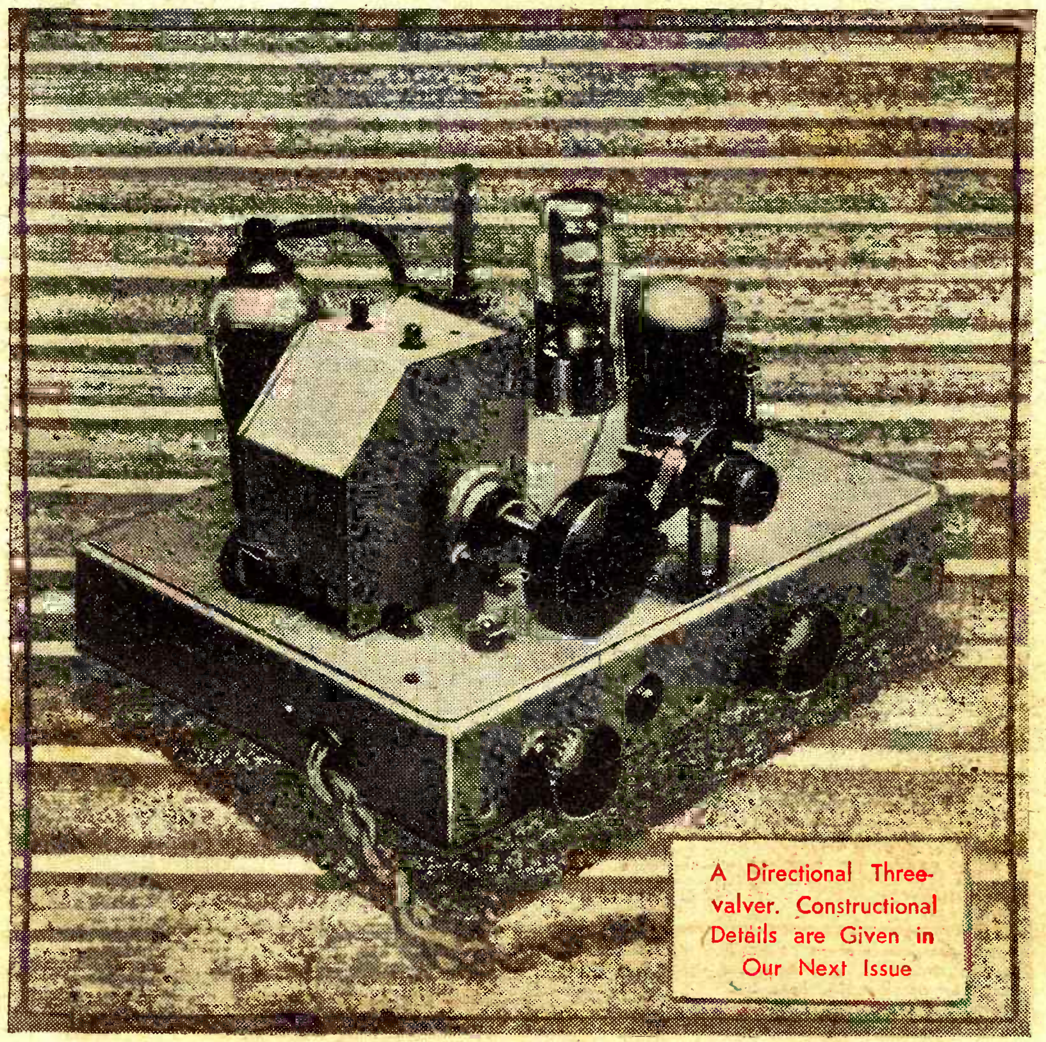
AN ECONOMY SUPERHET

Practical Wireless

9D EVERY MONTH

Editor F. J. CAMM

Vol. 21 No. 469 NEW SERIES JULY, 1945



A Directional Three-valver. Constructional Details are Given in Our Next Issue

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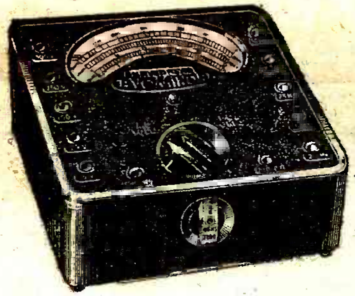
"AVO" Instruments, by their simplicity, extreme versatility and high accuracy, make possible that economy of time which is the essential feature of servicing and maintenance.

These two compact pocket-size instruments, with the "Avo" high standard of accuracy, are particularly recommended where extremely small size and economy of weight are primary considerations.



The D.C. AVOMINOR

Electrical Measuring Instrument

A 2½-inch moving coil meter for making D.C. measurements of milliamps, volts and ohms. The total resistance of the meter is 100,000 ohms, and full scale deflection of 300 v. or 600 v. is obtained for a current consumption of 3mA. or 6mA. respectively.

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An accurate moving coil meter providing 22 ranges of readings of A.C. voltage, D.C. voltage, current and resistance, on a 3-inch scale. Total resistance 200,000 ohms. Self-contained for resistance measurements up to 20,000 ohms, and by using an external source of voltage the resistance ranges can be extended to 10 megohms. The ohms compensator for incorrect voltage works on all ranges. Suitable for use as an output meter when the A.C. voltage ranges are being used. Complete with leads, testing prods, crocodile clips, and instruction booklet.

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SUPER QUALITY AMPLIFIERS, 12 watts output, high and low gain inputs with mixer, treble and bass controls, two DB 30-11,000 cycles, negative feedback, 2, 4, 8, and 15 ohms output, **£14 14s.**

A.C./D.C. AMPLIFIERS, 5 watts output, high gain, three-stage, feedback, **£8 8s. 0d.**

BATTERY CHARGERS for 2 v. batt. at ½ a., **25/-**; for 2, 4 or 6 v. batt. at 1 a., **45/-**; for 6 v. batt. at 1 a., **30/-**; for 2, 6 or 12 v. batt. at 1 a., **49/6**; for 6 v. batt. at 4 a., **£3 10s.**

MAINS TRANSFORMERS, 300+300 v., 60 m/a., three 4 v. 2-3 a. windings, **25/-**; 350+350 100 m/a. 5 v. 2 a., 6.3 v. 2-3 a., **29/-**; 350+350 100 m/a., three 4 v. 2-3 a. windings, **29/-**; 350+350 150 m/a., two 4 v. 2-3 a., two 4 v. 1 a. windings, **39/-**; 350+350 150 m/a., 5v. 2a. 6.3 v. 2 a., 6.3 v. 2 a., **36/-**; 500+500 250 m/a., 5 v. 3 a., 6.3 v. 2 a., 6.3 v. 4 a., **65/-**; 425+425 200 m/a., 4 v. 2-3 a., 4 v. 2-3 a., 4 v. 3-6 a., **47/-**; 350+350 150 m/a., 4 v. 1-2 a., 4 v. 2-3 a., 4 v. 3-4 a., **36/-**; 500+500 150 m/a., four 4 v. 2-3 a. LT windings, **47/-**.

1-VALVE BATTERY S.W. RECEIVER, with 2-volt valve, 4 coils, 12-170 m. bandspread tuning, **55/-** including tax.

STEEL CHASSIS, 16 x 8 x 2½in., **7/-**; 16 x 8in., **8/6**; 20 x 8in., **10/6**.

SHORT-WAVE COILS. fit octal sockets, 4-pin aerial coils, 9-15, 12-26, 22-47, 41-94, or 76-170 m., **2/6** each; 150-350 or 255-550 m., **3/-**; 490-1,000 or 1,000-2,000 m., **4/-**; 6-pin H.F. trans., 9-15, 12-26, 22-47, 41-94, or 76-170 m., **2/6**. S.W. chokes, 10-100 m., **1/3**; 5-200 m., **2/6**.

SHORT-WAVE CONDENSERS, all brass, easily ganged, 15 mmfd., **2/11**; 25 mmfd., **3/3**; 40 mmfd., **3/3**; 100 mmfd., **3/11**; 160 mmfd., **4/8**; 250 mmfd., **5/8**; 2-gang, 160 mmfd., **15/-**; shaft couplers, 7½d.; flexible ditto, **1/6**.

MIDGET "P" TYPE COILS. 12-35, 16-47, 34-100, 91-261, 250-750, 700-2,000, 200,557, available as H.F. trans., aerial, or osc. coils, **2/3** each. Suitable Yaxley type wave-change switches, every type available; locators, **2/-** each; wafers, **1/-** each. Suitable small 2-gang condensers; .0005, **15/-**; suitable matched pairs iron-cored 465 K.C. I.F. trans., **15/-** pair; midget type, **21/-** pair. Suitable 60 mmfd. trimmers, **1/-**; osc. padder, 750 mmfd., **1/9**.

MOVING COIL SPEAKERS. Rola 6½ or 8-in. P.M., no trans., **25/-**. Plessey 8-in. P.M. with trans., **29/6**. Goodmans 3½-in. P.M. no trans., **30/-**. Midget, standard or P.P. trans. for any above, **10/6**. Super quality giant Match-maker output transformers, match any tube single or P.P. to any voice coil, 7-watt, **22/6**; 15-watt, **30/-**; 30-watt, **49/6**; 60-watt, **59/6**.

CHOKES 8H. 300 ohms, 40 m/a, **4/6**; 30H., 400 ohms, 60 m/a, **13/-**; 30H., 100 m/a., 400 ohms, **19/6**; 30H., 165 ohms, 150 m/a., **25/-**; 25H., 250 m/a., 120 ohms., **39/6**; 15H., 500 m/a., 62 ohms., **65/-**.

SMOOTHING CONDENSERS. 50 mf., 30 v.w., **3/-**; .1, 1,000 v.w., **2/-**; .01, 600 v.w., **1/-**; 2 mf., 250 v.w., **3/9**; 2 mf., 350 v.w., **4/6**; 4 mf., 450 v.w., **7/6**; .5 mf., 350 v.w., **2/-**.

SUNDRIES. 2 mm. Systoflex, **2½d.** yd.; resin-cored solder, **6d.** per coil or **4/6** per lb.; screened 2-pin plugs and socket, **9d.**; ditto, 8-pin, **2/-**; Octal sockets, **10½d.**; ditto, amphenol type, **1/3**. Morse buzzers, **1/11**. Valve screens, **1/2**. Knobs, **6d.** Pointer knobs, **1/1**. Crocodile clips, **4d.** "Gain" and "tone" indicator plates, **7½d.** Fuses, any size, **5d.** Fuse holders, **6d.** 6-volt vibrators, 4-pin, **12/6**. Crystal pickups, **£3 18s. 9d.**, including tax.

AMERICAN VALVES. Many types in stock at controlled prices, including 6V6, 6F6, 5Y3, 5Z4, 25L6, 75, 6K7, 6A8, 45Z5, 1C5, 12SK7, 25Z5, 25Z6, 42, 80.

ENAMELLED COPPER WIRE. 1 lb. reels, 16 or 18 g., **3/6**; 20 g., **3/9**; 22 or 24 g., **3/10**; 26 or 28 g., **4/2**; 30 g., **4/4**; 32 g., **4/6**; 34 g., **5/-**; 36 g., **5/6**; 38 g., **6/4**.

REACTION CONDENSERS, bakelite dielectric, .0001, **2/9**; .0003, **2/11**; .0005, **3/3**; .0003 diff., **3/3**.

RESISTANCES. 360 x 180 x 60 x 60 ohms, .3 amp., **5/6**; 500 x 100 x 100 x 100 x 100 x 100, .2 amp., **5/6**; 40,000 ohms tapped every 5,000 ohms, 10 w., **5/-**. ½ w., res., **6d.** each; 1 w., **9d.** each.

VOLUME CONTROLS, any value, **3/9**; with switch, **6/6**.

WIRE. Single screened, **1/3** yd.; double, **1/6**; waterproof cable, 3-way, **1/-** yd.; 5-way, **1/6** yd.; pushback, **2½d.** yd.; 2-way line cord, .15 amp., 60 ohms, per ft., **1/3**; ditto, .3 amp., **1/6**.

ELECTRIC SMOOTHING IRONS, pre-war quality. Weight 5lbs., **33/6**.

Send for details of other accessories available. All enquiries must be accompanied by a 2½d. stamp.

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Practical Wireless

and PRACTICAL TELEVISION

13th YEAR OF ISSUE

EVERY MONTH.
Vol. XXI. No. 469. JULY, 1945.

Editor F. J. CAMM

COMMENTS OF THE MONTH — BY THE EDITOR

The Post-war Market

THE Radio Society of Great Britain has prepared a list of the radio components, valves and associated equipment which in its view will find a ready sale among constructors and experimenters, and particularly amateur transmitters immediately experimental licences are reissued. No announcement has yet been made as to when amateur transmitting will recommence. It is possible that security regulations in that connection will continue until the war with Japan is over.

As it seems reasonably possible that this will take place some time this year the publication of this list will be of great use to manufacturers. It is noted that the list includes some items which were introduced prior to the war, but which were not available at prices which compared favourably with those of foreign competitors.

The list includes A.V. transformers, such as Class B, microphone transformers, modulation and humbucking transformers, and sets of parts, together with interchangeable windings in a wide variety of gauges and turns. It is thought also that there will be a demand for the following items:

Disc batteries for wiring into apparatus; butterfly circuits for V.H.F. work; small cathode-ray tubes for use in oscillographs and having high deflection sensitivity; swinging chokes; smoothing chokes of higher inductance; and chokes for cathode modulation circuits; fixed vacuum capacitators for high voltage and suitable for connection in banks; mica-blocking condensers; a full range of variable condensers; connectors; components for rotary beams; Faraday screens; crackle-finish paint; silver-plated copper tube; plastic sheet, rod and tube; coaxial cable; quartz crystals in enclosed holders; moving-coil head sets; I.F. amplifiers; a range of plug-in coils in 25 and 200 watt sizes with variable links; unbreakable low-loss transposition blocks and spacers; prefabricated masts; sectional steel masts; a full range of meters, microphones and morse keys; potentiometers, power supply systems and power transformers; all-British amateur bands communications type receivers and kits of parts; thyratrons; test apparatus; amateur television equipment; stabilisers and neon tubes; speakers, and a wide range of valves.

Constructors' Requirements

THIS list is comprehensive and really catalogues most of the lines which were available before the war; thus it is a request for manufacturers not to desert the constructor, experimenter, and the transmitter, in order to cater for the completely assembled receiver and transmitter.

The constructor and transmitter market is a large one, and it can only exist if supplies of components are made available. It may seem to some manufacturers more attractive now that the war in Europe is over to make complete receivers rather than the parts, because of the great demand now existing owing to the lack of production during the last six years. That will, however, be a temporary boom, and if some of the component manufacturers desert the component market, other firms will step in and take their place.

The imminence of television needs the continued service of the great army of private experimenters who, for their own interest and enjoyment, yet conduct such valuable experiments and in the past have contributed so much to the perfection of radio. A new task awaits them with television and in the short-wave and ultra-short-wave sphere.

In the early days of television it will be necessary to build up a television audience, and to interest the public in television programmes. It will be a limited service at first, but experimenters in exhibiting their receivers to their friends will be creating the demand for television apparatus by the non-technical.

The Radio Society of Great Britain is prepared to send its recommendations on the range of components for the post-war amateur radio market to any British radio manufacturer who has not yet received a copy.

Queries

Will readers please note that our query service is still suspended. We hope, as staff becomes available, to reintroduce it this year. Readers should await a further announcement.

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

The Editor will be pleased to consider articles of a practical nature suitable for publication in PRACTICAL WIRELESS. *Such articles should be written on one side of the paper only, and should contain the name and address of the sender. Whilst the Editor does not hold himself responsible for manuscripts, every effort will be made to return them if a stamped and addressed envelope is enclosed. All correspondence intended for the Editor should be addressed: The Editor,* PRACTICAL WIRELESS, *George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.*

Owing to the rapid progress in the design of wireless apparatus and to our efforts to keep our readers in touch with the latest developments, we give no warranty that apparatus described in our columns is not the subject of letters patent.

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

ROUND THE WORLD OF WIRELESS

B.B.C.'s Regional Stations

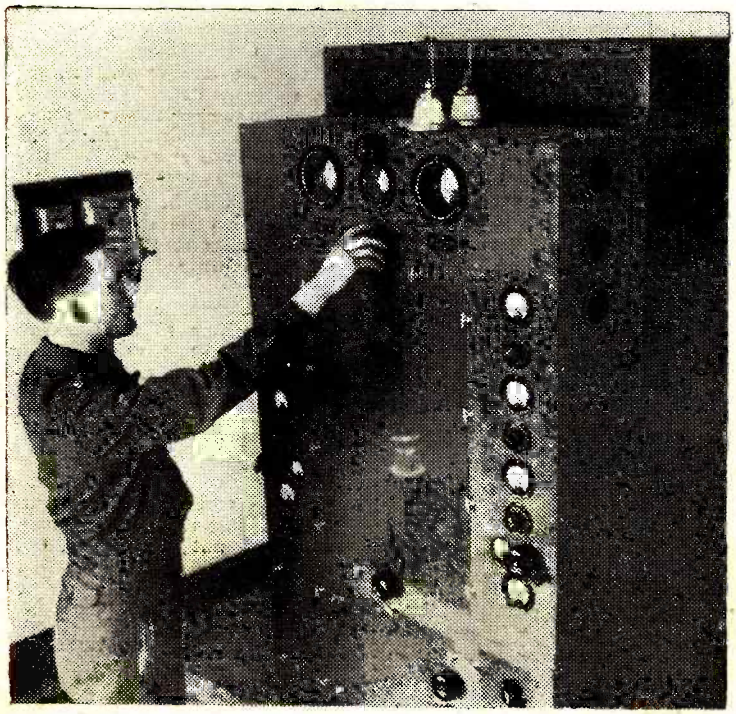
ACCORDING to a recent statement by Mr. W. J. Haley, Director-General of the B.B.C., regional broadcasting stations will be back on the air within 90 days of the end of hostilities in Europe. "The B.B.C. intend," said Mr. Haley, "to make in regional broadcasting the most wholehearted efforts to reflect the pleasures and preoccupations, the gravities and gaieties, the interests and gifts of each community that we have yet made."

Factory Workers Broadcast

ONE morning recently three factory operatives visited the B.B.C. to make their first recording for a public broadcast. They were employees of the well-known Firestone Tyre and Rubber Co., and they were contributing to the series of instructional broadcasts to schools entitled "How Things are made." Their joint talk was heard by school children throughout the country in the Home Service programme and dealt with the most modern processes of making cycle tyres.

I.E.E. Meeting

AT a meeting of the Institution of Electrical Engineers (Radio Section) held in the Lecture Theatre of the Institution, Savoy Place, Victoria Embankment, London, W.C.2, on April 25th, a lecture on "The Fundamental Principles of Frequency Modulation" was given by Dr. Balth Van Der Pol, who made a special visit from Holland for the purpose.



