), and the corresponding energy supplied from the HT source tends to maintain oscillations in LC. After instant D, however, the pulses of anode current decrease rapidly and the oscillations are quickly damped out, the rate of damping being dependent upon the decay factor, $R/2L$, of coil L_1.

During interval FG, condenser C_2 is discharging through R_2, and the grid bias decreases until, at G, anode current commences once more.

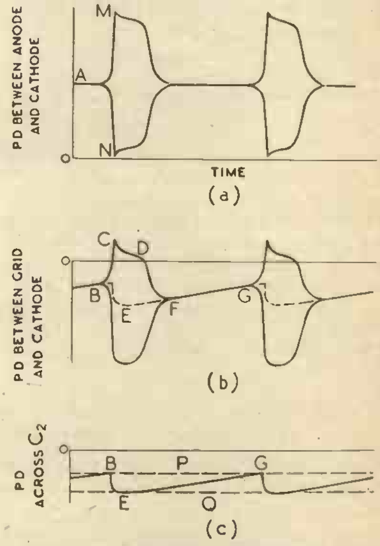

Fig. 2. Typical "envelopes" of the RF oscillations.

The influence of the mean grid-cathode PD upon the oscillations can be confirmed by closing switch S and increasing the bias from potentiometer P until the oscillations cease. The line traced by the Y_1 beam of the CRO corresponds to the dotted line Q in Fig. 2 (c), and is found to pass through E. The slider on P (Fig. 1) is then moved back slowly, and it is found that, just before oscillations recommence, the line traced by the Y_1 beam is represented by the dotted line P in Fig. 2 (c) and passes through B and G. In a particular case, the bias V_2 had to be increased to -30V to stop the oscillations, and then reduced to -18V before the oscillations recommenced.

Coupling Effect

It is found that the difference between these critical grid voltages depends upon the mutual inductance between L_1 and L_2, i.e. upon the EMF induced in L_2 by a given oscillatory current in L_1. When this EMF is relatively large, the oscillations, once started, will continue

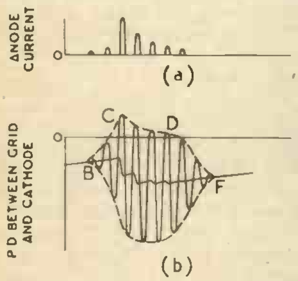

Fig. 3. Analysing an oscillation pulse.

with a mean grid bias considerably greater than the cut-off value. This is due to the positive peaks of the EMF induced in L_2 being sufficient to send the grid positive for a short portion of each cycle and thereby produce pulses of energy from the HT source sufficient to maintain the oscillations. Once these oscillations cease, they cannot be restarted until the negative bias on the grid falls sufficiently for the anode current to commence flowing.

The looser the coupling between L_1 and L_2, the smaller is the difference between the value of V_2 to stop the oscillations and that which allows them to recommence; and it is the magnitude of this difference that determines whether an oscillator squegs or does not squeg.

It will now be evident that the recurrence frequency of the squegs is higher the shorter the time required for the PD across C_2 to fall from E to G in Fig. 2, i.e., the smaller the time constant C_2R_2. The frequency also depends upon the mutual inductance between L_1 and L_2, since this controls the difference between the voltages at B and E and therefore influences the time required for the bias to fall from E to G. The duration of the squeg, i.e., interval BF in Fig. 2, depends upon the capacitance of C_2 and upon the coupling between L_1 and L_2, but is hardly affected by the value of the leak R_2. These conclusions can be confirmed by varying C_2, R_2 and the coupling independently and noting the effect on the shape of the oscillogram.

FIXED CONDENSERS:

A New Specification

A NEW British Standard Specification (B.S. 1082) has recently been published for fixed capacitors. This specification is based on technical information supplied by the British Electrical and Allied Research Association, which organisation has carried out considerable experimental work with a view to revising and extending the scope of the 1926 Specification.

The earlier Specification was limited in scope to the small condensers used at that time in radio receivers, but the considerable extension of wireless in recent years, and the parallel developments of other activities involving the use of fixed condensers, clearly necessitated the drafting of a more comprehensive specification. The present specification covers all fixed condensers for general purposes, whatever the nature of the electrodes and insulant. It is not, however, intended to apply to condensers for specialised application.

Copies of this new British Standard may be obtained from the British Standards Institution, 28, Victoria Street, Westminster, S.W.1, price 2s. (2s. 3d. by post).

AIRCRAFT DEVELOPMENT

OUR associate journal *Flight* recently published a series of articles by its Managing Editor, G. Geoffrey Smith, on the development of aircraft thermal jet propulsion systems. These articles have now been reprinted, together with amendments and additions, in an illustrated handbook, "Gas Turbines and Jet Propulsion for Aircraft," price 3s. 9d., including postage, which can be obtained from "Flight," Dorset House, Stamford Street, London, S.E.1.

GOODS FOR EXPORT

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this journal should not be taken as an indication that they are necessarily available for export

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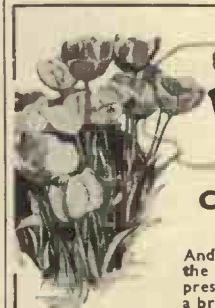
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WORLD OF WIRELESS

AMATEUR ACTIVITIES

IN a message to amateurs regarding post-war activities, A. D. Gay, president of the Radio Society of Great Britain, states that "as far as can be judged at present the G.P.O. is agreeable to the restoration of full licences to all pre-war licence holders, but for Service reasons questions relating to frequency, power and other matters of detail cannot be considered officially at the present time. With many Axis amateurs still on the air, without apparently causing any embarrassment to Service requirements, there seems to me no reason why British licences, terminated in September, 1939, should not be restored within, say, two months of the time hostilities cease, followed by the return of our impounded equipment as promptly as it was collected."

The Annual Report of the Society records the growth of the membership during the year from 3,130 to 4,480, and records a very healthy financial position.

It is learned from the report that negotiations have proceeded between the Society and Government Departments regarding the issue of a Service radio trade certificate, or its equivalent, to Service personnel when they return to civilian life. The purpose of these certificates would be to establish proof that the holder achieved a certain defined standard in radio theory and/or morse knowactive service and that he will be exempted from possible examinations in radio theory and/or Morse knowledge, when applying for an amateur transmitting licence.

Professor C. L. Fortescue, president of the I.E.E. and a member of the R.S.G.B. for well over 20 years, has been elected a vice-president of the Society.

Dr. R. L. Smith-Rose, who is the chairman of the I.E.E. Wireless Section and a founder member of the Wireless Society of London—the forerunner of the R.S.G.B., has been elected an honorary member.