One of the Royal Signals transmitters used at the "Hotel Scribe" for sending messages to the G.P.O., London.

From Front Line to Fleet Street

ONCE a fashionable Paris hotel, the "Hotel Scribe" served as the nerve centre of all the news from the Western Front. Teleprinters, wireless transmitters, broadcasting and recording studios were installed in the bedrooms, and cables and wires were laid along the corridors. Some of the bathrooms were used as photographic darkrooms, and the reading rooms as map rooms. The news arrived at the "Scribe" from three main channels—the communiqué section, which wrote and issued daily communiqués; the map room, or briefing section, which received the latest detailed news from all fronts; and the front line reporters, who sent in descriptive stories direct from the front line.

The illustration on this, and the following page, show some of the equipment at the "Scribe" used for transmitting news to London.

Post-war Television Prospects

ACCORDING to a recent report the outlook for television in this country so far as the public is concerned is not at all clear. Apparently, it is unlikely there will be any development until after the end of the war against Japan.

The B.B.C. estimate that at least six months—and possibly nine—will elapse after the end of the war before they are able to get the Alexandra Palace television studios working.

When television is restarted it will probably be as recommended by the report of Lord Hankey's Television Committee, published in March, on the basis of the old system used before the war. When the B.B.C. is ready with transmission the trade will, no doubt, be ready with some receivers. A great deal depends on how soon—and how much of—the Hankey report is adopted by the Government.

Cable and Wireless "Blue Train"

THE Cable and Wireless, Ltd., mobile wireless unit—known as the "Blue Train"—which began transmitting messages from forward areas in Northern Italy on April 11th, was operating within 46 hours of leaving Rome, 300 miles away.

"Leaving at dawn on Monday (April 9th), the Blue Train," wires Mr. G. T. Edwards, the company's senior official in Italy, "crossed the mountains and threaded its way through the mass of transport moving up to the battle front. The Unit joined the 8th Army at 10 o'clock on April 10th, and was on the air since 5 o'clock on the morning of April 11th.

"To have travelled 300 miles over mountain passes with heavy equipment and set up a high-speed station all within 46 hours was a fine achievement."

B.I.R.E. Meeting

AT a meeting of the British Institution of Radio Engineers (London Section) held at the Institution of Structural Engineers, Upper Belgrave Street, S.W.1, on May 17th, a joint paper on "The Measurement of Cable Characteristics at Ultra-High Frequencies," was read by F. Jones, B.Sc. (Hons.) and R. Sear, B.Sc. (Hons.).

"Victory in Burma"

THE B.B.C. has celebrated Victory in Europe. On May 21st there was another celebration of victory, this time in the Far East, where there has been no "cease fire." "Victory in Burma" told of the men of S.E.A.C. and their tribulations and triumphs which came to a climax in the capture of Rangoon just before the onset of the monsoon. Lord Louis Mountbatten took part in the programme.

"People of Britain"

RECENTLY the Stationery Office published a White Paper, in which imposing rows of statistics bore mute tribute to the exertions of the civilians of this war, who, in the turn of events, became front-line troops while still living in suburb or slum.

The purpose of "People of Britain," broadcast on May 17th, was to turn these embattled and paper statistics into living, breathing terms. All parts of the country contributed; all the stories told were true. This was the tale of the "indispensable millions," to quote a Churchill phrase.

U.S. Visitors to Cable and Wireless, Ltd.

MEMBERS of the United States Senate Committee on Communications, accompanied by the Chairman of the Federal Communications Council and U.S. Army and Navy communications chiefs, recently visited Electra House, London, headquarters of Cable and Wireless, Ltd.

Senator Burton K. Wheeler headed the party, which was received by Sir Edward Wilshaw, chairman, and shown over the London telegraph station.

The company's London station is the centre of the British Empire's telegraph system and is the largest overseas telegraph office.

Car Radio

AT the London general meeting of the Institution of Automobile Engineers, which was held on Tuesday, June 5th, at the Institute of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1, Mr. A. W. Martin, chief engineer of E. K. Cole, Ltd., read a paper entitled "Car Radio."

The paper commenced with a brief review of the various stages through which car radio has passed since its inception in the early 1920s. It then went on to deal with such questions as size, output, shape and styling, the various types, tuning and controls.

The question of aerials was then dealt with and considerable attention was devoted to the suppression of interference. Details were also given of typical sets, i.e., the single unit or "all-in-one" type and the multi-unit type.

Royal Society of Arts Meeting

AT a meeting of the Royal Society of Arts held at John Adam Street on May 23rd, the Thomas Howard lecture on Wire-broadcasting was delivered by Paul Adorjan, M.I.E.E. The lecture, which was illustrated by lantern slides, was presided over by Air Vice-Marshal Sir Victor Tait, K.B.E., C.B., Director-General of Signals, Air Ministry.

B.B.C. Standard Frequency Transmissions

THE B.B.C. announces that certain of its transmission frequencies are now controlled within ±1 part in one million of the nominal frequency. Whenever these frequencies are used by B.B.C. transmitters they can therefore be employed as a reference standard.

The frequencies in question are 200, 6,180, 9,510 and 17,810 kc/s, and reception of one of other of them should generally be possible anywhere in the world for a period of each day. Transmission hours will change with alterations in B.B.C. services, but the present schedule of transmissions is as follows (times in G.M.T.):

(a) 200 kc/s (European Service), 0400–1330, 1430–0045
(b) 6,180 kc/s (Home Service) 0500–1330, 1430–2215
(European Service) 0400–0500, 2230–0045
(c) 9,510 kc/s (Overseas Service) 0400–0800, 1730–0215
(d) 17,810 kc/s (Overseas Service) 0900–1515.

B.B.C. Music Library

MANY who listen to music on the air have little idea of the practical work that has to be done before the Overture, Symphony or Chorus is wafted to the ear. Not only do adequate rehearsals have to be arranged, but music, scores and parts have to be supplied. That is a big job, for the musical demands of the various orchestras and choruses of the B.B.C. are heavy and constant.

In the main orchestral library, there are 17,000 parts for full orchestra, 12,000 for Section B of the orchestra, and from 7,000 to 8,000 for still smaller orchestral combinations. There are many thousands of dance band sets and over 3,700 bags of military band music. Chamber music accounts for about 1,500 sets, and choral music for about 6,000. All kinds of music have to be available for use in the regions as well as in London. The B.B.C. Music Library has 20,000 manuscript scores in its possession.

A perforator in one of the wireless rooms at the "Hotel Scribe." The correspondent's copy is perforated on paper tape before being transmitted automatically at 80 words a minute.

An Economy Communications Superhet—1

Constructional Details of an Efficient S.W. Receiver

By P. STEARN

HAVING long felt the need among amateurs for a compact, efficient short-wave superhet, I have designed the five-valve Economy model, which can be made large or small, adapted for any desired waveband, and, best of all, most components are fairly easily obtainable at the moment. The description is sectionally arranged, because I have found it best to construct such receivers as a basic model first, and then to add the refinements after the first lining-up process and initial testing is completed. This simplifies the tracing of wiring errors and component faults, which would otherwise be a very complicated business.

In passing on my ideas to other "DX" fans, it will have to be assumed that the reader at least understands the theory of the superhet, even though no previous constructional experience has been obtained, for it is beyond the scope of this article to give very detailed technical advice regarding the winding of coils, loud-speaker matching data, etc., but the valve equivalent tables, basing data and circuit diagrams serve to simplify the construction of the receiver, and photographs serve as a guide to the layout. American metal valves are shown, but the receiver will operate efficiently with the standard "GT" types. The receiver shown has been modified to provide for medium-wave switching, and the extra coils are seen beneath the chassis. The description of this modification, and others, will follow later.

The Valves

Although good results may be obtained by using a reflex circuit, and I certainly do not despise this type of design, a straightforward arrangement may be obtained by using multiple valves. A glance at the basic circuit diagram will prove that the equivalent of one complete pentode, or one double-diode triode valve is gained by using these multi-unit valves.

6K8GT (Beam Triode-hexode) is the valve which I have chosen to function as the frequency-changer, because its construction ensures the complete isolation of signal frequency and oscillator circuits, and the amount of gain obtainable as a result can only be equalled by a separate oscillator and mixer valve. It will be appreciated that this isolation of the two frequencies is essential if good selectivity and freedom from "locking" is to be accomplished.

12B8GT (Triode-Pentode) is very much in vogue these days. It consists of a high impedance L.F. triode and a high slope R.F. pentode in the same glass envelope. The amplification factor of the triode is 110 approximately, but this figure cannot be approached unless the anode load resistor is set to optimum, and the bias voltage carefully adjusted. The pentode section has variable-mu characteristics, and this is utilised in the receiver by incorporating the valve in the A.V.C. system. The suppressor grid and the internal shield of this valve are both internally connected to the pentode cathode, thus conserving two valve pins. The two cathodes are separate.

6B8GT (Double-diode R.F. Pentode) is a normal H.F. pentode, similar in characteristics to type 6K7, only two diodes are added. As the grid base is rather short, and the valve handles rather a high signal voltage in its position as second I.F. amplifier, it has been found advisable to exclude it from the A.V.C. system.

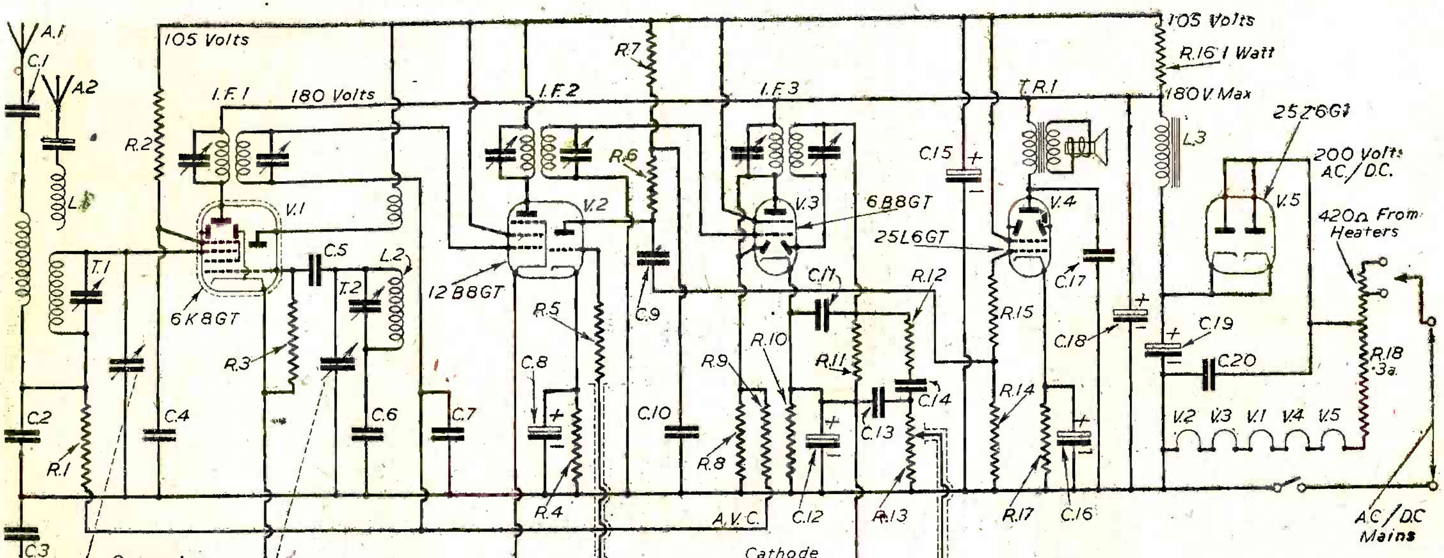
25L6GT is a beam-power output tetrode, with a very high mutual conductance, about 8 mA/V., and compared with its nearest pentode counterpart 25A6GT (3.5 mA/V.) is very efficient. With 180 volts anode and 135 volts screen, nearly 5 watts speech output can be obtained, but to increase the life of the valve and to reduce distortion, the voltages are slightly reduced in my model, giving approximately 3.5 watts.

25Z6GT is a universal rectifier, with two anodes and two cathodes. As a half-wave rectifier the anodes and

VALVE ALTERNATIVE CHART

Valve	Plug-in Equivalent	Change Valveholder Equivalent	Remarks, etc.
6K8GT	1. 6J8GT/G 2. 6A8GT/G 3. X65 Osram 4. X63 Osram 5. 12K8GT (80 ohm.)	6A7 UX Base	Other equivalents with fil. shunts in Mullard "E" series of valves.
12B8GT	25B8gt (25 v., .15a) and 175 ohm fil. shunt	6F7, 6P7 and circuit alt. Cath. is common both sec.	Supplies limited. Not impossible.
6B8GT	12C8GT (80 ohm shunt) EBF32 Mullard (65 ohm)	7B7 (U.X.) WD30 Osram (9-pin)	6K7, 6J7 and two Westectors are a possibility.
25L6GT	25A6GT (Bias r. 500) 25B6GT (Bias r. 500) KT32 Osram KT33C (see notes)	KT30 (7-pin) 43 (U.X. and 500 ohm bias r.)	KT33C Osram is a permit valve. 160 ohm bias r. pin 1 left dis. Important.
25Z6GT	U31 Osram 25Z4 Brimar	25Z5, 25Y5 (U.X. base) 1D6 Brimar (U.X. base)	Many more in good supply in .2a range.
6J7GT	6K7GT/G KTZ63 (Osram) KTW63 (Osram) Z63 (Osram) W63 (Osram)	6D6, 6C6, 77, 78 (U.X.)	EF38, EF39 "E." With 65 ohm shunt, very good substitute.
Y63	——	6U5/6G5, 6E5, 6ab5/6N5. All U.X. possibilities	Y63 readily obtainable.

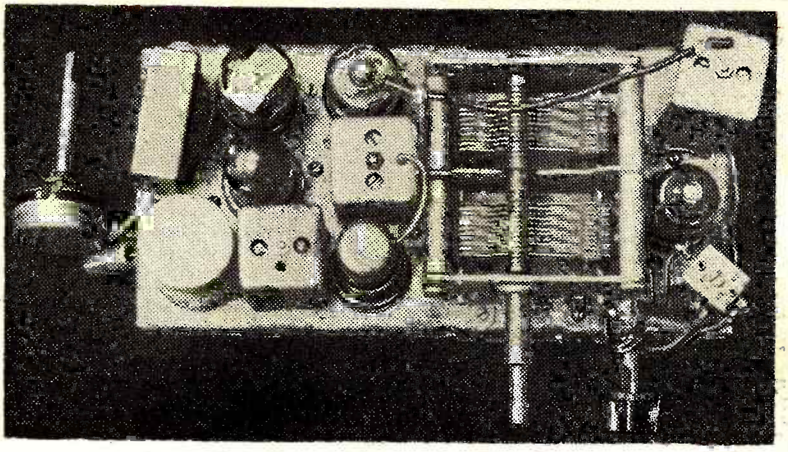
Numbers in brackets after some types indicate the value of resistance required in parallel with valve heater to match up valves taking less heater current to the .3 amp. line. Resistances should be 2 watt and wire-wound for preference.



The theoretical diagram of the Economy Communications Superhet.

LIST OF CHIEF COMPONENTS. All resistors ¼ watt excepting R16.

C1	50 pf ± 5 per cent	C14	.01-.02 mfd.	R7	50,000/100,000 ohms	L1	Aerial coil.
C2	.05 mfd. 500 v.wkg.	C15	8-30 mfd. 150-500 v.wkg. ...	R8	300,000 ohms	L2	Oscillator coil.
C3	.25 mfd. 400 v. A.C. wkg. ...	C16	20-50 mfd. 25 v.	R9	200,000 ohms	T1	40 pf trimmer.
C4	.01 mfd.	C17	.01-.05 mfd. Depends on tone recd.	R10	100 ohms	T2	30 pf trimmer.
C5	50 pf ± 1 per cent.	C18	10-30 mfd. 250 v.	R11	1 megohm	TR1	40 ma. Pentode O.P. trans.
C6	See text. ± 2 per cent. fol.	C19	8-20 mfd. 500 v.	R12	100,000 ohms	L3	Smoothing Choke or L.S. field 500 ohms.
C7	.05 mfd.	C20	.1 mfd. 500 A.C. wkg.	R13	V/C. See text	V1	6K8GT or Metal F.C. valve.
C8	25 mfd. 12 v.	R1	250,000 ohms	R14	500,000 ohms	V2	12B8 GT. with Screening Can.
C9	.01/.1 mfd. 1,000 v.wkg.	R2	50,000 ohms	R15	50,000 ohms	V3	6B8 GT (screened) or 6B8 metal.
C10	.25 mfd.	R3	50,000 ohms	R16	3,000/4,000 ohm 1 w.	V4	25L6 GT, 25A6 GT and alter R17 to 450 ohms.
C11	100/250 pf.	R4	2,500 ohms	R17	200 ohms	V5	25Z6 GT.
C12	50 mfd. 12 v.wkg.	R5	100,000 ohms	R18	600 ohms. Tapped from heaters ; 425 ohms to H.T. tap, total res. 210 v. mains. 450 ohms, 230 v. = 515 ohms ; 250 v. = 585 ohms		
C13	50/100 pf.	R6	200,000 ohms	I.F.1 2 3	465 kc/s screened	—	.0005 mfd., Twin-gang Tuner, less Trimmers.



Top of chassis, showing tuning unit, etc.

cathodes are strapped, placing the two sections in parallel. Having thus introduced the valves to be used, a short description of the rest of the circuit is required. Starting at the input side, we will consider the frequency changer and its associated components.

Coils

The coils should be of the type which tune from 15 to 50 metres with a .0005 mfd. tuning condenser, and a good range to choose from is the Wearite "P" series, obtainable from some of the advertisers in this magazine. The aerial coil shown in the circuit diagram has two primaries, one which closely couples the aerial by means of bottom capacity, giving added gain, the other is one or two turns of thick wire, loosely coupled, and may be used to feed in a di-pole or doublet aerial. Alternatively, the top end may be returned to chassis, giving a more selective circuit, with corresponding decrease in second-channel interference. Should the constructor wish to wind his own coils, the coils may have identical grid windings (10 turns 20 s.w.g. copper wire, 1/10 in. spaced, on ½in. former). The main aerial primary should consist of five turns 36 s.w.g. D.C.C. wire, closely wound and spaced ¼in. from grid coil. The additional primary may be about three turns 22 s.w.g. copper spaced as far as possible from the grid winding.

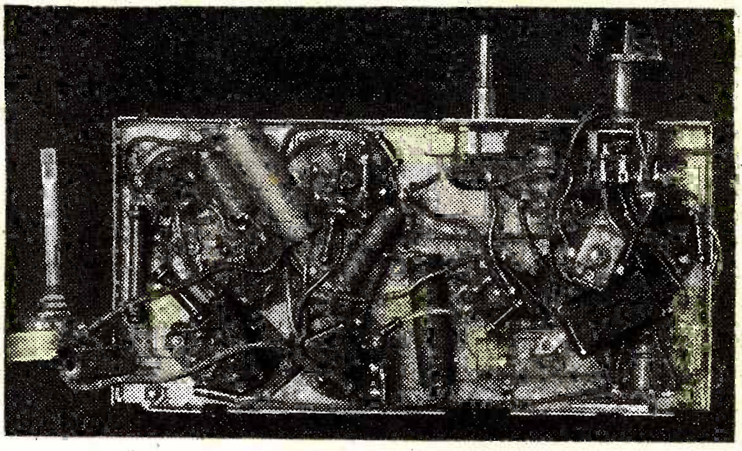
The oscillator coil, grid winding as aerial, primary, or anode reaction coil, four turns 30 s.w.g. D.S.C. copper wire, *wound in the same direction as the grid coil.* The two outside wires, one from primary and one from secondary, are then connected to their respective anode or grid, the inside connections are connected to H.T.+ and padding condenser. This is the universally accepted method of construction and wiring of a reaction circuit.

The screening grid of the mixer portion of the frequency changer is fed through a 50,000 ohm resistor from the 105 volt H.T. line; this is to reduce the voltage slightly and limit the amplification of that section, and also to filter out any stray R.F. voltages which may be present in the H.T. wiring. An important point to watch in the selection of a 6K8 valve is the connection to pin 1. This is usually connected to the internal shield surrounding the anode, but for some obscure reason the metal type of 6K8 (as shown in photograph) has also the beam-forming deflection plates. To sum up, the glass type has the beam plates connected to cathode, the metal type to pin 1, the metal shield. Therefore in the former case pin 1 is led to chassis, in the latter case to cathode.

A single point earthing system is used, because various regions of the chassis are at different R.F. potentials. By connecting all the negative return wires of each stage to the same point on the chassis, some of these minute voltages tend to neutralise one another, due to phase shift from different portions of the valve. At the worst, it prevents currents flowing through areas of chassis metal and mixing with other voltages to form feedback, either regenerative or degenerative. At the same time, it is no use employing a superior type of frequency changer, with internal screening, if the remainder of the circuit is badly laid out. "Pulling and locking" is one way of saying that the two high frequencies normally found in a frequency changer stage have become dependent on one another for their exact frequency. The only complete solution to the problem is to build the receiver in such a way as to isolate the two tuned circuits and their associated wiring. By placing one coil at a right-angle to the other, and placing one above and one below the chassis, the problem is solved—provisionally. For if medium waves are to be added later, complications exist in wiring the wave-change switch, and some wires may have to be screened. Do not forget that a badly situated aerial series condenser may prove troublesome, and I have found the little "cup" type ceramic condenser a great help in this difficulty, so if one is obtainable, the inside connection to the cup should go to aerial, the outer to the coils.

There is thus more in building a superhet than wiring up a few components. Little more need be said about this portion of the receiver except that there is nothing to be gained in using components other than those advised, except perhaps in some cases a different value of oscillator grid condenser may lead to improved reception at the lower half of the short waveband.

The intermediate frequency stages are quite conventional, and should require little description. As



Sub-chassis wiring.

seen in the photograph, the cans are arranged to form a type of shield round the valves. This is not at all essential, but it does help to stop instability. A small point which should be cleared is in the first I.F. amplifier grid lead. No resistance is shown in the circuit diagram, whereas a ¼ watt resistance is shown in the photograph. This was incorporated in the original design, as I feared lots of instability, but my fears were groundless. The resistance is not required, although I had to screen the long grid lead. With a different layout even this may not be required. A single point earthing system is again used in the I.F. stages. But as a common cathode arrangement is used for the F.C. and two I.F. valves, complications arise. As a result, I have taken the easiest course, and returned the decoupling condenser to the electrolytic H.T. decoupling condenser's earthing point. Antiphase voltages from the anodes and screens may be found here, and thus a stabilising process should take place. This has been found entirely satisfactory, and may be a point worth remembering when designing another receiver.

The A.V.C. system is also quite straightforward, although the component values are rather smaller than is normal in a commercial model. This is because a shorter time-constant is required, to cope with the extra rapid fading often encountered on the short waves. The damping imposed upon the third I.F. transformer is light, however, because of the smaller feed condenser used. This may be mounted directly to the valveholder tags 3 and 4. The decoupling condenser C7 may be fastened to one of the nuts fixing the second I.F. transformer to the chassis. The I.F. coils will be mentioned later in the alignment notes and the section describing several additions and improvements.

VALVE-BASE CONNECTION CHART

Valve	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Cap
6K8GT	Shield	Heater	Mix A	Screen	G osc.	A osc.	Heater	Cathode	G
12B8GT	C (Pen) and Shield	Heater	Pen A	Screen	Triode A	Triode C	Heater	G Triode	G Pen.
6B8GT	Shield	Heater	Anode	Diode	Diode	Screen	Heater	Cathode	G
25L6GT	—	Heater	Anode	Screen	Grid	—	Heater	Cathode	—
25Z6GT	—	Heater	Anode	Cathode	Anode	—	Heater	Cathode	—
6J7GT	Shield	Heater	Anode	Screen	Supp. G	—	Heater	Cathode	Grid
Y63	—	Heater	Anode	Target A	Grid	—	Heater	Cathode	—

The A.F. Section

The detector diode load resistance is returned to the common cathode line, to prevent imposing a delay voltage on the diode. The small filter condensers may be mounted inside the third I.F. can, to prevent hum. The lead to the volume control should be screened for the same reason. The value of the volume control is not critical, and may be between ¼ and 2 megohms. Overloading and instability may result with the 2 meg. component, however, and I suggest a high-grade 1 meg. screened control as the most suitable. The mains on/off switch should be separate, and not ganged with the volume control. There is not any objection to ganging the on/off switch with a tone control, and one may be added as described later.

The anode load to the first L.F. is .2 megohms, and is decoupled by a series resistor and a .1 mfd. condenser. The intervalve coupling condenser may be between .005 and .05 mfd., and as the most suitable compromise, I advise a mica dielectric .01 mfd., or a very good quality paper condenser. It is essential that this condenser does not leak at all, otherwise positive volts will be applied to the grid of the output valve, causing poor quality, and a very short life for the valve. The tone correction condenser may be either .01 or .02 mfd., but if exceptionally brilliant tone is required, values between .001 and .005 mfd. may be used. As to the ratio of the output transformer, the nearest ratio for a 2 ohm impedance speech coil is 45 : 1, and a 3.5 ohm coil should be 35 : 1. Much could be said regarding the design of the output transformer, but a component with a high primary inductance, designed to carry 40 mA., and having a fairly heavy core stamping, is almost essential. In an emergency a midget transformer would do, but for quality reproduction, the above specification should be adhered to strictly.

The Power Circuit

This follows the lines of conventional commercial practice and consists of a half-wave rectifier, with choke-capacity smoothing. I was rather fortunate in having to hand a 30+20+20 mfd. 300 v. wkg., +30 mfd., 25 v. wkg., can condenser, which proved to be ideal for the purpose. Because these multiple condensers are very scarce, I submit a list of the minimum capacities required, which may be made up from tubular units.

C19 should not exceed 32 mfd., or the rectifier may be damaged when operating the receiver on A.C. mains, otherwise the larger capacity obtainable the better. The

—	50 cycles A.C.	100 cycles A.C.	D.C. Mains
C19 Reservoir	10 mfd.	8 mfd.	4 mfd.
C18 Smoothing	8 mfd.	8 mfd.	8 mfd.
C15 Smoothing No. 2 ..	8 mfd.	8 mfd.	4 mfd.
C8, C12 Bias	25 mfd.	25 mfd.	25 mfd.

H.T. feed to the rectifier anodes is taken from a tapping on the mains dropping resistor. The position of the tap may easily be calculated by ohms law, or found with a meter with the valve heaters running, and should be so arranged that exactly 180 volts are measured across C18. There is no objection to the use of line cord as the mains dropper, for any arrangement to stabilise the temperature inside the cabinet is an advantage.

Testing the Receiver

After the wiring up has been completed it is always advisable to run over the circuit with an ohmmeter to avoid any possibility of a short circuit occurring when connected to the mains supply. Points to check are heater continuity, dropping resistance, H.T. points to chassis and, of course, valve base connections. A complete chart of connections is given, including many alternatives and change valve-holder possibilities. After taking all due precautions, the receiver may be connected to the supply. The first thing to do is to check over the H.T. voltages and watch for any warming up of components. Having thus been satisfied the L.F. portion of the receiver may be tested by touching the first L.F. grid with a moistened finger, when a loud hum should issue from the speaker. No more can be done until the I.F. transformers have been adjusted to the correct frequency. For this operation a modulated oscillator is essential, and the model described by Mr. S. Brazier in "Workshop Equipment" should be quite efficient, providing the calibration is correct.

Alignment Procedure

As it is too much to expect a signal to rush through the receiver from the frequency changer valve in the first instance, the receiver must be roughly tuned to the I.F. first, and then "peaked up" afterwards. The operating sequence to be described is very simple, and leaves no chance for mistakes.

(1) Tune oscillator to 470 kc/s, and inject modulated signal to 6B8 grid. Adjust trimmers on I.F.3 to give maximum signal.

(2) Inject same signal to 12B8 grid, and adjust I.F.2 trimmers.

(3) With a shorting wire across the oscillator tuning condenser, inject signal to 6K8 grid, and adjust I.F.1.

(4) Connect a 5-volt A.C. meter across the speech coil on speaker, keeping the speaker still connected.

(5) Short over the oscillator grid leak with a strip of fine wire.

(6) Inject modulated 470 kc/s signal between 6K8 grid and chassis, attenuate signal to read 1.5 volts on output meter, and starting from the third I.F. transformer, work back to the frequency changer, adjusting all trimmers to show maximum deflection, all the time keeping the signal low, to show under 2 volts on output meter. Any tendency shown by the I.F. transformers to go into oscillation on adjustment can be corrected at this stage by some of the many methods described in a text-book published by Messrs. George Newnes.

On the completion of this adjustment the trimmers should be sealed over with sticky paper to prevent any possible alteration of the settings.

The R.F. Circuits

After removing the shorting link from the oscillator grid-leak the receiver should now be working after a fashion. I do not advise the use of a modulated oscillator for the alignment of short wave circuits, for it requires long practice to separate out the various images and harmonics which are found in abundance. The best method for the amateur to use is the simple method of selecting a strong broadcast signal and adjusting the receiver to same.

Turn the tuning condenser to about 10 deg. from minimum, and, after midday, several 16 metre transmissions should be available. Select a steady signal, and after unscrewing the oscillator trimmer to about half-way-peak up the signal with the aerial trimmer. It is essential to have the oscillator trimmer almost unscrewed, for otherwise the oscillator frequency will be below that of the incoming signal, resulting in poor selectivity, and a mass of whistles above 30 metres.

When this stage was reached in the testing of my receiver I was very worried by the large amount of background hiss which I was receiving. After testing for parasitic oscillation, etc., with no result I checked the amount of noise obtained on a commercial model employing two I.F. stages. The noise level was almost identical with that of my model. It appears that the internal noise issuing from the frequency changer valve was being greatly amplified by the high sensitivity I.F. valves, and, being rectified with the normal signal, was reaching the loudspeaker. Adapting one of the old-fashioned noise-limiter circuits to suit my receiver was simple, and will be described in the next section of this article, together with an I.F. aerial filter, headphone operation, and, more important still, the alterations required to operate the receiver on medium waves, and with an additional stage of R.F. amplification to reduce second channel whistles.

(To be continued.)

NOTES AND NEWS

Mr. Fred Keller

MR. FRED KELLER, Advertising Manager of the Raleigh Cycle group, has been elected chairman of the Incorporated Advertising Managers' Association (London).

* * *

Radar Adds Safety to Airports

THE C.A.A. experimental station at Indianapolis is working on the perfection of two radar devices, one for airport use and the other a collision-warning device used in the airplane itself. Almost ten carloads of radar equipment has been lent to the C.A.A. for this research.

At airports the radar tower control will permit the tower operators to see on a screen the actual position of any and all aircraft within a radius of about 25 miles. This immediately detects any hazardous condition that might occur because of a pilot's error or a mechanical failure in the radio landing system. The radar operator can then adjust the controls of all out-bound traffic at a fog-bound airfield, because he will have complete knowledge of the exact position of all planes. The only way in which this can be done to-day is for a ground operator to determine the position of planes near his field by position reports radioed in by pilots. Only one such report can be handled at a time and the distance estimates are not always accurate.

The collision-warning device is mounted right on the instrument panel of the plane. Here the radar screen will be of immense value. It will report to the pilot his own position in the air relative to other planes as well as obstacles in his path, such as radio towers, beacons, water towers, and other objects that may be hidden from actual eyesight.

With radar instruments, pilots will find it easy to maintain proper distances from other aircraft while climbing to their assigned altitudes, or descending to an airport for landing. The complete landing approach will be handled by the pilot while the control tower acts as a monitoring agent through its radar screen. This will speed up landing and take-offs in thick weather.

* * *

Many Civilian Uses for Radar

FOR peacetime use the radar idea will find applications which are not even dreamt of to-day. First and most important, saving human life through prevention of collisions is probably the most urgent need. Radar on locomotives will prevent not only head-on collision, but rear-end collisions with other trains as well. Fog, thick weather and darkness, whether at night or in tunnels, do not interfere with radar. What is true of trains is equally true for airplanes, which no longer will collide with other planes in flight nor run into mountains at great loss of life, as at present. Ships at sea will not collide either with other ships, nor will they run into icebergs or other obstacles, including uncharted, newly-made volcanic islands. Automobiles can be made practically collision-proof because radar will stop head-on and rear-end auto collisions. A driver who has gone to sleep will not crash into another car, if his own car has been made collision-proof by means of radar instrumentalities. It is possible, even with the driver asleep, to brake his car automatically by a radar system in order to prevent crashes. These are only a few and the most obvious uses of radar, and any technician can let his imagination run wild if he wishes to think up new applications in the radar principle. Anything that moves anywhere may be radar equipped for safety or other purposes if found necessary. This also suggests many industrial uses in factories, plants, mines, etc., where radar not only will save untold lives and accidents but also will speed up work.—*Radio-Craft.*

Portable Receivers

General Considerations Governing the Design of Portable Receivers, which Many Amateurs Try to Make, but Few Succeed in Getting Good Results

SINCE the inception of broadcasting, amateur and professional designers have been striving to produce the perfect portable. The early efforts were, apart from the fact that they were self-contained, far from being portable, when considered from the present day point of view. They weighed something like forty to fifty pounds; their dimensions were more in keeping with a suitcase, and, in spite of this, their efficiency was not of a high order.

The circuit, except for one or two reflex arrangements, was more or less standard. Five valves were usually employed in the following line-up. Tuned frame aerial feeding two *triode* untuned H.F. stages, the output of which was rectified by another triode acting as a leaky-grid detector. Capacity controlled reaction was normally incorporated, and in many instances the 4th and 5th valves were transformer coupled to their preceeding stages. The output valve was generally of the power or super-power type, and this supplied the signal to the moving-iron operated cone loudspeaker. To those who have not had the *joy ?* of handling or servicing one of these receivers, the statement that they were prone to many weird and varied faults will not be surprising, when comparison is made with modern technique. Instability was the basic cause of most of the troubles, and, owing to the use of a single tuned circuit, selectivity was not what could be called good. One had to make generous use—insofar as stability would allow—of the reaction control, plus careful manipulation of the receiver to get the frame aerial in the correct line so that its maximum directional properties could be utilised.

The H.T. and G.B. batteries were perfectly standard types, and these, especially the former, accounted for a considerable portion of the weight and size of the set. The accumulator used to be a fairly large unspillable model, as five valves at, say, a minimum of 0.1 amps. each, imposed quite a large load on the L.T. supply.

Illustrated advertisements of the period in question, used to depict attractive young ladies, and even children, carrying portable receivers with the greatest of ease. The writer's memory recalls no such scenes in actual fact, but rather the painful vision of himself staggering along with a load which became heavier and heavier with each step.

The introduction of the screen-grid valve and the L.F. pentode opened up a new field for the designer, whose activities were encouraged by the practical co-operation of the battery and component manufacturers, to the extent of smaller components, etc. Miniature valves contributed yet another step in the right direction, and, when the now popular 1.4 volt range of valves were released, manufacturers of portables were quick to take advantage of them, as they did, at last, allow the accumulator to be replaced by a dry cell without sacrificing useful period of service or life.

Loudspeaker design and construction has made wonderful headway since the moving-iron instruments fitted in the early sets. Response, bearing in mind the limitations imposed by a portable, can now be very satisfactory, and, although a greater mass of metal is naturally required for a moving-coil model, weight has not increased in anything like the same ratio as quality of reproduction, thanks chiefly to the development of the new magnetic materials which allow a high flux density to be obtained for a very small mass.

Circuits

What might be termed—in view of the fact that it is so widely used—the standard four-valve circuit is shown in Fig. 1. It uses a variable Mu H.F. pentode in the H.F. stage ; a leaky-grid triode detector with capacity controlled reaction on to the H.F. coupling: a triode L.F. stage, either resistance capacity or transformer coupled to a steep slope economy L.F. pentode in the output stage feeding a permanent magnet type of moving coil speaker.

The H.F. coupling in the majority of designs is tuned-grid or tuned-anode, the former being shown in

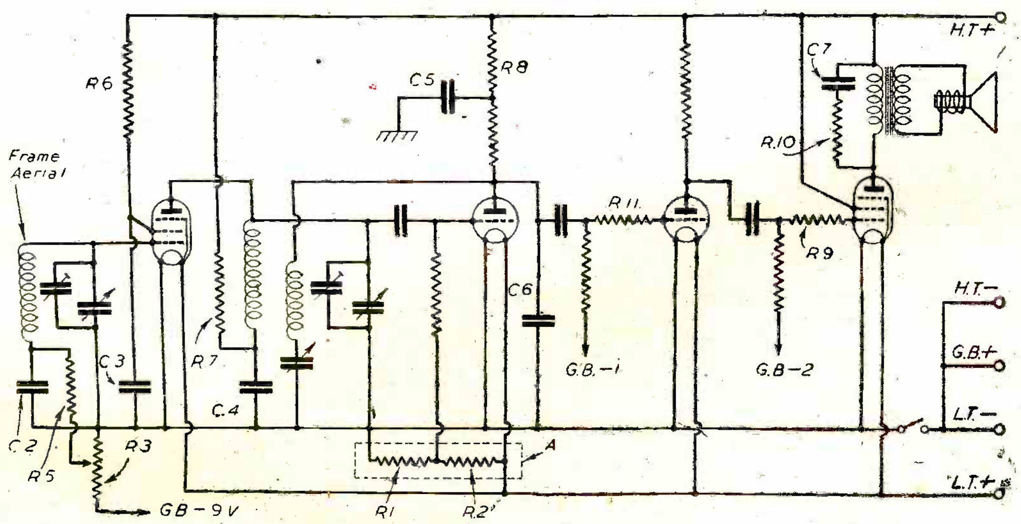


Fig. 1.—A four-valve arrangement, using tuned-anode H.F. coupling, which could be considered as a standard circuit for a portable receiver.