SIR PHILIP JOUBERT

DURING the seventeen months in which Air Chief Marshal Sir Philip Joubert was A.O.C.-in-C. R.A.F. Coastal Command, he made full use of his extensive knowledge of short-wave wireless for the development of radiolocation. Commenting on Sir Philip's work the Aeronautical Correspondent of *The Times* says: "His great technical knowledge has been invaluable in a campaign which cannot be fully appreciated until the war is over."

Sir Philip Joubert has relinquished the position of A.O.C.-in-C. Coastal Command to become an Inspector-General of the R.A.F., in which position it is hoped he will be able to continue to make full use of his technical ability.

NEW YEAR HONOURS

THERE were surprisingly few representatives of the world of wireless to be found in the New Year Honours List. The appointment of C. O. Stanley, managing director of Pye, as an O.B.E., will meet with general approval among members of the wireless industry. Dr. C. Dannatt, head of a section of the Research Department of Metropolitan-Vickers, was also appointed an O.B.E.

E. C. S. Megaw, scientific officer in the G.E.C. Research Laboratories, who is a frequent contributor to our sister journal *Wireless Engineer*; A. L. Chilcot, chief engineer of the Electronics Department of Ferranti; and T. W. Morgan, works manager of Marconi's, were among those appointed Members of the Order of the British Empire.

Members of the B.B.C. staff were also among the many civil awards for public service. D. Stephenson, assistant director of the Near East Services, becomes an O.B.E.; D. C. Birkinshaw, engineer-in-charge of the Daventry station, an M.B.E., and Miss H. F. K. Fuller, principal private secretary to the B.B.C. Director General, an M.B.E.

Among the many members of the Merchant Navy who received awards was D. Thomson, first radio officer, who becomes an M.B.E.

Two overseers in charge of Air Ministry radio stations, W. B. Crawford and F. E. Feaver, were awarded the British Empire Medal.

VOICE OF AMERICA

A RECENT agreement between the U.S. Government and the owners of fourteen of America's international short-wave stations virtually places the entire control of the programme arrangements for these stations in the hands of the Government. The owners will, however, continue the technical operation of their transmitters, without profit—the Government paying the costs.

This scheme, which unifies the operation of the nation's short-wave stations, has, it is learned from *Broadcasting*, necessitated the transfer of a number of members of the stations' staffs to the Office of War Information and the Co-ordinator of Inter-American Affairs who will be responsible for the provision of programmes.

Most of the following fourteen stations are linked in what is known as the Bronze Network, so that the multilingual programmes originate in New York.

WLWO, Mason, Ohio.
KGEI, KWID, San Francisco, California.
WCRC, WCBX, WCDA, Brentwood, N.Y.
WGEO, WGEA, Schenectady, N.Y.
WRCA, WNBI, Bound Brook, N.J.
WBOS, Hull, Mass.
WRUL, WRUW, WRUS, Scituate, Mass.

In addition to these stations there are one or two stations, such as WCW and WCAB, which have for some time been transmitting Government programmes.

"IONOSPHERE PERMITTING!"

AN interesting talk on the ionosphere and the vagaries of short-wave broadcasting was given by Sir Edward Appleton in a recent broadcast in the B.B.C. Home Service. A difficult and complex subject was

NAVAL TELEGRAPHISTS at the communications centre in the North—the busiest signal station outside the Admiralty—are here seen engaged in long-distance communication with ships. Wrens carry out much of the work, and are employed as telegraphists, radio-telephonists, cypher officers and in many other duties.

dealt with in a manner which should have been readily understood by the average listener.

He stated that "it is possible to receive speech from this country in practically every inhabited part of the world on between 70 to 90 per cent. of the days in the year, varying with the area in which reception takes place. With really elaborate receiving equipment the 1940 figure was as high as 92 per cent. for short-wave communication between this country and the United States."

Sir Edward suggested that just as open-air functions are often advertised as taking place "weather permitting," so short-wave oversea broadcasts should be advertised as taking place "ionosphere permitting"!

BRITISH STANDARDS

THE latest information regarding the issue of new and revised British Standards, of which there are at present over a thousand, can be obtained from the British Standards Institution Library at 28, Victoria Street, London, S.W.1. The Library, which is open between the hours of 10 a.m. and 5 p.m., Mondays to Fridays, and at other times by appointment, also contains a large selection of specifications prepared by the standards bodies in Australia, New Zealand, South Africa, Canada, U.S.A., Argentine, Sweden, France, Germany, etc. Extracts from specifications may be made, if desired, and copies of the oversea specifications may be borrowed from the Library.

For readers in the provinces it may be of interest to state that most of the technical libraries, Universities and Central Public Reference Libraries maintain a complete set of British Standards.

ETHIOPIAN WIRELESS OPERATORS

STARTING an army virtually from scratch was the task which faced Major-General S. S. Butler, C.B., C.M.G., D.S.O., and the British Military Mission to Ethiopia.

The chief feature that has been aimed at in the training and formation of this army is its mobility, and communications, therefore, formed one of the most important sections. The Ethiopian is not by nature mechanically minded, but the training of signalmen and wireless operators was accomplished in remarkably short time.

Not only were the majority of recruits unable to read or write, but they had to be taught English, both reading and writing. The principle was to select a hundred boys for a preliminary general course of training, and to follow it with a two years' specialised course. A proof of their ability was shown during the Gondar operations, where a large number of the wireless telegraphists were Ethiopians.

WHITHER S-W BROADCASTING?

SIR NOEL ASHBRIDGE, B.B.C. Controller (Engineering), in a recent broadcast to oversea listeners, summarised the technical progress in short-wave broadcasting during the ten years since the introduction of the Empire Service. He asked: "What will be the future of short-wave broadcasting when and if news becomes a matter of less pressing importance?" He contends that "if the progress in the next ten years is anything like that in the last ten years, we may look forward to the day when reception from far-off countries is almost as good as from the local station, and a few years after that we may even see the addition of pictures."

NEW P.M.G.

BEFORE assuming his duties as Postmaster - General, Captain H. F. C. Crookshank is going to the United States to review the staffing of our wartime missions there. This will be his final task in his old office as Financial Secretary to the Treasury. Mr. W. S. Morrison, who has been P.M.G. since 1940, has been appointed Minister-Designate for the new Ministry of Town and Country Planning.

CONSERVING EQUIPMENT

WITH a view to prolonging the life of American broadcasting station equipment the Federal Communications Commission recently ordered all transmitters to be "under-run." Concurrently the Commission also authorised the relaxation of the normal engineering standards for broadcast equipment and also the regulation requiring stations to operate for not less than two-thirds of their authorised time each day.

AUSTRALIAN LISTENERS

FOR the purpose of issuing receiving licences in Australia a system of zoning has been introduced by the new Broadcasting Act. The standard licence fee for one receiver in Zone 1, which comprises territory within a 250-mile radius of a broadcasting station, is £1, and that in Zone 2, which comprises territory outside that radius, is 14s.

Another innovation is the necessity of obtaining a licence for *each* set in use in a house. The licence fee for additional sets is half the standard rate in each zone. In hotels, boarding houses, etc., the standard fee is charged for the master receiver and an additional half fee for each receiving appliance (i.e., phones or speaker) installed in separate rooms.

No fee is charged for hospitals and charitable institutions where reception is for inmates. Old age pensioners have to pay half fee, whilst

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The World of Wireless—
blind listeners, as in this country, obtain free licences.

Wireless dealers and service men are required to have one licence only. To ensure that all receivers are licensed, dealers now have to notify the Radio Inspector of each set sold.

IN BRIEF

Planning of Science.—Sir Stafford Cripps and Sir Robert Watson-Watt will be the main speakers at a conference arranged by the Association of Scientific Workers to discuss the "planning of science in war and in peace." This open conference will be held at the Caxton Hall, Westminster, London, S.W.1, on January 30th and 31st.

Radiophoto Service.—To inaugurate a radiophoto service between America and China, a handwritten letter from the President to General Chiang Kai-Shek was transmitted. A new radiophoto circuit between Stockholm and New York was also recently opened by R.C.A. Communications in co-operation with the Swedish Telegraph Administration.

Obituary.—We record with regret the death, at the age of 46, of Owen H. Relly, G2AO, who had held a transmitting licence since 1919. He was among the first to contact some remote parts of the Empire and was the first British amateur to contact China. In 1933 he did considerable work on the then high frequency of 56 Mc/s, and also established a two-way television link with G5JZ on 1.7 Mc/s.

Swiss Wired Wireless.—Five carrier frequencies with a frequency separation of 33 kc/s are employed in the new radio-frequency wired wireless system installed by the Swiss Postal Administration to serve St. Gall, Rorschach and the Upper Rhine Valley with five different programmes. The carrier frequencies are between 175 and 307 kc/s and are therefore receivable on standard long-wave receivers.

Radio Officers.—It is learned from the Radio Officers' Union that more than 500 men who have obtained the P.M.G.'s Special Certificate are awaiting berths.

HT Batteries.—The Board of Trade, after consultation with the Central Price Regulation Committee, recently made an Order controlling the prices of HT batteries imported under the Lease-Lend provisions.

Canadian FM.—The Toronto Transportation Commission will have the first frequency-modulation transmitting system to be used by a transport concern in Canada. Traffic supervisors' cars are to be fitted with two-way FM apparatus

Empire News Bulletins.—The current schedule of the B.B.C.'s transmissions of news in English for oversea listeners is given below. In some of the wavebands shown as many as three wavelengths are employed for some transmissions. The times are BST.

0200	49, 31	1400	25, 19
0345	49	1600	31, 25, 19, 16
0530	49, 41	1700	31, 25, 19, 16
0715	41, 31	1900	25, 19
0900	41, 31, 25	2045	31, 25, 19
1000	49, 41, 31, 16	2245	49, 41, 31*, 25*
1200	25, 19	2345	49, 31

* Sundays excepted.

Brazilian Industry.—The establishment of a wireless industry in Brazil is being studied by a recently appointed State Commission.

I.E.E. Wireless Section.—The next meeting of the Section will be held on February 3rd, at 5.30 p.m., when Prof. Willis Jackson, D.Sc., D.Phil., will deliver a paper on "The University Education and Industrial Training of Telecommunication Engineers."

Appointment.—Sir Edward Wilshaw, chairman and managing director of Cable and Wireless, Ltd., has been appointed to the board of Marconi (China), Ltd.

Brit.I.R.E. Meeting.—The subject of the paper to be read by J. H. Reyner at the meeting of the Brit.I.R.E. on February 19th, at the Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1, will be "Industrial Applications of Electronics."

NEWS IN ENGLISH FROM ABROAD

REGULAR SHORT-WAVE TRANSMISSIONS

Country : Station	Mc/s	Metres	Daily Bulletins (BST)
America*			
WNBI (Bound Brook)	17.780	16.87	2.0†, 2.45‡, 4.0§‡, 6.0.
WRCA (Bound Brook)	9.670	31.02	7.0 a.m., 9.45 a.m.
WRCA	15.150	19.80	2.0†, 2.45‡, 4.0§‡, 6.0.
WGEO (Schenectady)	9.530	31.48	9.55 a.m., 9.0†, 10.55§‡.
WGEA (Schenectady)	15.330	19.57	9.0 a.m., 2.0, 3.0, 7.45§‡, 11.0.
WBOS (Hull) ..	11.870	25.27	12.45 a.m.†, 12.0 mdt.
WBOS	15.210	19.72	9.0 a.m., 2.0†, 2.45‡, 4.0§‡, 6.0.
WCAB (Philadelphia)	6.060	49.50	6.0 a.m.
WCBX (Brentwood)	15.270	19.65	11.30 a.m., 3.30, 7.30‡, 9.30.
WCRC (Brentwood)	11.860	25.30	11.30 a.m., 3.30, 7.30‡, 9.30.
WCW (New York) ..	15.870	18.90	3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0.
WCDA (New York) ..	17.830	16.83	1.0, 2.0.
WRUL (Boston) ..	11.790	25.45	9.30‡.
WRUL	15.350	19.54	1.0, 9.30‡.
WLWO (Mason) ..	6.080	49.34	6.0 a.m., 7.0 a.m., 8.0 a.m., 9.0 a.m., 10.0 a.m.
WLWO	11.710	25.62	7.0, 8.0, 9.0, 10.0.
WLWO	15.250	19.67	3.0, 4.0, 5.0.
Australia			
VLQ6 (Sydney) ..	9.580	31.32	7.0 a.m.
VLQ5 (Sydney) ..	9.680	30.99	8.0 a.m.
VLG3 (Melbourne) ..	11.710	25.62	8.0 a.m.
Brazil			
PRL8 (Rio de Janeiro)	11.720	25.60	8.0.
China			
XGOY (Chungking)	11.900	25.21	2.0, 4.0, 5.15, 9.30.
French Equatorial Africa			
FZI (Brazzaville) ..	11.970	25.06	8.45.