Fig. 1 and the latter in Fig. 2. There is not a great deal of difference between the two circuits so far as overall efficiency goes, and the ultimate choice is mainly governed by layout and the characteristics of the valves.

The detector follows orthodox leaky grid principles, but two little refinements will usually be found worth incorporating. The first of these is connected with the grid-leak return. To obtain the most satisfactory stable rectifying conditions, it is not always sufficient to return the leak to one side of the filament; in certain instances (portables and S-wavers, for example) the correct operating potential can best be secured by returning the grid-leak to a suitable potentiometer connected across the L.T. supply. A typical arrangement is shown in the dotted frame "A" in Fig. 1. The resistors R1 and R2 form the potentiometer, typical values being 250 ohms, 1,500 ohms or, if the grid-leak is omitted and the grid electrode connected to the junction point of R1 and R2, 2 megohms for each of the resistors.

The second refinement connected with the detector, is the ganging of the variable control governing the bias applied to the H.F. valve (R3), to the reaction condenser. By adopting this system, the reaction condenser does not start to influence the circuit *until* maximum gain is being obtained from the H.F. stage. It is not difficult to incorporate such an arrangement, provided the reaction condenser has a spindle suitable for use with a ganging coupling sleeve, and a little care is taken to determine satisfactory values for both components. It will usually be found that R3 should have a low resistance compared with the more normal arrangement, something in the region of 5,000 ohms giving the smoothest control.

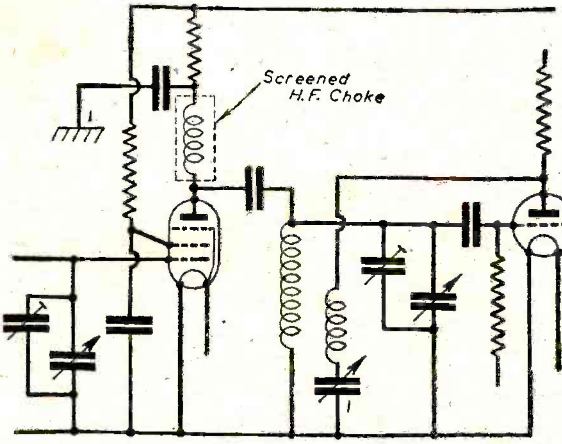


Fig. 2.—Tuned-grid coupling shown here forms an alternative arrangement for connecting the H.F. stage to detector. The H.F. choke must be a good one.

L.F. Couplings

In the early designs, L.F. transformers were nearly always used to provide the L.F. coupling. This did not, of course, help to reduce weight, but owing to the circuits and valves then in use, they did help to give an increased amplification, even if stability and quality of reproduction were not as we like them to-day. In modern circuits, resistance capacity is more favoured, not only from the consideration of saving of space, weight and cost, but also from the point of view of quality. Some designs still use one stage of transformer coupling, but the component, thanks to the development of nickel-alloy, etc., materials for the laminations, is vastly different from the bulky items of the past. Such transformers invariably are connected in the parallel-feed system which forms a combination of resistance capacity and transformer coupling, and prevents any direct current from flowing through the transformer primary. The system is shown by Fig. 3, the resistor R4 being the anode load resistor; the condenser C1 the coupling condenser, and T the transformer. By preventing D.C. from flowing through the primary, a higher inductance value is obtained from a given winding and core, or the primary and core can be reduced in size without detrimental effects, in fact, the method of coupling usually allows a far better response to be obtained if care is given to the selection of the value for C1 in conjunction with the characteristics of the transformer, etc.

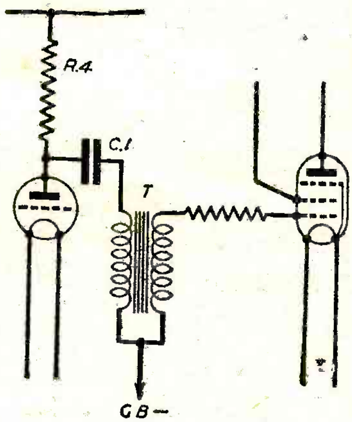


Fig. 3.—The parallel-feed system is advised for use with L.F. transformers.

Decoupling

Owing to the general factors so closely linked with the design and layout of portable receivers, one cannot pay too much attention to the all important question of decoupling various sections of the circuit. Starting from the H.F. stage, the variable Mu bias supply should incorporate a decoupling resistor and condenser (R5 and C2), *especially so* if automatic bias is being obtained. The component values can vary between 100,000 ohms-500,000 ohms for R5, and 0.25 mfd.-0.1 mfd. for C2.

The H.T. supplies to the screen and anode of the H.F. valve must be decoupled by the components R6—C3, and R7—C4, approximate values being 50,000 ohms for R6; 5,000 to 10,000 ohms for R7; 0.1 mfd. to 1.0 mfd. for C3 and C4.

The detector anode circuit is decoupled by R8—C5 which should be in the region of 30,000 to 50,000 ohms and 2 mfd. respectively. The H.F. by-pass C6 is usually an advantage, though its exact value must be determined by the reaction circuit, etc. An average capacity is 0.0002 mfd.

On the L.F. side of the circuit, anode decoupling is not so critical, but if conditions permit it being used in the anode of V3, so much the better, but, unfortunately, one is usually concerned with that electrode receiving as much H.T. as possible.

The grid circuits, however, do call for attention, and the constructor will be wise to insert the "grid-stoppers" R9 and R11. From the point of view of quality, the values should be kept as low as possible, but, once again, one may have to sacrifice certain ideas in the interest of perfect stability. One can always correct, to a reasonable extent, frequency response, therefore, it would be as well to consider R9 and R11 as having values in the region of 100,000 ohms.

On the output side, a simple tone corrector should be included. Space, or rather the lack of it, will prevent a variable arrangement being employed, so tests should be made—in the absence of maker's figures—to determine the best values for the fixed corrector former by R10 and C7. (Average values 5,000 ohms and 0.005 mfd.).

When dealing with a circuit of the type under discussion, difficulty is often experienced in securing satisfactory ganging between the frame aerial and the H.F. coupling tuning condensers. This is largely due to the fact that a frame aerial does not appear to follow the same laws as an ordinary coil. In keeping with ordinary ganged tuning circuits, a trimming condenser should be fitted to each section of the ganged condenser, and, unless one of the circuits is comparatively flatly tuned, it is always advisable to have a panel controlled trimmer across one of the circuits, say, the frame aerial. This allows maximum matching to be obtained, and is well worth incorporating. In pre-war days, one could purchase slow-motion dials which had a very compact trimming condenser operated by a small spindle through the main control, split knobs being fitted to allow adjustment of the ganged condenser or the trimmer, without an extra control, so to speak, being fitted to the panel.

The number of turns required for the frame is another matter which often worries the amateur. Unfortunately, it is not possible to give any hard and fast figures in this article, as, naturally, the number of turns will be governed by the size of the frame, how it is wound, the gauge of wire and the final capacity across it. For the medium-waves, it is best to use, say, 26 S.W.G. D.C.C. or enamel covered wire, and space each turn the thickness of the wire from its neighbour. The actual length of wire required can vary between 45 and 75ft., therefore, for initial tests, it is fairly safe to use 60ft. of 26 S.W.G., the turns being spaced as mentioned above.

If the circuit is of the simple detector plus two L.F. stages, reaction will have to be applied to the frame winding, and the turns for the reaction circuit will be found to be approximately three-quarter those of the aerial section. The additional winding should be located ¼ or ½in. away from the low potential end of the aerial winding, and wound with much thinner wire, say, 32 S.W.G. and with no spacing between turns.

Avoid the use of H.F. chokes unless they are of the screened type, or due care is given to their location. Try and secure a straight follow through valve layout, to reduce possibility of interaction between circuits. The larger the frame aerial, the greater will be its sensitivity; avoid as much as possible, the presence of any large mass of metal within or close to the frame, i.e., keep the speaker as far away from it as possible. Pay particular attention to decoupling and screening of H.F. leads, etc.

Some Aspects of Volume and Tone Control

A WIRELESS set is provided with a volume control, so that the user may adjust the volume or loudness to his liking.

To understand what happens when we turn the volume control up or down, we must have some idea of the working of the human ear. Although not strictly true, it is convenient to consider the ear as containing a very large number of reeds or tightly stretched strings, each tuned to a certain frequency. The number of reeds is such that they provide a discontinuous "spectrum" from about 20 c.p.s. to 20,000 c.p.s. Each reed is connected by a nerve to the brain, and when any particular reed, such as the one tuned to, say, 500 c.p.s., is set in motion, the brain perceives it as a sound which it recognises as a 500 c.p.s. note (although, of course, the numerical classification is rarely noticed).

When a pure tone strikes the ear only, one reed is set into vibration, namely, the one tuned to that particular note. But pure tones are extremely rare in music, and in the majority of cases it is a complex tone that we hear from musical instruments such as the violin, i.e., the fundamental has imposed upon it a number of harmonics. The ear automatically sorts out the different frequencies, each of which actuates the corresponding reed in the ear, and the overall nervous impulse reaching the brain gives rise to the sensation which the brain has learned to associate with that particular complex tone. It is in this manner that we recognise the sound of a violin.

Now, although the average ear is tolerant enough to pass as music sounds which are far removed from the real thing, there is a definite boundary beyond which it ceases to recognise the sounds as being pleasant. This has nothing whatever to do with loudness, for the ear can stand a volume of sound far louder than the majority of wireless sets are capable of providing, if the sound is reasonably free from spurious (unwanted) frequencies. When you "turn up the wick," and the music at once becomes harsh and disagreeable, this does not mean that loudness, *per se*, is the cause of the harshness; it simply means that too big a grid swing in the output or other valves is causing them to generate an undesirable amount of second and third harmonic distortion.

The sensitivity of the ear varies with the frequency of the sound which impinges on it, but it must not be forgotten that the sensitivity also varies with the loudness of the reproduced sound. By the latter statement it is implied that there is a definite loudness at which a programme should be reproduced, and that it cannot be "natural" if the intensity, *at the listener's ear*, is above or below this level. From this it follows that a distortionless amplifier, working into a perfect loudspeaker, may yet not be natural because it is working at an intensity (particularly) above the original.

For perfect reproduction, all the frequencies which are audible to the human ear should be uniformly reproduced, but in practice this is impossible for a variety of reasons. If the frequencies below 50 c.p.s. are cut out, only the deep pedal notes of the organ, and the fundamental tones of the double bass, bass drum, etc., will be affected. If the frequencies below 300 c.p.s. are removed, or are reproduced only at a very attenuated intensity, the general clarity of speech and music will not be seriously affected, though to a musician the music would be thin and lacking in body. If all frequencies above 10,000 c.p.s. are absent, only the very finest shades of musical timbre will be lost, and the defect will normally only be noticed by a trained musician.

When the frequencies above 5,000 c.p.s. are absent, the natural quality of speech and music will be deteriorated so that in the case of speech it will not be easy to recognise the voice, and in the case of an orchestra the finer differences between similar types of instrument will be lost, and it will be difficult to distinguish between an orchestra and an organ. In the extreme case where all frequencies above 3,000 c.p.s. are removed, speech will still be intelligible but will have lost its natural quality.

What in general terms is called a tone control is, in reality, a device for suppressing an undesirable amount of second harmonic distortion arising from the use of pentodes in the output stage. This harmonic distortion, which is of a high frequency (10,000-15,000 c.p.s.), is by-passed through a condenser and fails to reach the loudspeaker, to the benefit of the listener's eardrums.

On the other extreme, it is fortunate that a good round bass response can be achieved without anything like the low notes which the listener imagines he is hearing being present at all: In many cases of complex sound waves it is possible for the fundamentals of the low notes to be absent, and yet we continue to hear them in a more or less natural form.

A Coneless Speaker Attachment

A Handy Unit for the Experimenter

IN previous articles, the writer has shown how earphone units can be converted into simple, practical pick-ups and miniature loudspeakers, the instructions and details of both components being found in *Practical Mechanics* dated March, 1945. Readers who made the tiny extension speaker can try out a further experiment with the vital parts—in fact, it is merely a matter of removing the reproducer from its housing and cone.

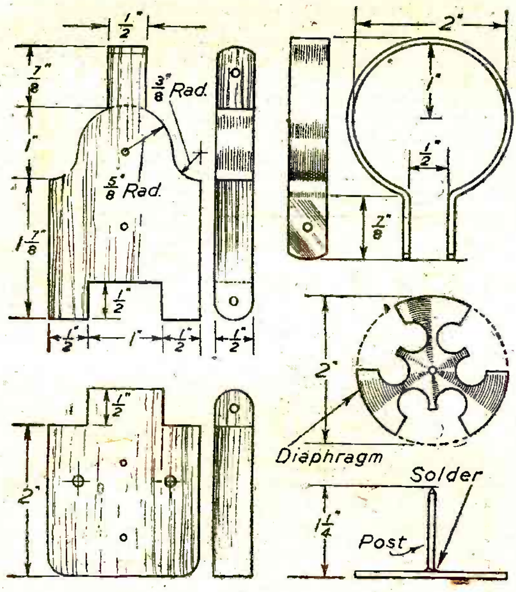


Fig. 1.—Upright support and base pieces, with details of earphone clip and special type of diaphragm.

The reproducer is a unit which can be used independently, i.e., without a cone. Because of its thick metal diaphragm and sound post, almost any thin surface can be made to vibrate and amplify the electrical impulses set up in 'phone coils. For example, by pressing the sound post against a window pane, reproduction is greatly magnified, and besides, speech, music, etc., can be heard inside a room and outside it.

Therefore, it occurred to the writer that the unit could be made as a loudspeaker attachment which serves a double purpose. It can be used to serve in a shop window, particularly the fan-light window above the door entrance. If the door itself has a reasonably thin window pane, the unit can be attached on the interior side. Whether the door is shut or open, broadcast features can be heard by the public inside or outside the shop.

Plate glass windows, incidentally, are just a bit on the thick side. A much larger and more powerful reproducer is wanted, and in this case, the working parts of an old moving-iron speaker would undoubtedly give better results.

However, there are many uses and various ways the attachment can be used. It can be fitted within a radio cabinet. The woodwork will vibrate and reproduce sound clearly, but a trifle dull and weak if the wood happens to be over ⅞in. in thickness.

The writer's idea is to have the sound post pressing at the front of the cabinet, at the interior side, of course. Most radio cabinets have a thin panel of wood at the face side. This will respond to the electrical impulses, including the sides of the cabinet.

Better results are obtained on soft woods, such as spruce, deal, whitewood, etc. A deal kitchen table on which the writer happened to be working responded nobly when, by an accident, the sound of his experimental speaker rested on the top. It was this discovery which caused him to devise the simple attachment illustrated.

The Diaphragm

For the benefit of readers who are unable to obtain back numbers of the issue of "P.M." mentioned, the diaphragm used in making the miniature speaker was cut from $^3/_{32}$in. thick sheet iron or mild steel to the shape shown at Fig. 1. A sound post, such as a piece of bicycle wheel spoke, is cut 1¼in. long (in the case of the attachment) and forced into a suitable hole drilled in the centre of the diaphragm and then soldered. The old, thin, soft-iron diaphragm is removed from the 'phone and the new one fitted. A conical point should, by the way, be filed on the projecting end of the sound post.

Upright Support and Base

The 'phone is supported by an upright member and a base piece, both being detailed at Fig. 1. Cut these parts from (preferably) ⅜in. oak or similar hardwood. The base, it will be seen, is knuckle-jointed to the support, the pivot being a piece of wire or a 2in. long wire nail.

A clip, to surround the 'phone casing tightly, is made to the sizes shown and drilled for a cheese-headed bolt and nut; roundheaded bolts can be used, if desired. The clip is cut from brass sheeting about $^1/_{16}$in. thick.

Now, the clip not only secures the 'phone casing to the top of the upright support, but allows a certain

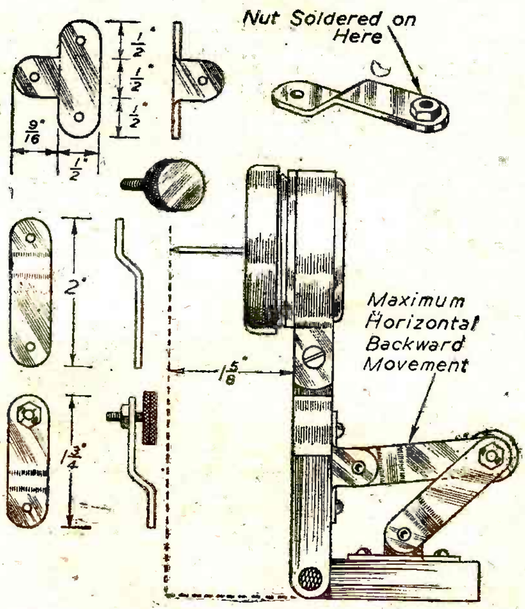


Fig. 2.—Metal stay parts, with side view of attachment.

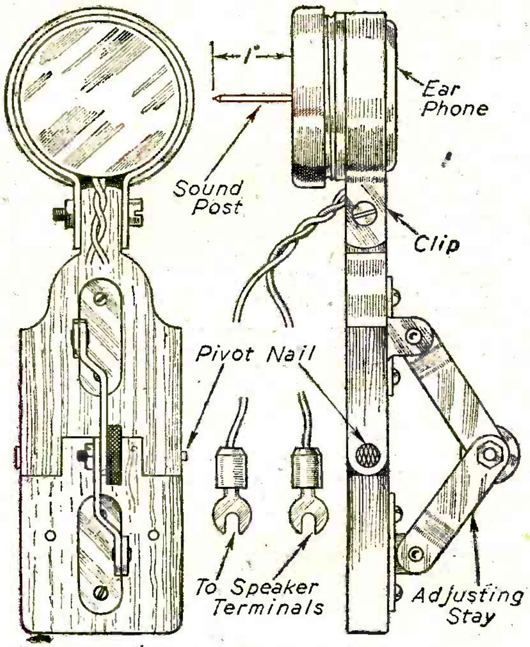


Fig. 3.—Plan views of the completed attachment.

amount of swivel movement. As a result, the clip must be a neat, true fit so that a correct screw tension can be applied to the "tongue" cut in the support. Should the clip be a trifle too large in circumference, a strip of gummed paper or piece of insulation tape can be used to rectify matters.

The Adjustable Stay

The adjustable stay required is made from brass sheeting, details of the various parts being provided at Fig. 2. The shorter stay arm (see detail) has a nut soldered to one of its ends. A milled-edged thumbscrew, such as the type indicated, should fit the nut; it is this screw which "locks" the stay in the positions wanted.