Country : Station	Mc/s	Metres	Daily Bulletins (BST)
India			
VUD3 (Delhi) ..	7.290	41.15	8.0 a.m., 1.0, 3.50.
VUD4	9.590	31.28	8.0 a.m., 1.0, 3.50.
VUD3	15.290	19.62	1.0.
Spain			
EAQ (Aranjuez) ..	9.860	30.43	6.15.
Sweden			
SBU (Motala) ..	9.535	31.46	10.20.
SBT	15.150	19.80	4.0.
Turkey			
TAP (Ankara) ..	9.465	31.70	7.15.
U.S.S.R.			
Moscow	5.890	50.93	11.0.
	6.970	43.04	11.45.
	7.300	41.10	8.0, 9.0, 10.0, 11.0.
	7.360	40.76	11.0.
	7.560	39.68	11.0.
	9.390	31.95	4.0.
	11.830	25.36	4.0, 6.0.
	15.110	19.85	2.15 a.m., 12.40, 11.45.
	15.180	19.76	12.40, 11.45.
	15.230	19.70	2.15 a.m., 11.45.
	15.270	19.65	12:40.
	15.750	19.05	1.0 a.m., 2.0 a.m., 11.45.
Kuibyshev	8.050	37.27	8.30.
	13.010	23.06	6.0 a.m., 2.0, 2.45.
	14.410	20.82	2.0, 2.45.
Vatican City			
HVJ	5.970	50.25	7.15.

MEDIUM-WAVE TRANSMISSIONS

Country : Station	kc/s	Metres	Daily Bulletins (BST)
Ireland			
Radio Eireann ..	565	531	1.40‡, 6.45, 10.10.

* With the unifying of the control of American stations some of the schedules given will be altered.
It should be noted that the times are BST—one hour ahead of GMT—and are p.m. unless otherwise stated. The times of the transmission of news in English in the B.B.C. Short-wave Service are given at the top of this page.
§ Saturdays excepted. † Sundays only. ‡ Sundays excepted.

Letters to the Editor

Operators' Qualifications • Distribution of Hearing Aids • New Wavelength Unit

P.M.G. Examinations

I HAVE read with interest the article appearing in the January *Wireless World* under the above heading and would like to make the following observations.

Prima facie, Mr. Moore's criticisms would appear to be justifiable, but it is necessary to consider carefully the duties of a radio officer on board ship and the essential requirements for such duties.

The main work of a radio officer is to send and receive messages in morse. Therefore he should be a first-class telegraphist. Some technical knowledge is obviously required, but the point is, how much?

I have had more than thirty years' experience of radio officers and their work and have yet to learn of any ship's wireless apparatus being unusable through lack of technical knowledge of the radio officers.

Therefore, on this premise, it is apparent that the standard of technical and practical knowledge as required by the P.M.G. syllabus is all that is necessary.

My only comment on the present P.M.G. syllabus is that the standard of morse is rather too low and the examination test of three minutes should be increased to five minutes.

Mr. Moore would prefer to have the technical knowledge raised to a high standard, and in addition students should have instruction in laboratory testing instruments. I consider, first, that it is unnecessary; secondly, the remuneration (taking the pre-war standard) would not be commensurate with such knowledge; thirdly, that the cost and expense of training would not be justified by the position obtained or obtainable.

With reference to the suggestion regarding classes of certificates and the experience to be obtained before being eligible to sit for a second- or first-class certificate, while this at first sight would appear to be desirable, is it a workable scheme?

For example, assuming a third-class officer, after 12 months' experience at sea, wished to sit for the second-class certificate, would he resign from his employment to do so, or would he be granted leave for such purpose? If he resigned, would he be guaranteed reinstatement as and when he obtained the second-class certificate, having regard to the fact that his post would have to be filled while on leave. If granted leave, would he remain an employee of the company, his position having perforce to be filled during his absence. A consideration of the suggestion shows that there is a possibility of it leading to a redundancy of radio officers.

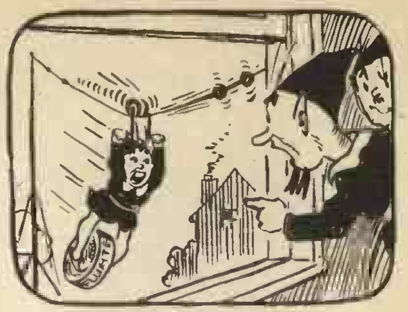
There is another matter with which Mr. Moore does not deal, and it may be an opportune moment for mentioning it.

A radio officer, though employed by a wireless company or perhaps directly by the shipping company, is liable to have his certificate withdrawn or cancelled by the Postmaster General if he fails to comply with the conditions under which that certificate is issued. Therefore we have the somewhat anomalous position of a man being employed by private concerns and his employment depending upon the Government. Would it not be far more consistent if radio officers were in the direct employ of the Postmaster General? He is the person to whom the radio officer is responsible; messages are dealt with by the Post Office wireless stations on shore, and a record of all messages has to be forwarded to the G.P.O.

It would be infinitely better for all concerned if wireless telegraphy at sea was conducted exclusively by the Government, and indeed better for the nation as a whole, for in times of emergency, such as arose in September, 1939, there would not be the confusion and rush for radio officers as happened at that time.

JAMES H. WEBB,
Principal, The British School of Telegraphy.
London, S.W.9.

AS a former Merchant Navy wireless officer who became dissatisfied with the prospects of the



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Letters to the Editor—

service, may I comment on Mr. Moore's article in your January issue?

Until the prospects are better, I would strongly deprecate any alteration to existing certificates, but would suggest an additional certificate, provided it would be of use to the officer ashore. This "Extra First" certificate, as it might be called, should carry definite recognition as a technical qualification by the competent examining bodies concerned.

JOHN A. W. EDWARDS.
London, N.W.9.

Hearing Aids

I CANNOT help feeling that one of the most important points relative to the distribution of hearing aids has been overlooked in the recent correspondence on the subject.

It is agreed that the present relatively high cost of good appliances is due to the overhead charges entailed in distribution. This would, of course, be overcome to a large extent by wider use of hearing-aid clinics, which will undoubtedly come into being after the war. The point most advocates of low-priced appliances appear to miss is the paramount need for the most comprehensive service after sale.

Fifteen years' experience in the production and distribution of medically approved appliances has shown that the deaf public require service facilities of an all-embracing nature. They like to feel that they can consult a hearing-aid technician at any time on the many personal and minor mechanical problems arising, particularly during the first few months. For instance, many persons who find difficulty in grasping such minor points as control of volume, removal and replacement of batteries, etc., are soon disappointed and discouraged unless they feel that some sympathetic help is readily available from a technician who can, if required, go to their home and deal with their difficulty promptly and courteously.

To most deaf persons a hearing aid is a very important part of their life, and they expect the supplier to feel the same way about it when service is needed. Many deaf persons have told me that they prefer to pay a little more for an appliance sold with the assurance of first-class service facilities than to have a cheaper aid, the selling price of which provides no margin for service on the scale they expect and require to keep them happy.