Having riveted the stay arms to the fixing plates to move stiffly, yet fairly easily, screw the plates to the base and upright support, then insert the locking screw through one of the arm ends into the nut in the second arm. This completes the construction of the attachment.

Wire leads are fixed to the 'phone terminals and fitted with wireless plugs or spade-ends, as shown in the plan views at Fig. 3. A 6ft. length of cheap black-and-red flex will doubtless suffice for your needs.

The side view of the completed work at Fig. 2 shows the maximum horizontal backward movement of the attachment. It reveals the amount of space required when the device is in its most confined position within, say, a radio cabinet.

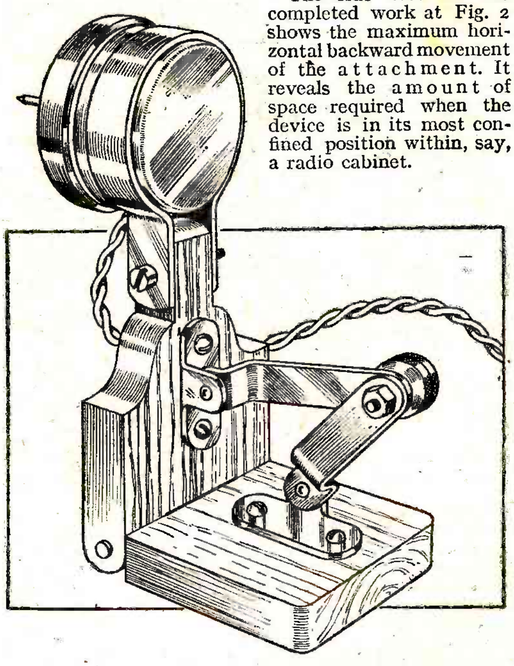


Fig. 5.—Rear view of the complete attachment.

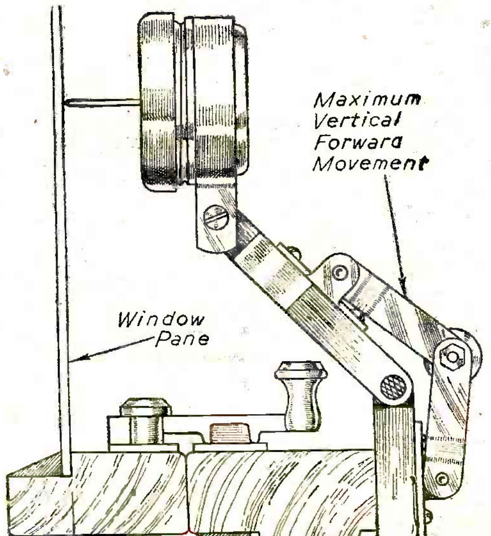


Fig. 4.—How the device can be attached to common window framing.

The diagram at Fig. 4 shows the maximum vertical forward movement of the attachment. The latter, to illustrate the amount of "stretch" possible, is shown fixed to the inside of a common sash window frame.

It will be observed that the conical point of the sound post rests against the glass, being pressed there by the stay. The 'phone clip has been adjusted so the sound post is horizontal. The adjustment screw, like the stay screw, must, of necessity, be quite tight. If not too tight, the slight vibrations set up by the agitated diaphragm are apt to slacken the screws after a time.

Incidentally, a great pressure is not wanted on the sound post. On the other hand, a light touch will render poor reproduction, so a "between" pressure is wanted, and this is best found by test and experiment. A few minutes should suffice to adjust the attachment correctly.

R.C. Oscillators for Audio-frequency

By S. A. Knight

AUDIO-FREQUENCY oscillator design generally follows that of the conventional beat-frequency oscillator, where the output from a variable frequency R.F. oscillator is mixed with the output from a fixed frequency R.F. oscillator operating at a slightly different frequency, the beat note thus obtained being amplified and passed to the output terminals of the instrument as Fig. 1 schematically depicts. Most readers are no doubt familiar with the process, a practical circuit having been described a few months ago in this journal.

The principle factors affecting the performance of a beat-frequency oscillator are frequency stability of the individual oscillators and the tendency of the oscillators to "pull" or synchronise at low difference frequencies.

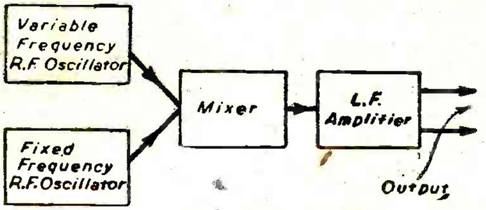


Fig. 1.—Block schematic diagram of a conventional B.F.O.

Overcoming the former difficulty means that the two oscillators must be nearly alike as possible not only to electrical, but also to thermal characteristics. Great care in layout is necessary to ensure that heat producing elements, such as rectifier valves do not cause temperature differences in the circuits of the oscillators, or the oscillators themselves set up any wide temperature variations in their own vicinity. The second difficulty is due to the fact that at very low frequency differences the two oscillators tend to synchronise unless the circuits are carefully screened and isolated. Valve oscillators have an inherent tendency to synchronise with any other oscillation of approximately the same frequency that may be present. Two frequencies differing by only a small percentage shift in such a way that the difference is reduced; when the frequencies are approximately the same the oscillators pull into synchronism. In B.F.O. design this effect is disastrous, for it means that small difference frequencies cannot be obtained, and so the lower range of the instrument is severely restricted. Badly designed audio-oscillators of this sort may pull together when their oscillator differences is as much as 20 cycles per second, a sorry state of affairs both for the designer and prospective operator.

It is not generally appreciated, however, when the design of an audio-oscillator is in mind, that *resistance-capacity* oscillators can be made to perform the work of the conventional B.F.O. in a rather unconventional manner. This sort of oscillator employs nothing in the nature of tuned circuits and therefore does not suffer from the above synchronising effect. it produces an excellent sinusoidal output with great frequency stability, and this output is virtually constant over very wide frequency ranges. This article sets out to investigate in a simple manner the action of a typical oscillator of this pattern, and describes a small practical circuit built by the writer to cover the audio range of 10 to 250 c.p.s. This circuit, whilst designed especially for bass-resonance tests is easily adaptable to cover the entire audio band, and may serve as a groundwork to the construction of a complete audio-oscillator.

The Multivibrator

The conventional multivibrator depicted in Fig. 2 is convenient for purposes of introduction to a description of resistance-capacity oscillators as a whole. The multivibrator, or relaxation oscillator as it is sometimes called, is a two stage resistance-coupled amplifier in which the output from either valve is applied to the input of the second. The circuit oscillates because each valve produces a phase shift of 180 deg., thereby causing the output of the second valve to supply an input voltage to the first valve of exactly the right phase to maintain oscillations.

Assume that, due to small fluctuations in the circuit of Fig. 2, the grid of V_1 goes slightly negative. The valve is thereby biased back and the anode voltage rises slightly, this positive increase being passed to the grid of V_2 via C_2 and R_2. The anode current of V_2 consequently increases and the anode voltage falls, this voltage decrease appearing on the grid of V_1 via C_1 and R_1, and carrying this valve towards cut-off. The anode voltage of V_1 thus increases still further, and is again applied to the grid of V_2 for re-amplification. This action takes place at great speed and is cumulative; finally, the grid of V_2 is highly positive, whilst the grid of V_1 is negative beyond cut-off. Amplification then ceases, one valve drawing a large anode current, the other none. This situation does not last, of course, for leakage through the grid resistors R_1 and R_2 quickly tends to restore the grids to normal. At the point when the grids are sufficiently restored for amplification to become possible again, small voltage changes cause the oscillatory process to repeat in the reverse direction, the grid of V_1 this time going positive and the grid of V_2 negative. The typical oscilloscope traces shown in Fig. 3 clearly reveal the nature of the changes occurring at the various electrodes.

The frequency of the multivibrator oscillation is determined primarily by the values R_1R_2 and C_1C_2, though inter-electrode capacities and anode potentials influence it to a certain extent. By selecting suitable values for the coupling condensers and grid leaks the circuit can be made to oscillate at frequencies ranging from a few cycles a minute up to at least 100,000 cycles per second.

In resistance-capacity oscillators for audio work, the principle of the multivibrator is employed, the regenerative coupling between the input and the output being so arranged that a sinusoidal waveform is produced, its frequency being made variable over certain bands by variations in the feedback.

Basic Circuit and Theory

A typical basic circuit for an audio-oscillator is shown

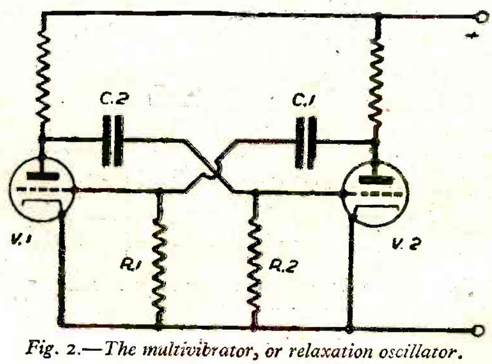


Fig. 2.—The multivibrator, or relaxation oscillator.

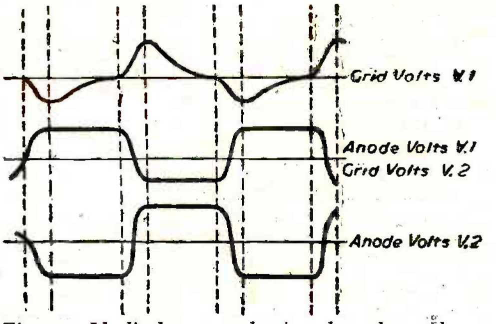


Fig. 3.—Idealised traces, showing the voltage changes occurring in a typical multivibrator.

in Fig. 4, where the resemblance to the multivibrator just discussed will be at once apparent. There are some small but important differences, however, which must not be overlooked when considering the theory of this arrangement in the light of an ordinary multivibrator.

A condenser now appears across the grid and cathode of V_1 and a resistance R_1 is joined in series with the V_2–V_1 feedback circuit. For the purpose of an elementary analysis the feedback circuit from V_2 to V_1 may be drawn as in Fig. 5, where the appropriate component lettering is carried forward from Fig. 4.

C_1 is actually a combination condenser, being the component itself in parallel with the inter-electrode capacity of V_1; we treat it, however, as a single condenser. The input voltage to V_1 derived from the output of V_2 appears across C_1R_1 as E_i. This voltage is the vector sum, i.e., the resultant, of the voltage across R_1 (V_{R1}) and the voltage across C_1 (V_{C1}), and so may be drawn as a vector E_i (Fig. 6). Treating this as the hypotenuse of a right-angled triangle, we draw in the vectors V_{R1} and V_{C1}, as shown, to indicate the components of voltage across R_1 and C_1 respectively, V_{C1} lagging on V_{R1} by 90 deg. Actually the vector V_{R1} now represents the voltage loss across R_1, whilst the vector V_{C1} represents the actual input voltage to V_1.

Arranging the forward coupling from V_1 to V_2 to give as little phase shift as possible, will now ensure that the grid voltage of V_2 is in phase with the anode voltage of V_1, and hence the anode voltage of V_2 will be in phase with the grid voltage of V_1. Representing this by a vector E_O (Fig. 6 dotted) in phase with V_{C1}, we observe that this vector is the resultant of the voltages across R_2 and C_2, and we may therefore draw vectors V_{R2} and V_{C2} at right angles to each other to represent the voltage V_{R2} across R_2 and the voltage V_{C2} across C_2. The magnitude and direction of these vectors will depend upon circuit conditions, but when V_{C1} is in phase with E_O, that is, when oscillations occur, V_{R2} must be in phase with E_i, since the latter is developed across part of the former. The complete vector diagram for oscillatory conditions is therefore that of Fig. 6 taken as a whole. The ratio into which R_2 is divided must be such that the input to V_1 is just sufficient to maintain oscillations; in a practical design, therefore, the lower half of R_2 can be a potentiometer, additional fixed resistors making up the total required. This ensures a smooth, non-critical control of feedback, and hence makes for ease in obtaining a good output waveform.

From Fig. 6 we see that when oscillations occur V_{C1} is in phase with E_O and V_{R2} is in phase with E_i. Hence—

$$\Phi_1 = \Phi_2$$

$$\therefore \tan\Phi_1 = \tan\Phi_2$$

$$\therefore V_{R1}/V_{C1} = V_{C2}/V_{R2}$$

Denoting the reactances of C_1 and C_2 by $1/\omega C_1$ and $1/\omega C_2$ respectively, we get—

$$\frac{R_1}{1/\omega C_1} = \frac{1/\omega C_2}{R_2}$$

$$\therefore \frac{1}{\omega^2 C_1 C_2} = R_1 R_2$$

$$\therefore \omega^2 C_1 C_2 R_1 R_2 = 1$$

and so $f = \dfrac{1}{2\pi\sqrt{(C_1C_2R_1R_2)}}$ = (since $\omega = 2\pi f$)

The frequency of oscillation is thus determined by the relative values of $C_1C_2R_1R_2$ in the feedback circuit. Putting $C_1 = C_2$ and $R_1 = R_2$, this formula reduces to—

$$f = \frac{1}{2\pi\, C.R}$$

where $C = C_1 = C_2$ and $R = R_1 = R_2$.

Also, since $C = C_1 = C_2$, then $1/\omega C = 1/\omega C_1 = 1/\omega C_2$ and the equation above—

$$\frac{1}{\omega^2 C_1 C_2} = R_1 R_2$$

reduces to $\dfrac{1}{(\omega C)^2} = R^2$

whence $\dfrac{1}{\omega C} = R$ .... (1)

The impedance Z of either R_1C_1 or R_2C_2 is given by

$$Z = \sqrt{R^2 + (1/\omega C)^2}$$

But $(1/\omega C)^2 = R^2$ and so

$$Z = \sqrt{2R^2} = R\sqrt{2} \quad \text{............ (2)}$$

These two results are interesting because (1) shows that it is of advantage to gang C_1 and C_2 together as equal condensers for then the oscillation frequency will always be such that $R = 1/\omega C$, and (2) shows that by ganging C_1 and C_2 and making R_1R_2 constant, the impedance of the circuits C_1R_1 and C_2R_2 will be the same at all frequencies and hence the amplitude of oscillations will be constant.

Practical Circuit

Fig. 7 shows a practical audio-oscillator which will cover the range 10–250 cycles per second approximately, with constant amplitude output throughout this range. The circuit is practically self explanatory and requires few components and little time to construct.

Both valves are American type 6C5's (though British AC/HL's are suitable equivalents) and all resistors may be rated ½ watt. C_1 and C_2 are each 0.001μf capacity and consist of two two-gang 0.0005μf tuning condensers in tandem, the gangs being paralleled to provide the requisite capacity. These constitute the frequency control.

Particular points to notice in construction are these: (i) one of the 0.001μf gangs must be totally isolated from earth and from the other gang; (ii) careful screening is absolutely necessary for the whole circuit, otherwise mains pick-up at 50 cycles will be extremely troublesome; (iii) a small trimmer (about 0.0001μf) across the C_2 gang will ensure accurate alignment and therefore a constant amplitude of oscillations; (iv) the layout should be as simple and as convenient for connections as possible.

The output of the oscillator may be conventionally

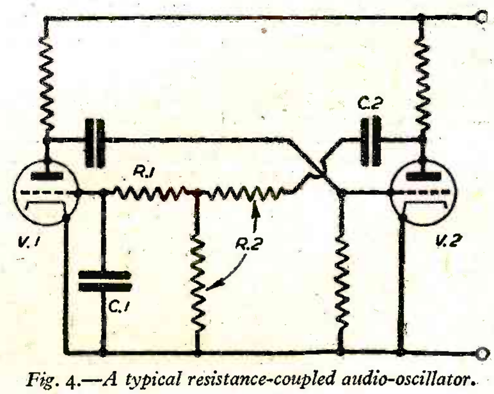


Fig. 4.—A typical resistance-coupled audio-oscillator.

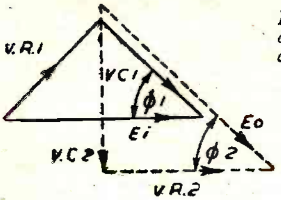


Fig. 6.—Complete vector diagram for oscillatory conditions of the circuit of Fig. 4.

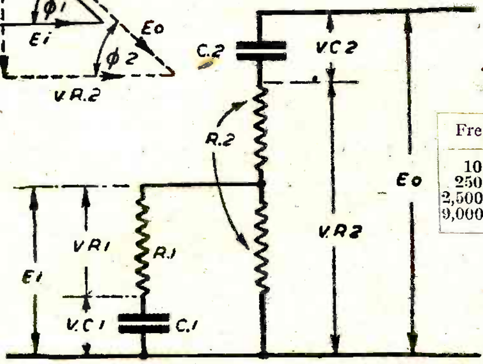


Fig. 5.—Equivalent circuit showing voltage distributions of the feedback section of Fig. 4.

amplified by two or more L.F. stages, and its output employed in the same manner as that of an ordinary B.F.O.

It is essential for good output waveform that the setting of R_3 should be as low as possible consistent with stable oscillations. Too little of R_3 will cause the oscillations to collapse, too much will result in the production of square waves in the manner of multi-vibrators. Those readers who are fortunate enough to possess a cathode-ray oscilloscope will, of course, find no difficulty in setting this control. Others may make a fairly accurate setting by connecting headphones after the first amplifier and increasing R_3 until the oscillation is just heard to begin. A *very slight* further increase in R_3 will then ensure a stable oscillation of good wave form. This operation should be performed at the lower end of the frequency range, that is, when the tuning condensers are fully closed. Next, a careful adjustment of the trimmer across C_2 will ensure constant amplitude of oscillations, though with good ganged condensers this control will not be found critical.

Those who wish to increase the range of the instrument to cover the entire audio-band (10 to 14,000 c.p.s.) may design a switching system to change the values of R_1, R_2 and R_3 for the other bands. For this purpose the following table will prove useful:

Frequency Band	R_1	R_2	R_3
10 to 250 c.p.s.	As circuit in Fig. 7		
250 to 2,500 c.p.s.	400 k.ohms	350 k.ohms	50 k.ohms
2,500 to 9,000 c.p.s.	100 k.ohms	75 k.ohms	50 k.ohms
9,000 upwards ..	75 k.ohms	40 k.ohms	5 k.ohms

These values allow adequate overlap between the bands. All other circuit values are unaffected, and R_3, once set up on *each* band as described, requires no further touching. It is hoped that these brief notes provide sufficient material for many experiments with resistance-capacity oscillators for audio work.