It is not difficult to imagine the reaction of a radio dealer, interrupted in the last stages of demonstrating a 50-guinea radio gramophone to deal with a distressed old lady indignantly declaiming that the hearing aid she bought last week won't work, and to find that an exhausted low tension battery is the cause of her grief!

By all means let us have lower-priced hearing aids, but in achieving this, let us bear in mind all the requirements of the purchaser, and plan accordingly.

T. CONSTANTINE.
London, W.1.

AS a deaf subject of many years' standing I would very much like to thank you for your attempt to awaken interest in the radio industry regarding the mass production of deaf aids.

The two aids I am using now (one at the office and the other at home) are carbon microphones, and the head-piece is the mastoid bone conduction type. These aids cost £25 each, the reproduction is far from natural, and they consume 100 milliamps continuously. I am experimenting with a valve type of hearing aid, and the opinion I am forming is that it is a vast improvement all round.

At first you tackled the problem in what I thought was the right way, but if you revise your procedure by bringing in the B.M.A. you will fail to produce a hearing aid that all can buy.

If the B.M.A. can do nothing at all for us medically, then we deaf people are out of their domain, and I claim I am justified in using any aid I can possibly hear well with.

The experimental section of a modern radio firm with the different type of material at their disposal should have a big advantage.

JOHN K. DALTON.
Rotherham, Yorks.

New Unit of Wavelength

THE Editorial in the December issue of *Wireless World* raises once more the problem of classification of frequencies and wavelengths, the last paragraph pointing out the difficulty of formulating a simple consistent scheme applying to both quantities.

The difficulty, clearly, is embodied in the relation between frequency, wavelength and velocity of propagation, i.e.,

$$n\lambda = c,$$

and the fact that c, expressed as a power of 10, is not integral when metres and seconds are the units.

The problem can be solved by a change of two of the units in the fundamental equation.

Except for work on aerials, linear circuits and waveguides, as pointed out in the Editorial, one has come to think in terms of frequency. The unit of wavelength normally used in radio practice is the metre, whereas, in workshop practice, aerials and the like are commonly measured in feet and inches. Hence, apart from the usual correction of approximately -5 per cent. for the lower propagation velocity in metals and for strays, a simple conversion is necessary in almost every practical instance.

If a light-second were used as the unit of wavelength, and the velocity of light as the unit of velocity, and employing Fleming-Williams' suggested frequency scheme, we would have a similar form for our wavelength scheme, as tabulated below.

Band No.	Frequency (in c/s)	Wavelength (in light-secs.)	Wavelength (in metres, approx.)
0	$1–10 \times 10^0$	$1–0.1 \times 10^0$	
1	$1–10 \times 10^1$	$1–0.1 \times 10^{-1}$	
2	$1–10 \times 10^2$	$1–0.1 \times 10^{-2}$	
3	$1–10 \times 10^3$	$1–0.1 \times 10^{-3}$	
4	$1–10 \times 10^4$	$1–0.1 \times 10^{-4}$	30,000—3,000
5	$1–10 \times 10^5$	$1–0.1 \times 10^{-5}$	3,000—300
6	$1–10 \times 10^6$	$1–0.1 \times 10^{-6}$	300—30
7	$1–10 \times 10^7$	$1–0.1 \times 10^{-7}$	30—3
8	$1–10 \times 10^8$	$1–0.1 \times 10^{-8}$	3—0.3
9	$1–10 \times 10^9$	$1–0.1 \times 10^{-9}$	0.3—0.03
10	$1–10 \times 10^{10}$	$1–0.1 \times 10^{-10}$	0.03—0.003

The first advantage of this suggested scheme is that our frequency bands, as numbered in col. 1 by Fleming-Williams, correspond in decades with our wavebands, without a 3 as multiplier or diviser.

Secondly, our unit of wavelength is more "fundamental" than the metre, bearing a precise relation to the frequency, whereas the usual statement that

Wavelength (m.) × frequency (c/s) $= 3 \times 10^{10}$

is only a good approximation, the velocity of light being, in fact, rather less than 3×10^{10} metres per second in free space.

The shortcomings of this suggested scheme seem few to the writer, the chief being the natural conservatism of the mind, radio engineers having been used to the metre as the wavelength unit for many years. The light-second (or, more commonly, the light-year) has, of course, been in use as an astronomical unit for a considerable time.

From the practical point of view in the construction of aerials and the like, we would merely have to remember a new constant for converting light-seconds into feet and inches, in place of that for converting metres into English measure.

In view of the clumsiness of the expression "light-second," a more convenient word might be coined and used with the usual metric prefixes, micro-, milli-, etc.

T. LYELL HERDMAN.
West Wickham, Kent.

Physiological Effects of UHF

DR. DALTON'S answer to your Brains Trust question regarding the effect of UHF on the human body was interesting. It calls to mind an article in *Nature*, June 29th, 1940, dealing with the destruction by a current at 1 Mc/s of parts of the poison ducts of a snake. Can there be any part of the human body (a cell of the brain, perhaps) which is similarly affected by current at very high frequencies?

S. C. MURESON.
Dunfermline.

The Editor does not necessarily endorse the opinions of his correspondents

BOOKS RECEIVED

Teach Yourself Radio Communication. By Eric M. Reid. No previous knowledge of the subject is assumed. Starting with elementary electricity and magnetism, the book then explains the qualities of inductance, capacity and resonance. Discussion of the principles of radio communication, including radiation and wave propagation, is followed by chapters on valves, transmitters and receivers. Pp. 175; 96 figures. Published by English Universities Press, Ltd., St. Hugh's School, Bickley, Kent. Price 2s. 6d.

A First Course in Wireless (2nd Edition). By "Decibel." Written mainly from the point of view of the broadcast listener who wishes to understand the functioning of his receiver. Introductory chapters deal with the nature of electricity, Ohm's Law, and AC and DC currents. Wave propagation, transmission and modulation follow; the remaining chapters deal with the details of receiver operation. Pp. 221. Published by Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, London, W.C.2. Price 5s.

D/F Handbook for Wireless Operators. 2nd Edition. By W. E. Crook. A chapter on aircraft DF has been added to this edition. A working knowledge of elementary theory on the part of the reader is assumed; the book deals with general principles and practices rather than with any specific type of apparatus. Pp. 85; 111 figures. Published by Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, London, W.C.2. Price 3s. 6d.

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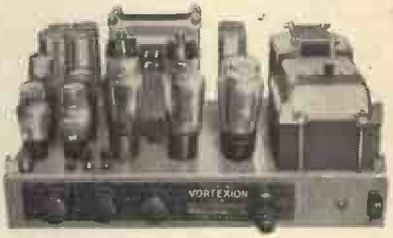

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The response curve is straight from 200 to 15,000 cycles. In the standard model the low frequency response has been purposely reduced to save damage to the speakers with which it may be used, due to excessive movement of the speech coil. Non-standard models should not be obtained unless used with special speakers loaded to three or four watts each.

A tone control is fitted, and the large eight-section output transformer is available in three types: 2-8-15-30 ohms; 4-15-30-60 ohms or 15-60-125-250 ohms. These output lines can be matched using all sections of windings and will deliver the full response to the loud speakers with extremely low overall harmonic distortion.

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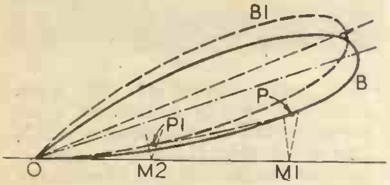
THE figure shows the outline of a blind-landing beam radiated on a centimetre wave with its major axis inclined, say, at an angle of 5 deg. to the horizontal. Once he has entered the beam, the pilot continues to fly along a path of constant field-strength, as indicated by his instruments, and this automatically keeps him on a descending course which approaches the ground at a tangent, as shown by the full-line curve BO.

According to the inventor, the tilt of the beam is gradually increased, as shown at B1, as the pilot passes the first marker-beacon M1, so that, in effect, the path of constant field-strength is straightened out between the points P and P1.



Automatic landing beam correction.

At the point P1, which coincides with the second marker-beacon M2, the guide-path again becomes curved, so as to reach the ground at a tangent, as indicated by the dotted line P1,O. A distance-measuring device of the altimeter type may be used to control the rate of tilt of the beams automatically in accordance with the speed of approach of the aircraft.

Standard Telephones and Cables, Ltd., and H. P. Williams. Application date November 20th, 1940. No. 546,021.

FREQUENCY-MODULATED SIGNALS

TO improve the signal-to-noise ratio in a frequency-modulated system, the bandpass width of one or more stages on the receiver is automatically varied with the signal strength.

Inherent noise is usually most troublesome when signals are weak, or when soft passages of music are being transmitted. By altering the acceptance width of the receiver, in step with variations in the frequency-swing due to modulation, the signal-to-noise ratio is increased when it is most wanted.

To secure this result, the input circuit of the receiver is shunted by an auxiliary valve, the effective resistance of which is controlled by a biasing voltage derived from a later stage in the chain of amplifiers. Signals representing a small frequency-swing serve to increase the resistance of the auxiliary valve, so that the tuning of the input circuit is kept sharp. On the other hand, strong signals act to reduce the resistance of the auxiliary valve. This increases its damping effect, and so widens the acceptance band of the receiver.

Marconi's Wireless Telegraph Co., Ltd. (Assignees of H. Tunick.) Convention date (U.S.A.) December 22nd, 1939. No. 546,011.

AERIALS FOR AIRCRAFT

THE trailing aerial of an airplane is released or wound-in by a small reversible motor, which is directly geared to the winding reel and is remotely controlled by the pilot or navigator. A switch in series with the motor circuit, and subject to the air-pressure from the pitot tube, automatically prevents the aerial from being released until the plane has reached a minimum speed of, say, 70 miles an hour. Provision is made for automatically releasing a given length of wire, according to the wavelength in operation, and for preventing overwinding and possible breakage of the wire when it is being retracted. As the speed of the plane falls, prior to landing, a relay is automatically operated to wind-in the aerial, and a pilot lamp informs the pilot when this has been done.

Lear Avia, Inc. Convention date (U.S.A.) September 27th, 1939. No. 546460.

FREQUENCY MODULATION

A FREQUENCY-MODULATED signal is produced by mixing two oscillations of different steady frequencies, so that they are incapable of being "pulled" or forced into step. This ensures a high degree of stability in the carrier to be modulated.

As shown, the triode section of the valve V is connected as a Hartley generator. The resulting oscillations in the tuned circuit LC are fed to the outer grid of the hexode side of the same valve, whilst the signal or modulating voltage from a source S is simultaneously applied to the inner control grid. The second steady frequency is generated by an electron-coupled pentode V1 in the circuit L1C1. The two frequencies are fed in parallel to a load impedance L_3, which is designed to resonate over the band lying between the two frequencies. By suitably adjusting the mean amplitude of the currents taken from valves V and C1, a linear frequency response is obtained. This is applied first to a limiter LM and then to an output impedance L4, which is resonant over the frequency range required for the signal, but not to the frequencies generated in the circuits LC and L1C1.

A. C. Cossor, Ltd., and D. A. Bell. Application dates February 13th and December 2nd, 1941. No. 546132.

RF INDUCTANCES

MAGNETIC cores are usually formed by first mixing metallic particles with a suitable paste or binder, and then wrapping the compound in some insulating material before fitting it inside the coil.

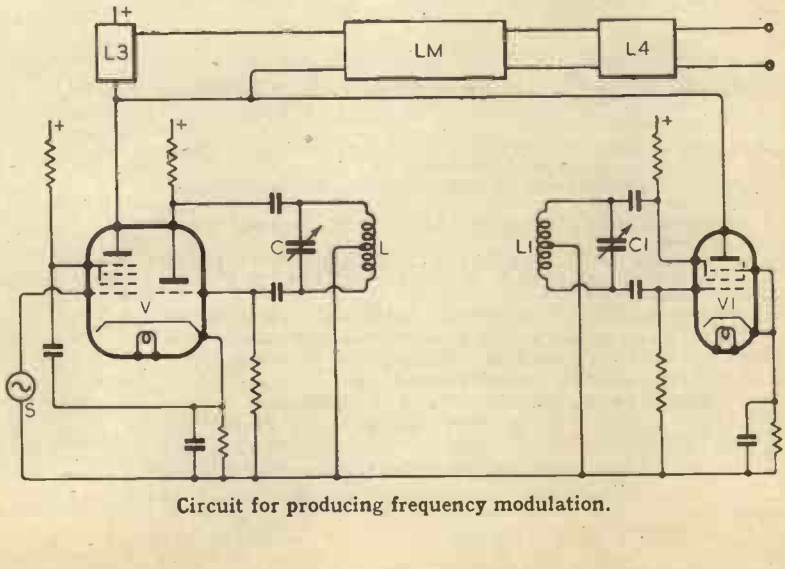
The invention is designed to render the use of an outer wrapping unnecessary. The bare wires of the coil are wound in direct contact with the outside walls of a hollow cylinder made of a solid compound or mixture of small magnetic particles suspended in polystyrene. So as to form a highly insulating mass, a core of the same compound is then fitted inside the hollow interior of the cylinder.

Alternatively, the coils of the inductance are embedded inside the solid walls of the cylinder. Or a magnetic core made of the mixture mentioned can be arranged to slide inside the windings of an inductance coil, without any precaution being taken to prevent contact between the mass and the bare wires.