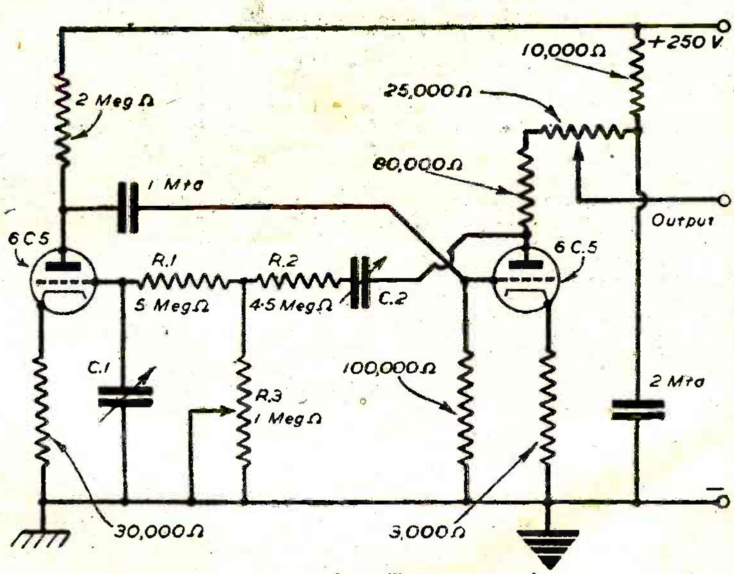


Fig. 7.—Circuit of a practical audio-oscillator to cover the range 10–250 c.p.s.

Magnets Suspended in Air

According to a member of the U.S.S.R. Academy of Science, a magnet which supports itself in air above a super-cooled lead plate has recently been demonstrated. The probable explanation is that the magnetic field of the magnet sets up incessant induction currents in the lead which, in turn, repel the magnet. This ability is manifested in a ferro-nickel magnetised bar 1 centimetre long.

In the experiment the lead plate had been cooled to 269 deg. Centigrade below zero, approximately 4 deg. above absolute zero.

When the tiny magnet was thrown on to the plate, it bounced into the air and remained floating until the temperature of the plate rose 3 deg., when it settled on its surface.

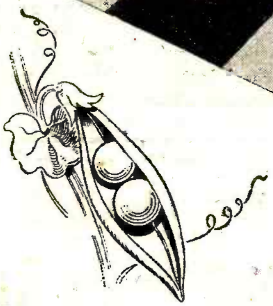
Free "Safety" Telegrams

Every member of an oversea British Empire unit who has been released from a prisoner-of-war camp is allowed on arrival in Great Britain to send a free telegram via Imperial to his relatives at home telling them of his safety.

Announcing this "Safe Arrival" scheme, Sir Edward Wilshaw, chairman of Cable and Wireless, Ltd., says "it is only natural that their first thoughts will be for their relatives at home, and I have a keen desire to render any service in my power to alleviate their anxieties and to ease the tension which their relatives must have felt during their long separation."

The oversea Empire governments concerned have expressed their appreciation of the scheme, in which the associated telegraph companies in the Empire are gladly co-operating.

ELECTRONIC AIDS *for* INDUSTRY



To all outward appearances, these two sections of steel bar are identical, yet their composition and properties may be totally different. One may be quite unsuited to the job that the other could perform with ease.

Until electronics provided a method of instant identification, checking up materials against specifications was a lengthy laboratory process, calling for special training and skill.

Now with the aid of an electronic instrument and the use of the thermo-electric effect, the material to be tested is compared directly with the known sample and rapid identification is achieved.

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GA

ON YOUR WAVELENGTH

By THERMION

Component Manufacturers Please Note

ONE of my readers, Mr. P. Moore, who is in the East at the present time, says that I shall be doing a good turn to all those out there by informing manufacturers that ordinary components are useless in that climate. Components need to be proofed against dampness and a larger safety margin would help to protect them during the summer months when the temperature is rather high. This reader has found that iron-clad pitch-filled transformers are quite good, but the open variety are a constant source of trouble.

Vibrator transformers are the worst offenders, and as spares are unobtainable and test equipment is conspicuous by its absence, it is more than ever necessary for components to be made in a form where they will give little trouble. I hope the manufacturers will pay due regard to this.

Television on a Rental Basis

OUR American contemporary "Radiocraft" says that the British policy of television set rentals before the war had succeeded in abundantly proving that television audiences could be built up to very large dimensions quickly, much faster, in fact, than would be possible by the time honoured outright sale methods. Dr. Lee De Forest has suggested a modified form of our television set rental plan. He thinks that in America it would be sensible on the part of the manufacturers of television receivers to be willing to assume their share of the cost of building up a television audience.

If their television receivers were made available on, say, a graduated rental basis, signed up for an initial quarterly period plus a reasonable installation fee, there would be a hundred customers for everyone able to purchase outright. This plan does not, of course, entail a very heavy cash investment on the part of the set manufacturer. His hope will be that in the near future his audience will attain such dimensions that the advertiser will finance the costly night programmes.

Bats Using Radar?

ACCORDING to a contributor in the same journal bats use radar! Bats were set free in a room in which a supersonic detector was located. These flying bats produced a constant stream of short cries in which frequencies around 45,000 cycles were most intense. When the ears were plugged the cries continued much as before, but the bat could not avoid obstacles such as a barrier of steel wire. Many of them crashed into the wall. When the mouth of the bat was taped shut, leaving the ears untouched, the cries were gradually diminished in intensity and all the animals floundered about, bumping into whatever lay ahead of them and behaving exactly as if their ears were plugged.

The contributor thus assumes from these experiments that the flying bat produces supersonic cries in its voice box, and that these cries enter the space through which the animal is about to fly, and are scattered by objects lying in the direction of flight. Some of the scattered sound returns to the ears of the animals as an echo and is interpreted as coming from an obstacle. The animal then changes its line of flight so as only to travel through space from which no echoes are received. The bat thus locates objects at a distance by the echoes they produce.

Well, this is an interesting theory, but I can imagine that human beings shut up in a room with their ears plugged, or their mouths taped shut, would behave very much in the same way. I suggest that we take a gaggle of crooners, lock them in a room, seal their mouths with insulating tape, and leave them to the internecine conflict which must ensue! Perhaps the caterwauling, known as crooning, is due to the supersonic effects given out by the screeches from the bats in the belfry!

Peace

PERHAPS the most welcome announcement ever made over the air was on Monday, May 7th, in the 9 o'clock news. Germany had unconditionally surrendered, and so once again the B.B.C. can speak peace unto nations. The war of words will cease, and we can devote our energies to more practical pursuits. It will not be many months before tens of thousands of our men return to civilian life. They will wish to pick up the threads at the point from which they left them when they departed to join one of the Services.

It seems that it will be some time before components, paper, complete receivers, motor cars and bicycles, clothing and watches, and all of those things which are the ingredients of peace are available in sufficient quantities to kill the black market. We shall gradually work, however, toward that end. Perhaps next year we shall have Radiolympia. The last one was tragic, for the war was declared during its run and it came to a premature end. One who had worked so hard to make that Exhibition an outstanding success has not lived to see the end of the war. Many others have fallen. They must not be forgotten in this moment of exultation.

Our Roll of Merit

Readers on Active Service—Fifty-fifth List.

T. W. Bennett (A.C.2, R.A.F.).
W. J. Kendall (F./Sgt., R.A.F.).
E. Phipps (Gnr., R.A.).
A. E. Carter (A.M./L., R.N.A.S.).
A. A. Parker (Sgt., R.A.F.).
S. Shacklock (Fus., 1st Royal Irish Fus.).
W. H. Presswood (Cpl., 20th Armoured Reg., C.M.F.).
F. Stuart (L.A.C., R.A.F.).
E. C. Brooke (Cpl., Royal Signals, C.M.F.).

SCRIPTURAL AUTHORITY

[A FAMOUS radio critic writes: "I now hate Dr. Joad's ringing laugh. He isn't a B.B.C. conductor. Or is he?"]

Cachinnation shrill and frequent,
Often without proper reason,
Broadcast now upon the ether
In and out of season.
How the listener yawns in boredom
At each silly giggle,
Till he switches off the broadcast,
Tortured nerves a-wriggle.
Cachinnation stands for "Culshaw,"
Much admired by B.B.C..
Though the reasons for the giggles
Often most inane may be.
And much reason for our hatred
We in Holy Writ have got.
Foolish laughter, it compares with
Crackling thorns beneath a pot.
Let the Brains Trust note this dictum—
And conductors also note—
Guffaws are not proofs of genius,
Too much giggling gets our goat!

"TORCH."

Some Tuned-circuit Questions

A Discussion of "Acceptor" and "Rejector" Properties

WHAT is the correct explanation of aerial tuning by a coil and condenser *in parallel* as in Fig. 1 (a)? Is this an "acceptor" or "rejector"?

In some respects, the terms "acceptor" and "rejector" are unfortunate ones, though they do serve as useful labels for the two ways a tuned-circuit may be energised, namely, in *series* or in *parallel*.

The acceptor property gives *maximum current*, or,

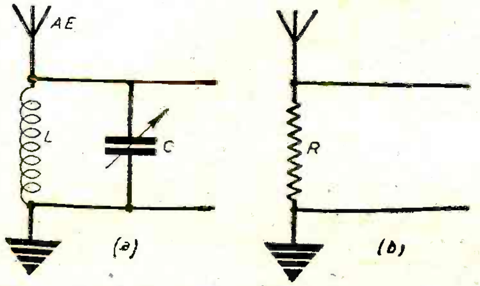

Fig. 1.—How is the aerial tuned? At resonance, the coil and condenser in parallel act as a high resistance R, (b), of the order of 100,000 ohms.

what is the same, *minimum impedance*, at resonance—and also *maximum voltage* across the inductance and condenser individually. It comes about by applying a signal e.m.f. to L, C, and r, *in series*, as illustrated in Fig. 2 (a).

Here, an imaginary alternator is shown generating the applied e.m.f., E. In an actual tuned circuit, this would be equivalent to inducing the e.m.f. E *into the turns of the coil*; for instance, by coupling to an aerial as in (b). An H.F. measuring instrument in the closed-circuit would indicate a peak current at resonance, whilst a valve voltmeter connected across L and C would equally show maximum voltage response.

The rejector property is diametrically opposite. Resonance gives *minimum supply current*, or *maximum impedance*—though *maximum current* would still occur in the closed-circuit. We are now energising the circuit differently by connecting L and C *in parallel* to the imaginary alternator, Fig. 2 (c).

Fig. 1 (a) appears as an exact equivalent of this, where the "alternator" is the e.m.f. "source" constituted by the aerial itself, i.e., E is one of numerous e.m.f's generated in the aerail of electromagnetic waves of various frequencies. Are we to say, therefore, that tuning is effected by adjusting the rejector to exact resonance with some desired frequency?

If you think about the matter for a moment you will see that this view gives rise to a serious difficulty. The rejector offers *maximum impedance* when turned to resonance. Moreover this impedance will actually be of a very high value of resistance, of the order of 100,000 ohms or more.

So, "tuning" by this method of parallel coil and condenser apparently means inserting an A.C. resistance of about 100,000 ohms into the aerial circuit at the frequency we desire to receive! The equivalent state of affairs is shown in Fig. 1 (b).

In other words: the current in the aerial falls to a *minimum* at the desired frequency, whereas we usually associate "resonance," if not with maximum current, at least maximum energy. Indeed, there seem to be insuperable obstacles in the way of giving an account of any aerial "tuning" along these lines. The effect appears the exact opposite of what is desired.

Ah! But what about *voltage*? With almost the entire impedance of the aerial now "lumped" in the region of the tuned-circuit, we are getting practically *all* the e.m.f. E developed across this 100,000 ohm resistance, in potentiometer fashion, whereas, otherwise, a considerable proportion of it would be straying across other impedances in the aerial.

The possibility of thus diverting the e.m.f. exactly where we want it, certainly sounds attractive—and plausible. After all, we can do a good many things by the principles of the potentiometer. Unfortunately, it will not do at all as an explanation of *tuning*—at least, not in this instance.

The Tuned-anode Circuit

In the case of a valve, Fig. 3, that explanation works well. The rejector acts as a resistance of the order of 100,000 ohms at resonance, and thus forms a pure A.C. resistance in series with the valve. The steady drop of volts is negligible, being only that due to the small D.C. resistance of the coil.

As in all stages employing a simple resistance as anode load, the alternating component of anode current will develop the "output voltage" across the resistance, which will increase as R is made greater in relation to the internal r_a of the valve. If u is the amplification factor, the

$$\text{Voltage amplification} = u \times R/(R+r_a),$$

which tends to approach the limiting value, u, as R becomes very large, i.e., the fraction $R/(R+r_a)$ will then tend towards unity.

This is a case where voltage magnification is obtained really *as a result of energy released from the H.T. supply source*. There is nothing of this kind about Fig. 1 (b), and though an H.F. voltage would be developed across R which would reach a maximum at the resonant frequency, it is not the true explanation of the circuit.

Tuning Aerial as "Acceptor."

It is not true, because if we inserted a sensitive thermo-ammeter in series with the aerial, we would find that the current becomes a *maximum* at the tuning point, as in an acceptor circuit, and not a minimum as suggested by Fig. 1 (b).

There can be no doubt on the matter: we are tuning the aerial, somehow, as a *series acceptor* even though the coil and condenser form a rejector arrangement in

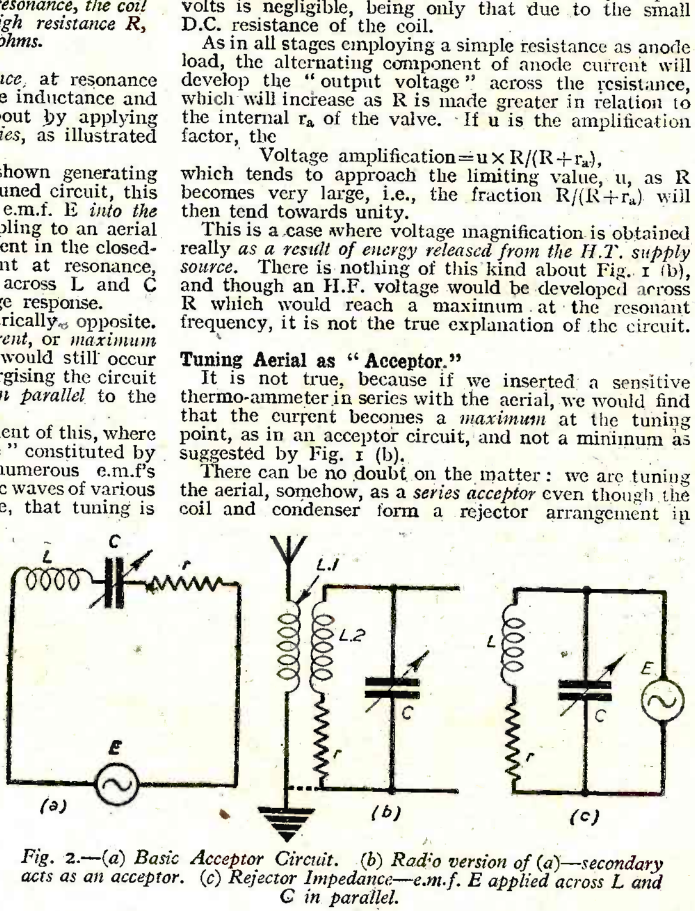

Fig. 2.—(a) Basic Acceptor Circuit. (b) Radio version of (a)—secondary acts as an acceptor. (c) Rejector Impedance—e.m.f. E applied across L and C in parallel.

this *part* of the circuit. How does this come about?

Well, in the first place the aerial itself has a certain capacity Ca to earth, an inductance L_a, and a series "loss resistance" r, all of which are shown in Fig. 4 (a). Whether it is the inductance or capacity that predominates depends on the frequency, or, in other words, upon the value of the expression,

$$\text{Resultant Aerial Reactance} = (wL_a - 1/wC_a),$$

which is sometimes written in the form, $\frac{w^2LaCa - 1}{wC_a}$

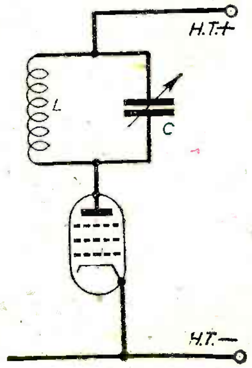

Fig. 3.—"Rejector Impedance" used as anode load resistance in tuned-anode i.f. stage; tuned primary of a transformer would function similarly.

If the length of the aerial is less than a quarter-wavelength—which is the case in all aerials of ordinary dimensions for medium and long waves—it can be shown that the nett reactance will be *capacitive*. This will not necessarily be the same as the capacitance Ca, because the effect of the inductance must also be taken into account.

However, we can make the whole aerial system resonate as an acceptor by adding series *inductance*, e.g., by varying L in Fig. 4(a), though resonant conditions in a system with inductance and capacitance *distributed* along its length will not be exactly the same as in a circuit having "lumped constants," such as Fig. 2(a) and (b).

For one thing, the current will not be the same everywhere in the aerial—it will actually be zero right at the top end. But at any other point the current will reach a maximum, the "greatest maximum" occurring at the base, or in the earth lead. Series resonance will take place when L is adjusted to a point where, with La, the total inductive reactance is equal and opposite to the reactance of C_a, i.e.,

$$w(L+La) - 1/wC_a = 0,$$

$$\text{or,}\quad w(L+La) = 1/wC_a.$$

"Effective Inductance" of a Rejector

Now, the "rejector" in Figs. 1 and 4(b) does not look very much like the straightforward variable inductance L in Fig. 4(a).

We have said that a rejector behaves as a pure resistance if tuned *exactly* to the incoming frequency. But what if it is not tuned exactly? At a frequency *higher* than the one to which it is tuned, the rejector will offer a *capacitive* reactance, since the condenser branch then takes more current than the inductive branch.

This is no use to us, because what we want is *inductance*. That can be quickly arranged by tuning our rejector to a frequency higher than the one it is desired to receive, i.e., the frequency is now *below* the one to which the circuit is set. In other words: *we can vary the nominal inductance of a coil simply by putting capacity in parallel (or in series) with it.*

Because the effect of capacitance is always opposed to that of inductance, we simply use one to cancel out a *certain amount* of the other. Actually, in a rejector, we can get inductive values just around the resonant point much *greater* than the nominal value of L itself, because a *small* lagging *current* is equivalent to a large inductive value.

All tuning methods boil down to balancing-out positive reactances by ones of opposite sign, or vice versa. So, after all, Fig. 1(a) reduces to something very much the same as inserting inductance in series with the aerial, only that we make use of a condenser to vary the "effective inductance." The rejector is tuned slightly *above* the frequency to be received—possibly quite a good bit above—and not to the exact resonant point that makes it a high resistance.

Condenser in Parallel with Aerial

But how does all this agree with the better known theory that the tuning condenser in Fig. 1 is simply in parallel with the aerial capacitance C_a? Why talk of "effective inductances," etc., when all we are doing is to put in "more capacity" to tune the frequency or wavelength required?

For instance, whatever the effective inductance of the coil and condenser in parallel, we know from practical experiment that the tuning range is very much the same as putting C_a in parallel with C. In fact, C_a can be measured in this way.

Actually, if we write the expression for the effective reactance of the rejector at some particular frequency, and consider C_a as being *in series* with it, we find that the formula for the resonant frequency becomes

$$f = \frac{1}{2\pi\sqrt{L(C+C_a)}},$$

which is the formula for a circuit with C and C_a in parallel!

There can be no doubt, therefore, of the effect on the *tuning range*—it is *equivalent to* putting capacity in parallel—where C stands for the *actual setting* of the rejector condenser.

This, too, will make the whole aerial an acceptor, i.e., we may say we are adding capacity to C_a to counteract the inductive reactance of L and L_a. Since, however, L_a and C_a are distributed quantities, this account is not so straightforward as it seems.

There cannot be much doubt, too, that the actual conditions involve *detuning* the rejector in series with the aerial, to give an effective inductance L^1 when

$$\text{the Resonant Frequency} = \frac{1}{2\pi\sqrt{(L^1+L_a)C_a}}.$$

If C_a in the previous expression is taken to mean the effective aerial capacitance after taking L_a, also, into account, the two formulæ will give exactly the same answer.

How Large Capacitances May Result

This brings up another interesting point. If we put inductance and capacity *in series*, the nett reactance at some frequency will be $(wL - 1/wC)$.

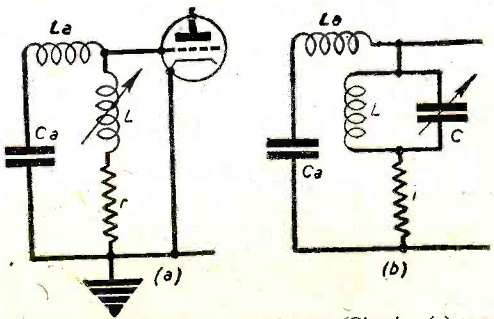

Fig. 4.—Aerial system, as an Acceptor Circuit: (a) tuned by variable series inductance L; (b) tuned by "effective inductance" of LC, Fig. 1 (a). (See text.)

The expression means, that if we have an inductance L, we can *reduce* its effective value by inserting capacity in series—or *increase* the effective capacitance of a condenser by inserting inductance. The expression represents the *difference* between two reactances, which must therefore be less than either.

But a smaller reactance implies *less inductance*, i.e., the whole series circuit behaves as if it had a smaller inductance than the nominal value of L itself. It may not be so clear how we can get a *larger capacitance.* Less reactance here means a series circuit behaving as if its capacitance were *greater* than the nominal value of C—since condenser reactance is in *inverse proportion* to the capacity, whereas inductive reactance is a case of direct proportion.

Indeed, just around resonance, capacity values enormously greater than the condenser value will appear. Exactly at resonance, (wL – 1/wC) becomes zero, i.e., all reactance vanishes. At frequencies a little *below* this point, 1/wC will be but a few ohms more than wL, so the difference of the two represents a very low *capacitive* reactance—equivalent to a very large capacity.

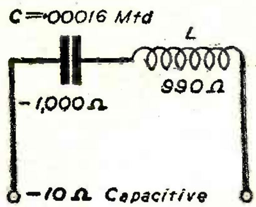

Fig. 5.—The "effective capacitance" near resonance may be very large as compared with the nominal value of C.

If the resistance were zero this simply means the acceptor is taking a comparatively large current, *leading the voltage by 90 deg.*, so *behaving like* a big capacity condenser.

For example: In Fig. 5 L has a reactance of 990 ohms, and C a reactance of 1,000 ohms at the applied frequency. The nett reactance (wL – 1/wC) = (990 – 1,000) = –10 ohms (condensive). Suppose the frequency is 1,000 kc/s, then the nominal value of C is about 0.00016 mfd. But –10 ohms of reactance is that of a condenser 100 times this capacity, i.e. the circuit acts like a condenser of 0.016 mfd.

If we tune still nearer to resonance the nett reactance will fall to 0.1 ohm, then to 0.01, 0.001 ohm, and finally vanish altogether at exact resonance. It might be impossible to vary the tuning within such limits, but it will be seen that in the case considered the effective capacitances would be successively 1.6 mfd., 16 mfds. and 160 mfds.!

These figures may sound rather fantastic when the capacity of the condenser in the circuit is only 0.00016 mfd. In a practical case, of course, there would be a resistance of the same order of magnitude as the low reactances to consider, but it remains true that there is a large capacitive current component just around the tuning point.

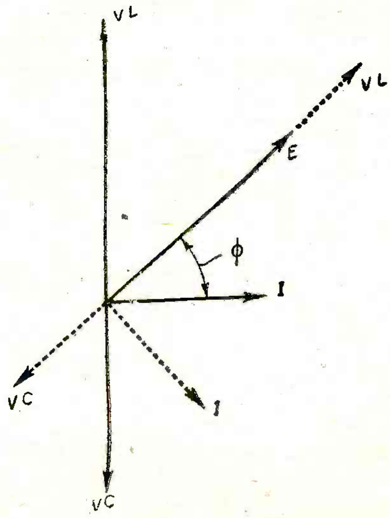

Fig. 7.—Showing phase-shifts in component parts of a series acceptor, i.e., off resonance.

If we reasoned similarly for an L.F. case, the possibility of getting capacities like 20 or 200 mfds., using only a 2 mfd. condenser, suggests itself.

But why isn't this done? Can any practical use be made of these resultant capacitances? Well, in the first place, there is an obvious "catch." The values referred to are purely an *A.C. effect* occurring near the resonant point of a series circuit. Such a "condenser" could not be used for D.C. purposes, e.g. as a reservoir in the output of a rectifier.

There is no reason why an acceptor could not be used for eliminating the ripple frequency to which it is tuned, but a condenser will be much more effective. "Tuned smoothing" may sometimes be employed with advantage if some particular harmonic is known to be causing a troublesome hum. Otherwise, it is not of much use, since a condenser can be arranged to be an effective by-pass to the lowest ripple frequency, and the reactance will be less to all the higher harmonics. It must not be thought that the "fundamental" at 50 or 100 c/s is the only ripple to be eliminated by smoothing—the output of a rectifier consists of complex waves containing many higher harmonics.

It is as a "harmonic suppressor," or "whistle filter" that interest mainly centres in the application of acceptors for purposes other than tuning. They are then tuned to resonance to act practically as a short circuit to the harmonic components, e.g. across an H.F. line as in Fig. 6(a). Alternatively, the high-impedance property of rejectors may be used as in (b).

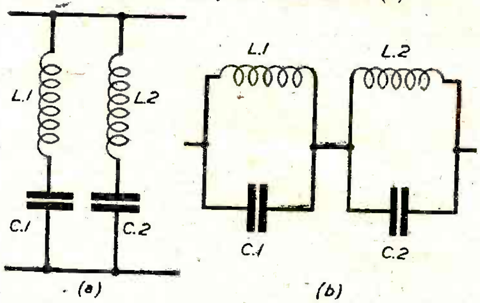

Fig. 6.—Use of acceptors and rejectors as harmonic filters.

So there seems but limited practical application for these A.C. capacitances as such. It is useful to realise, though, that a given combination of L. and C—where C may well be the interelectrode capacity of a valve—can act as an effective by-pass if the frequency approaches the resonant value. The matter has been discussed here as an aid towards the understanding of tuned-circuits. There are plenty of them, involving "resultant reactances," as we saw in discussing the method of aerial tuning shown in Fig. 1.

Many queries are received by the writer from time to time as to the way a tuned-circuit can cause a *phase-shift* to an applied voltage.

The question cannot be considered in detail now, but the following explanation will be helpful. Referring to Fig. 2(a) and (b): If tuned to resonance the voltage across r will be in-phase with the current and applied e.m.f., but the reactive voltages across L and C will respectively lead and lag 90 deg. on the e.m.f. Thus, by taking a tapping off either L or C we can get a voltage at 90 deg. to E, i.e. a 90 deg. phase-shift.

If, now, the tuning is altered from resonance the current will, let us say, lag by an increasing angle — on the applied e.m.f., Fig. 7. The voltages across L and C will remain at 90 deg. to the current, I, but will be shifted in their phase relative to E along with I. Eventually, if the circuit became almost entirely inductive I would lag on E by nearly 90 deg., and the voltage across the condenser would be almost phase-reversed (at 180 deg.) to the applied voltage, as indicated by the dotted lines.

Experimental Oscillator Circuits

Some Details of the Dynatron, Transitron, Multi-vibrator, Resistance Capacity and Phase Shift Types of Oscillator

WHEN speaking of oscillators one usually thinks of the Hartley, Colpitts, Tuned Anode-Tuned Grid and normal feed-back types. There are, however, many others, each of which has its own particular application. In some cases, the special oscillator may be employed when it is required to ensure frequency stability on one frequency only; or it may be that an oscillator is required to generate a pure audio tone for calibration and test purposes.

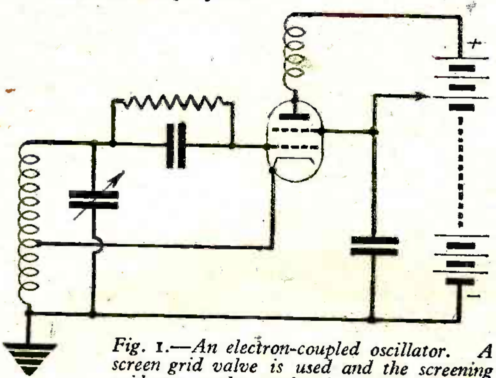

Fig. 1.—An electron-coupled oscillator. A screen grid valve is used and the screening grid acts as the anode of a triode oscillator

It becomes easier to follow the action of some of the less-usual types of oscillator if one first obtains a good grasp of the underlying principles of an oscillator of any type. This can perhaps best be done by considering an oscillatory circuit—which consists of an inductance and a capacitance; a coil and condenser if you like. Assuming that the two are in parallel, it is known that if a source of D.C. voltage is momentarily connected between the ends of the circuit, an oscillation is set up. This is because the condenser receives a charge, with the result that one of its plates becomes positive and the other negative. Then, the coil being in parallel with the condenser, the charge begins to "leak" away through the coil. Current passing through the coil causes a magnetic field to be set up around the coil; by the time that the condenser becomes discharged, however, current flows back into it as the magnetic field collapses, again causing a current to pass into the condenser. By this time, the polarity of the two condenser plates has been reversed, and the whole sequence of events is repeated. And it would be repeated for an indefinite period were it not for the fact that the coil has a certain amount of resistance and that there are certain losses in the condenser and in the circuit generally. Because of these losses the oscillation dies out; the particular type of oscillation is said to be "damped."

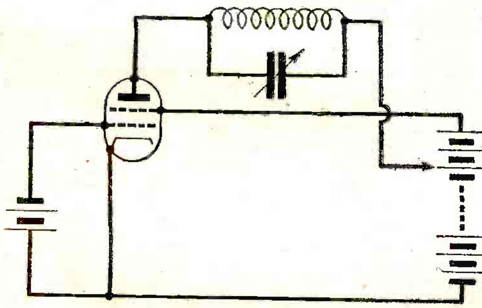

Fig. 2.—A simple dynatron oscillator, the operation of which depends upon the negative—resistance characteristics of the S.G. valve when operated in certain conditions.

Sustained Oscillation

In the ordinary way we use our oscillator valve to make good the losses, so that we may produce a sustained rather than a damped oscillation. It will be seen that the requirements of the valve are that it should provide energy, in the form of an alternating voltage, and that the alternating voltage should be in phase with the initial oscillation. In other words, it should apply positive and negative "kicks" to the ends of the oscillatory circuit, these "kicks" corresponding with the polarities at the ends of the circuit at any instant. Another way of regarding the valve is as a negative resistance—a device for overcoming the resistance and other losses in the oscillatory circuit.

To meet the requirements set out, it will be seen that if the oscillatory circuit is connected between the anode and grid of the valve, the two electrodes must always be 180 degrees out of phase; thus, when the grid reaches its maximum positive potential the anode must reach its maximum negative potential, and vice versa. In the case of the Hartley circuit (to take the simplest example)

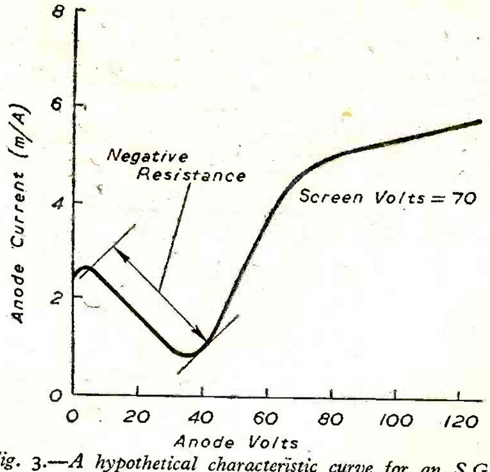

Fig. 3.—A hypothetical characteristic curve for an S.G. valve.

the coil and condenser are connected in parallel directly between the anode and grid, while an earth tapping is taken from a suitable point on the coil. When H.T. and L.T. are first applied to the valve, a D.C. "kick" is applied to the oscillatory circuit, and it may be assumed that the anode end of the circuit is positive in respect of the grid. The condenser is charged, and then commences to discharge. On discharge the polarity is reversed and the grid is swung positive. And when the grid becomes more positive there is an increase in anode current, as a result of which the anode voltage drops due to the IR drop across the anode load. This means that the end of the oscillatory circuit connected to the anode becomes more negative. On the next reversal of current flow through the oscillatory circuit, the grid is swung negative, so that the anode current is reduced and the anode voltage increased. In other words, the anode becomes more positive. And so the process continues, the amplitude of oscillation tending to rise at each successive half cycle. Stability is reached, however, due to the fact that when the grid is swung sufficiently positive grid current flows, and anode current is restricted. On the other hand, when the grid is swung so far negative that the cut-off point is reached, the valve ceases to function. In addition, it is customary to include a grid condenser and leak in the circuit, and these provide a measure of self-bias which will suffice to limit the amplitude of oscillation, and therefore to maintain the valve in a stable condition.

Electron-Coupled Oscillators

That brief explanation is intended as a "refresher," and we can now look at one of the less usual oscillator circuits previously referred to. Fig. 1 shows the circuit of a simple electron-coupled oscillator, where a screen-grid valve is employed. This can be seen to be a close relation of the Hartley circuit when it is realised that the screening grid acts as the oscillator anode; the real anode operates in conjunction with the cathode and control grid as an amplifier. This type of oscillator is described as electron-coupled due to the fact that the screening grid, which acts as an anode, is placed in the electron stream between the control grid and actual anode.

The electron-coupled oscillator is fairly widely used in short-wave circuits, but it has many other applications.

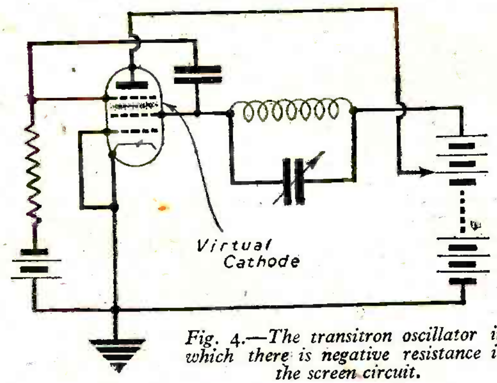

Fig. 4.—The transitron oscillator in which there is negative resistance in the screen circuit.

The valve is operated at normal anode and screening-grid voltages, and the grid condenser and leak may be of conventional values, although it will generally be found that a leak having a resistance of not more than .25 megohm is most suitable.

Negative Resistance—The Dynatron

An entirely different type of oscillator is that shown in Fig. 2. It will be seen that there is only one tuned circuit, and no coupling between grid and anode. But in spite of these apparent deficiencies, the oscillator does work, and is a valuable one where stability is required over a small frequency range. Operation is dependent upon the negative-resistance characteristics of a screen-grid valve when operated at certain screen-grid and anode voltages. Fig. 3 shows a typical anode volts-anode current curve for a screen grid valve. It will be seen that as the anode voltage is increased from about 5 to approximately 40 volts there is actually a reduction in anode current; this is due to the liberation by the anode of secondary electrons, which are attracted to the screen. This gives the required negative resistance, which is employed in the circuit shown in Fig. 2 to cancel out the resistance losses in the tuned circuit connected between the anode of the valve and the high tension positive tapping.

For this circuit to operate, it is necessary that the voltage applied to the anode shall be less than that applied to the screen. It is also necessary that an anode voltage be chosen (in relation to the screen-grid

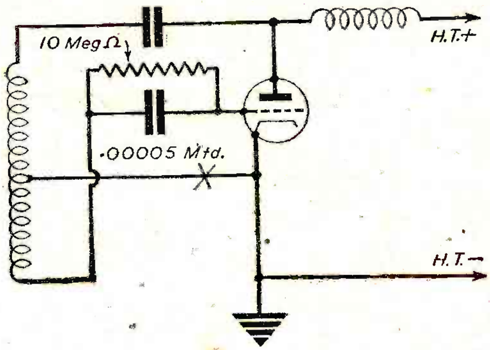

Fig. 5.—A blocking oscillator or "squegger." Note the high value of the grid leak.

voltage) so that the valve works on the left-hand portion of the characteristic curve. In practice the screen would be operated at a voltage in the region of 90, and the anode at a voltage of 50 to 60, dependent upon the particular valve chosen.

The Transitron

Yet another unusual form of oscillator, used for purposes similar to those for which the dynatron is employed, is the transitron, shown in Fig. 4. The transitron has the advantage that its operation is not impaired by continued use of the valve, whereas in the case of the dynatron the condition of the anode surface has a marked effect on behaviour. This is because the negative-resistance property of the valve used as a dynatron is dependent upon secondary emission by the anode. In the case of the transitron a cloud of electrons tends to accumulate between the screening and suppressor grids, and this cloud acts as a virtual cathode. Perhaps it should be mentioned that the accumulation of electrons is due to the negatively biased suppressor which tends to repel electrons in transit to the anode, and also due to the fact that the screening grid is again at a higher potential than the anode.

As the screening and suppressor grids are at the same radio-frequency potential, because they are connected together by a condenser, any increase in screen potential brings about a corresponding increase in suppressor potential. This counters the effect of the initial negative bias on the suppressor and allows a greater flow of electrons to the anode. At the same time it brings about a reduction in screen current. We thus have a negative-resistance effect in the screen circuit, and hence free oscillation in the tuning circuit connected between the screen and the high-tension positive supply point.

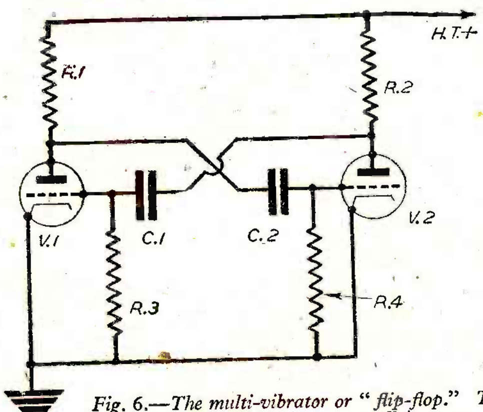

Fig. 6.—The multi-vibrator or "flip-flop." The valves conduct and are cut off in turn.