Marconi's Wireless Telegraph Co., Ltd. (Assignees of R. L. Harvey and C. Wentworth.) Convention date (U.S.A.) January 31st, 1940. No. 546,864.

A CONSTANT-COUPLING DEVICE

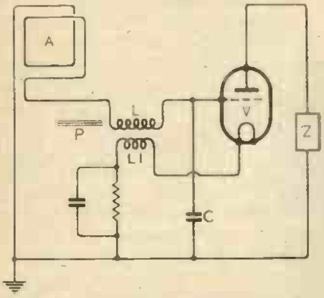
THE signal voltage induced in a receiving aerial is directly proportional to the carrier frequency, so that a station transmitting, say, on 200 metres will, other things being equal, come in



Circuit for producing frequency modulation.

three times the strength of one operating at 600 metres.

The figure shows a scheme which automatically ensures a substantially uniform response to all stations working inside a given waveband range. The aerial A is connected in series with an iron-cored tuning coil L to the grid of a back-coupled valve V. The set is, of course, tuned to the lower end of the waveband,



Constant response aerial coupling.

i.e., to the longer waves, by moving the powdered-iron core farther inside the coil L so as to increase its effective inductance. This in turn intensifies the magnetic coupling with the feed-back coil L1, and so increases the signal strength when it would otherwise tend to fall off. Conversely, as the core P is withdrawn, to tune the set to a shorter wavelength, the back-coupling is simultaneously reduced. By using a core of suitable composition, the ratio of inductance to resistance of the coil, i.e., the gain due to the "Q" of the coil, can also be kept constant throughout the whole of the tuning range.

Johnson Laboratories, Inc. (*Assignees of W. A. Schaper.*) *Convention date* (*U.S.A.*) *February 19th, 1940.* No. 547,367.

AERIAL FEEDERS

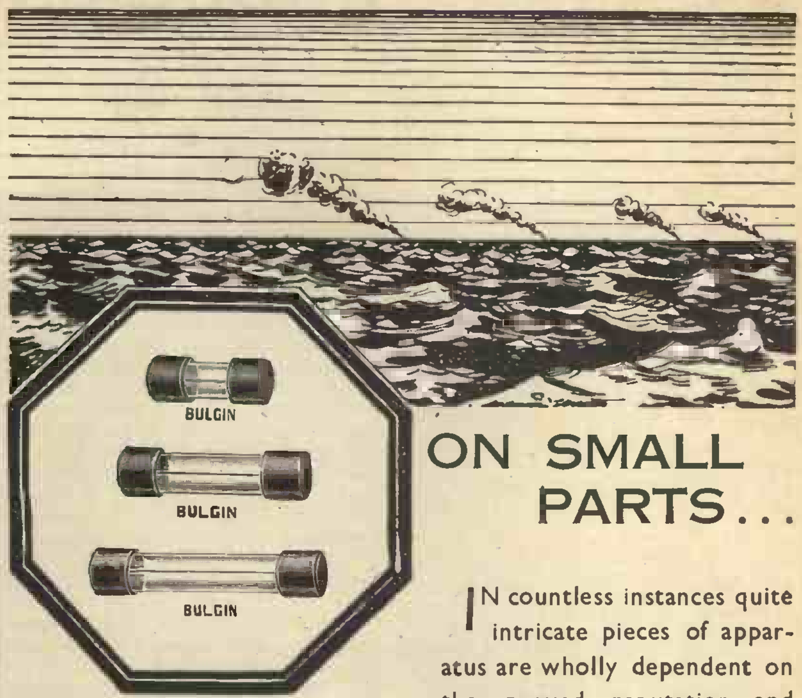
A RHOMBIC aerial is fed at one end of its long diagonal, and is closed at the other end of the same diagonal by a resistance which prevents reflection. It therefore carries a progressive or travelling wave which gives it useful directive properties.

For high-powered working, it is difficult to construct an aerial of this type which will have an impedance of less than 500 ohms, as seen from the feeder. It would, of course, be possible to match a feeder capable of carrying, say, 100 kW by means of a transformer coupling. The invention discloses a simpler and more economical method of securing the same result by gradually tapering or increasing the spacing between the wires of a twin feeder, and connecting the ends to the aerial wires at a distance of half a wavelength from the vertex of the rhombus. The specification gives an interesting mathematical analysis of the conditions to be fulfilled.

Marconi's Wireless Telegraph Co., Ltd., and O. M. Böhm. Application date February 4th, 1941. No. 547,035.

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.

COMMUNICATIONS DEPEND...



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UNBIASED

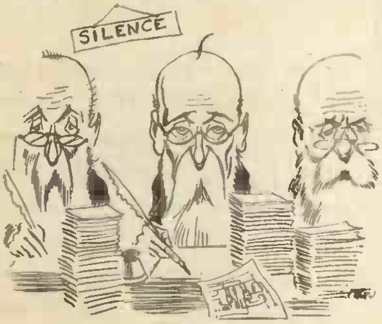
By

FREE GRID

Binaural Bilge ?

THE amount of technical ignorance displayed by many so-called high-fidelity fans as a result of my recent remarks about realism in reproduction is almost unbelievable. Musicians or music lovers they may be, but scientists they certainly are not. I suppose that one can love good music without bothering about the mechanics of it just as some people can enjoy good food and wine without worrying about the way it is handled by their digestive organs. Personally, I cannot.

As I intimated last month I had intended dealing with this matter in the Brains Trust section of *Wireless World*, but it is far too important for that and in any case I am not at all sure that I care about some of my fellow Brains Trustees. I would, however, like to point out here one or two facts about this business which *nobody* seems to appreciate. Very few *Wireless World* readers are so lacking in technical knowledge as to think that stereophony can be achieved by merely connecting two loudspeakers to the output of the receiver, but they all seem to think that it can be correctly done by emulating the example of a woman with her bottom drawer and having two of everything. This is quite wrong.



Some of my fellow Brains Trustees.

If two "separate-channel" loudspeakers are used it is unavoidable that the left ear will overhear some of the sound intended exclusively for the right ear and vice versa. It is analogous to stereoscopy where it is so vital to prevent one eye seeing anything of the photograph intended for the other eye that we have a suitable partition in our stereoscopes to prevent it. The only solution is to use "separate-channel" *earpieces*. The problem is then solved.

Now for another point. If you are making a recording of, say, a singer performing in the Albert Hall, don't think, as some readers do, that to obtain the utmost realism when listening you must repeat the original conditions by placing the reproducing gramophone in the Albert Hall where the singer did his stuff. On the record will be the reverberation due to the Albert Hall, and if the reproducing gramophone is placed in this hall, this recorded reverberation will itself reverberate and make confusion worse confounded. If you have the loudspeaker in your living room this double reverberation effect will be avoided, but you will still have the reverberation coming from the same spot as the music instead of from all around you as in the original performance. Two stereophonic recordings and "separate-channel" *earpieces* should solve the problem completely.

Yet another point. You cannot get more out of a record than you put on to it, screech and scratch excepted. The ordinary gramophone or player-piano recording is merely a one-eared version of the original. Here again the two-of-everything rule applies, not even excepting the necessity of two player-pianos *and earpieces*.

Have You Noticed It ?

I WONDER if any of you fifth columnists who habitually listen to the transmissions of the Axis stations have observed the curious background of noise which accompanies all programmes. When I first noticed it I suspected my set, and promptly disembowelled it. I do not, of course, mean the normal slight background noise which is inevitable when receiving any station other than a purely local one, but a curious "breathing" noise which radio men of an older generation will always associate with the magnetic detector.

It was this very resemblance to the magnetic detector background which gave me the clue to the puzzle as there flashed into my mind that there is another and more modern radio-associated instrument which also makes use of a moving-iron band, namely, the steel-tape recorder, or Blattnerphone, as some people invariably call it. If you listen to the B.B.C. programmes when they are being re-transmitted by one of these moving-wire recorders you will instantly recognise the noise to which I refer. But whereas this faint but distinctive background noise is only heard from B.B.C. stations when recorded programmes are being given, it is an inevitable accompaniment to all Axis transmissions.

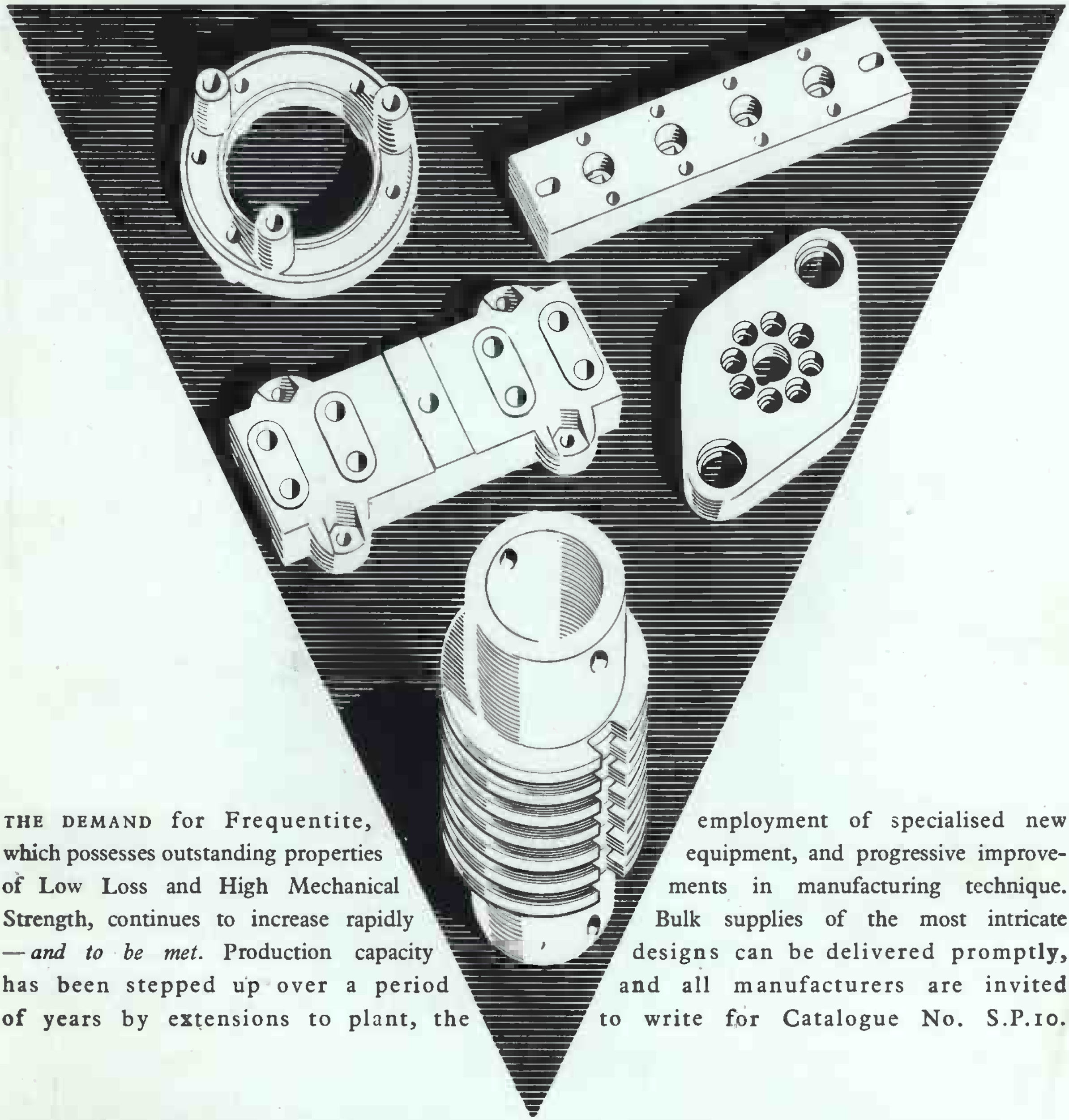
For a long time I was puzzled as to why the Axis stations, and the German ones in particular, were apparently making use solely of recorded programmes, but what really aroused my interest was the discovery that, judging by the fact that the same background noise was present, the German time signals were recorded, too. The absurdity of such a procedure nearly led me to abandon my theory until I made the still more remarkable discovery that the time signals were invariably ten seconds late. Having studied Conan Doyle's "Science of Deduction" in my youth, it did not take me long to fathom the mystery, the accuracy of my solution being subsequently confirmed by interrogation of a certain highly placed prisoner of war who fell into our hands some time ago.

The programmes including the time signals *are* all coming from a recording, but they have been recorded only ten seconds previously. The signals from the microphone, instead of being passed to the transmitter in the usual manner, are fed to the recording coil of a steel-tape instrument. A short distance along the tape is a pick-up coil which passes the signals to the transmitter, the distance between the two coils being such that it takes ten seconds for any given point on the tape to traverse it. Therefore broadcast items are all subject to ten seconds' delay.

"I promptly disembowelled it."

Half-way between the two coils is a wipe-out coil connected to a switch on which rests the heavy hand of a Gestapo agent wearing headphones connected to the microphone output. Thus the Nazi broadcasting system is protected from any subversive remark suddenly shouted out by a broadcaster. Musical programmes are similarly treated because of the revelations I recently made about morse signals being interwoven into musical items by our friends in Europe.

FREQUENTITE



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