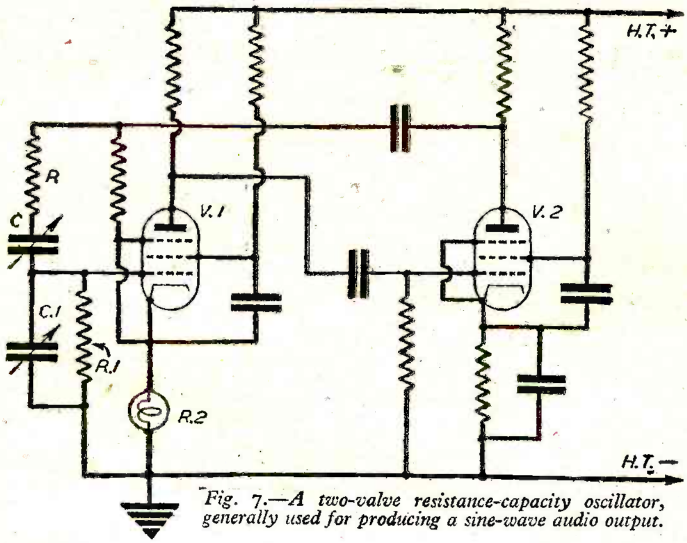

Fig. 7.—A two-valve resistance-capacity oscillator, generally used for producing a sine-wave audio output.

A Pulse Generator

The oscillators referred to above are all intended for use where a sine-wave output is required. One for quite a different purpose is shown in Fig. 5. This, as regards the actual circuit, is just like a normal Hartley oscillator, but it will be seen that the values of grid condenser and leak are unusual; the condenser is small and the leak large. The result of using these values is that a very large negative bias can be built up on the grid—so large, in fact, that the valve is biased beyond cut-off and oscillation ceases. Due to the high value of the leak, an appreciable time is taken for the charge on the condenser to leak away. When the charge has leaked away and the valve again conducts, oscillation commences, but after a single cycle cut-off is again reached and oscillation ceases. We thus have a series of short pulses, with relatively long gaps between them.

The term blocking oscillator is applied due to the fact that cathode-anode electron flow is blocked after each pulse; another name is a "squegging" oscillator. This type of oscillator is used in television work for such purposes as providing synchronising pulses, and for that purpose a synchronising voltage is applied to the grid circuit at the point marked with a cross. It is important with this type of oscillator that very tight coupling should be provided between the anode and grid circuits and also, to increase efficiency, that the ratio of inductance to capacity in the tuned circuit should be as high as possible.

The Multi-vibrator

We now come to an entirely different type of oscillator, and one which may not at first be recognised as an oscillator, for it has no tuning circuit, and would therefore appear to be aperiodic. The simplest type of "multi-vibrator" is shown in Fig. 6. Here there are two resistance-capacity-coupled valves, the output of each being fed to the input of the other. It will be seen that feed-back is the necessary 180 deg. out of phase, due to the anode of V2 being connected to the grid of V1, and the anode of V1 being connected to the grid of V2. When H.T. and L.T. are first applied there will be no flow of anode current through either valve due to the cathodes being cold. But there will be a flow of current to the two condensers C1 and C2, and therefore these condensers will receive a charge; they will probably be charged to the full H.T. supply voltage before the valves commence to conduct.

Due to slight differences in the valves, one will start to conduct before the other. Suppose V2 first begins to pass anode current. There will be a voltage drop across R2, and condenser C1 will commence to discharge through R3 and V2. This will cause V1 to be biased back, probably beyond cut-off. The bias will be removed, however, as C1 becomes discharged, and so V1 will start to pass anode current. In doing so it will tend to discharge C2, so biasing-back V2. But when V2 is biased to cut-off condenser C1 will again be charged.

The output from the anode circuits of this type of oscillator has a square wave-form, and is therefore rich in harmonics. This type of oscillator is useful when a wide range of harmonics is required, and is often used as a frequency divider for such purposes as calibrating a cathode-ray oscilloscope. The frequency to be divided may be applied to either the grid or anode circuits, according to convenience; it is generally in the form of a pulsating voltage.

An oscillator which bears some resemblance to the multi-vibrator (sometimes described as a "flip-flop" circuit, because the valves "flip" into and "flop" out of action in turn) is the resistance-capacity type shown in Fig. 7. Two pentodes are shown, and it may be seen that the output from V2 is fed back to the grid of V1, 180 deg. out of phase. The frequency is controlled by the setting of the condensers marked C and C1, and by the values of the resistors marked R and R1.

This type of oscillator is mainly useful because of the excellent sine-wave characteristics of the output, and is therefore often used as an audio oscillator for producing pure tones. It will be seen that a small pea-lamp is included in the cathode lead of V1; the lamp is marked R2 and it acts as a miniature barretter. This lamp controls the amount of degeneration present, because at low amplitudes of oscillation when the cathode current is low the voltage drop across R2 is low. On the other hand, a rise in amplitude brings about increased cathode current, a larger voltage drop and increased degeneration. In consequence, the amplitude of oscillation is stabilised.

Fig. 8 shows the circuit of a single-valve phase-shift oscillator, where feed-back from anode to grid is through a condenser-resistor network. The network is designed to bring about 180 deg. phase shift at the resonant frequency, which can be varied by adjusting the capacities of the three condensers simultaneously.

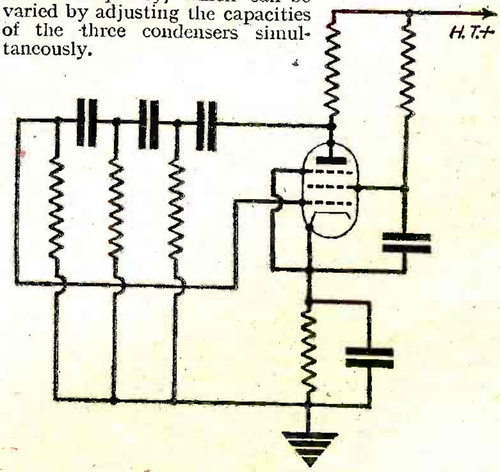

Fig. 8.—A single-valve phase-shift oscillator. It is used for producing an audio output of good wave-form.

Future Applications of Radio

Some Topical Comments by a Casual Observer

SO vast have been the strides made in radio developments during the war that it would be a bold—or foolish—man who would attempt to prophesy the state of the science in ten years' time. Some changes are certain, however: for example, frequency modulation will undoubtedly be adopted for some types of broadcast; television will be available in better and cheaper form than hitherto—but it is by no means sure that the transmission and reception *systems* will change in the near future, excepting in so far as colour and stereoscopic television are concerned; the use of radio-frequency emanation will undoubtedly be used more extensively in the medical field for diathermy treatment and as the "radio knife" for use by surgeons; centimetre, and perhaps even millimetre, technique appears to be inevitable; electronic techniques will have a much wider field of utility in industry, where photo-electric devices will play an important part, especially in the packaging and inspection departments.

Railway Telephones

Those are just a few of the directions in which radio will tend to extend. In addition, one can be quite sure that the installation of radio receivers for normal entertainment will become customary for long-distance railway trains. Such trains will probably carry transmitters as well, so that passengers can despatch telegrams—and probably even "telephone" while in transit.

One branch of radio which has grown probably more than any other during the war years is that known as radar. Although it has been in use since 1939, the need for secrecy has prevented the general public from knowing very much about it. Even now, only a very slight amount of information has been publicly released. We do know, however, for the newspapers have told us —though often in inaccurate and unnecessarily flamboyant terms—that radar is employed for providing navigational assistance to air crews and ships' officers. We know also that it can act as a detector of submarines and surface ships as well as of aircraft which are well beyond the visual range or hidden by fog. By means of other radar devices the bombardier of an aircraft can drop bombs accurately on to a target which is completely invisible to him.

Seeing in Fog

Because these things are known it has become a popular pastime to debate the possibilities of one or other of these radar devices, or of modifications of them, as the "eyes" of the motorist or railway engine driver in fog. The man who "swallows" some of the newspaper stories considers that if the pilot of an aircraft can "see" through fog with one of these instruments—if he can obtain a clear picture of a target several miles below him and hidden by fog—then surely it would be logical to see the road and traffic a few hundred yards ahead of the motorist.

It will be helpful to consider in very simple terms the action of some of these radar devices; let it be clearly understood that the explanation will not be complete because details are still covered by the Official Secrets Act. The fundamental idea is that a pulse transmission is sent out in the form of a very narrow beam and is made to "scan" the target or other area. On striking different objects and surfaces the transmitted pulses are reflected in different ways, so that if we present the reflected signals on a cathode-ray tube we have, in effect, a picture. The general process, it will be seen, is analogous to that used in television, except that in that case it is a beam of light which is transmitted and reflected on to the lens of the television camera.

The radar picture obtained, however, could scarcely be said to resemble a cinematograph picture, and a certain amount of expert "interpretation" is required. It is certain that the average motorist would not feel competent to drive "blind" with such a device as this. Nor would the road be a safe place if drivers were abroad and driving in this way!

A Popular Fallacy

Even if the difficulties of presentation could be overcome—and it is doubtful whether they could for very many years—there are many other reasons which would preclude the use of radar fog-driving aids in private cars A suitable piece of equipment would probably cost at least £300, even if quantity produced. It would be expected to weigh, say, 250lb., and it would require power up to, perhaps, 1 horse-power, whilst occupying several cubic feet of space. Consider these facts in relation to a popular 10 horse-power car costing £200, weighing under 2,000lb., and having a "family" saloon body!

No, it will not do. Those who anticipate the early abolition of difficult fog driving must think again.

Alternative Possibilities

But even if the scheme were possible and practicable, it would appear that there are many simpler and less expensive methods of achieving the same result. The use of the now familiar "cat's eyes" down the centre and along the verges of all roads would be more economical in the long run. If we are to use radio devices to increase the safety of fog driving there should be distinct possibilities in the way of laying iron rods in the road surfaces and using a device similar to the sapper's mine detector in the road vehicle. It might, in fact, be possible to introduce a modification into the standard car-radio receiver so that the set could also provide "navigational" aid.

Another possibility might lie in the direction of running a series of cables under the road surface and passing R.F. or A.F. through them. With single-track roads different cables would be keyed with "coded" dots or dashes or with different tones. A search coil fitted to the car and connected to a receiver and loud speaker would complete the chain. In the case of double-track roads a different system of coding would be necessary so that the driver would know that he was on the correct side.

An alternative may be to lay cables in three lines, one on each side of the road and one down the centre, keying the side cables with "A's" (. — in Morse) and the centre one with "N's" (— .). When the car was exactly midway between a pair of cables the driver would hear a steady note, whereas if it were nearer to one of the cables, the driver would hear a steady note with one of the letters superimposed.

Radar Signalling for Railways

When one considers the possibilities of radar on railway the position is somewhat different, and a far better case can be made in favour of radar. But it does seem that there are many simpler devices which would serve an equally useful purpose. For example, a photo-cell could be placed at one side of the track, with a source of infra-red at the other, so arranged that the infra-red beam was cut whenever a train passed. The photo-cell could be made to actuate a relay which would modify the output from a transmitter. The photo-cells would be placed in the various sections of the track in the same way that visual signalling devices are placed, and any train approaching any section would pick up on its receiver a certain form of signal; this would indicate whether or not the section was clear.

There is little doubt that radar navigational aids will be used on ships, where they will also be employed to give warning of other nearby shipping, of rocks or of shallows. In the same way radar will continue to be used in aircraft, primarily as an accurate guide to navigation, but also perhaps at a later date, should the air become congested in various areas, to give a warning of the proximity of other aircraft.

Beam Navigation

It may, however, be found that the system of beam approach (previously known as blind approach and, before that, as Lorenz) will be a simpler and less expensive navigational aid. By means of beam approach, aircraft can be landed safely in conditions of very poor visibility, because the pilot merely flies his aircraft along a radio beam. Should he leave the centre of the beam he is warned by the production of warning dots or dashes (according to whether he is to the left or the right of the centre line) in his earphones. A corresponding system was in use in America before the war for normal point-to-point flying, and it was possible to fly on any recognised route simply by keeping "on the beam." It would appear that a similar system could very easily and conveniently be used for bringing ships into harbour in fog.

One big advantage of beam approach or track-guide navigation is that a relatively simple receiving system is all that is required in the craft. And even the fixed transmitter is of simple design and can be efficiently maintained by wireless mechanics after a short period of training.

Television Relays

With regard to the future of television, one of the greatest difficulties will probably be that of relaying the transmission from a central station to the various sub-stations that will be necessary to give ample coverage even over this country. It will be remembered that it is necessary to use ultra-short waves, and that the transmission range of these is visual only. The method of relaying used for sound broadcasts—by means of land lines—is out of the question because of the extremely wide frequency band which has to be covered. Special cables can be made, but they are extremely expensive. In consequence, it might be found more satisfactory to employ radio links, beaming the transmission from one station on to another, which will re-transmit the received signals.

Well, these are a few of my guesses for the future of radio. They are incomplete, and if radio development during the next five years maintains the pace set during the past five years, my forecasts will probably be out of date within a decade.

Colour Television

Precis of a Discussion at a Meeting of the Radio Section of the Institution of Electrical Engineers, held on Tuesday, March 13th, 1945

THE discussion was opened by Mr. L. C. Jesty, B.Sc., M.I.E.E., who stated, in his introductory remarks, that it seems inevitable that a colour television service will ultimately be established. Any deliberate influence that can be exerted on the natural development of this art should be directed towards (a) the agreement of the technical methods to be employed, particularly with regard to the colour analysis and synthesis of the picture, and (b) the standard of definition to be achieved before colour is introduced.

With regard to (a), the literature shows that the methods proposed for colour television have followed logically the same steps as already trodden in colour photography and cinematography, but have not yet reached an equivalent of the elegant solution to the photographic problem known as the "subtractive integral tri-pack" technique (available pre-war on 16-mm. film, etc.). Television, however, being electronic and therefore practically inertialess and instantaneous, enables the older "additive" principles to be used more advantageously than in cinematography.

All the demonstrations of colour television so far given, by Baird in this country and Bell Telephone and C.B.S. in America, have employed scanning processes, embodying various colour sequences for analysis and synthesis. It is now taken for granted that the science of colour has established the necessity for a minimum of three primary colours for acceptable reproduction.

Scanning Sequences

Scanning sequences can be classified under three heads: (1) Scanning each picture point, (2) scanning each picture line, and (3) scanning each picture frame in the three primary colours. Of these (1) is the most attractive, but the most difficult. It gives the minimum of difficulty in colour registration and fringing; allows the retention of the same basic scanning frequencies (line and frame) as the equivalent definition black-and-white picture; and allows the possibility of adding colour to an existing black-and-white system, the existing receivers continuing to receive the picture in black and white. The difficulties with this system lie in changing the colour of the scanning spot at about three times the maximum video frequency of the black-and-white picture, and in maintaining colour synchronism. At the other extreme (3) offers the simplification of changing the colours at only about three times the equivalent black-and-white frame frequency, but at the expense of three times the frame and line frequencies; it also suffers from the inability to add colour to an existing black-and-white system.

Various methods from "roseau" screens to moving filters have been proposed for producing the necessary primary colours. All additive colour systems result in a loss of sensitivity in the transmitter camera, and loss of brightness in the received picture. These must be restored by improvements in cameras and cathode-ray tubes. Additive systems fall into two main classes: those employing optical or electron-optical superposition of the colour images, and those employing sequential projection or scanning of the colours. The former suffer from errors of superposition of the images, giving colour fringes where the registration is inaccurate, but offer the possibility of using separate channels for each colour, with corresponding advantage. The latter suffer from colour fringes on moving objects, owing to the time lapse between the presentation of the successive colours, but these lags can be made imperceptible provided the colour sequence is fast enough.

Electronic scanners give high relative accuracy in the location of picture points, but absolute accuracy is of a low order. Their use for the former method is therefore ruled out, unless some auxiliary device is used for ensuring registration. The same argument applies to the use of a fixed "roseau" with either scanning sequences (1) and (2) above.

It would appear, therefore, that the only immediately practicable system is the "sequential-colour frame-scanning" system ((3) above), unless some unpublished device has been perfected, such as a method of altering the colour of a fluorescent screen at will, or receiver picture storage, or the simultaneous transmission of all picture points instead of scanning.

Standard of Definition

With regard to the standard of definition, the additional information to be conveyed in a colour picture results in an increase in the video band-width of about three times compared with the equivalent definition black-and-white picture. In going from a black-and-white to a colour picture with the same available band-width it follows that the black-and-white picture will have about three times the number of lines of the colour picture. At low definition this would be very noticeable, but in the region of 400 lines or over the comparison in definition would become less obvious. A 405-line colour picture would require about three times the video band-width, and with vestigial sideband transmission about twice the other space of the pre-war 405-line transmission. On this basis, a 500–600-line colour picture is not inconceivable as a long-term development. Should it be demonstrated, however, that higher definition—say 800–1,000 lines—is necessary on purely visual grouuds, then it would seem that colour television is only a remote possibility, until much greater experience of the higher transmission-frequency bands has been obtained. In this case, it is possible that electronic colour-scanning methods will prove more useful in the field of photographic reproduction, before they are adopted for television purposes.

During the course of his remarks, Mr. Jesty gave demonstrations of the synthesis of white light from three primary colours. Sequential illumination of a set of snooker balls through a rotating three-colour filter served to show brilliant colour fringes when the balls were set in motion.

Colour fringing on moving objects was a serious defect of present frame-by-frame scanning methods. It could also be caused by hum in the receiver if the vertical scanning rate were not an integral multiple of the mains frequency, and by fading in a propagation system depending on a network of radio links. Point-by-point scanning must be the ultimate goal, and one method by which this might be reached was to introduce transverse velocity modulation in the time base so that the wanted colour in each point would receive a longer period of illumination.

In a written communication, Mr. J. L. Baird, who was unable to be present through indisposition, expressed the opinion that point-by-point scanning did not offer sufficient advantages over line-by-line scanning to counterbalance the increased difficulties involved. With present frame-by-frame scanning methods a considerable reduction in colour flicker was obtained by increasing the number of interlacings (and, consequently, the frame frequency) for the same number of lines. He thought it rather misleading to state that frame-by-frame scanning could not be added to existing black and white systems. A two-colour 600-line system (200-line frames at a frame frequency of 50 per sec., interlaced three times) could be used in the pre-war B.B.C. 405-line system, and would be received as a 200-line black-and-white picture on existing receivers. A three-colour system was necessary for *accurate* colour reproduction, but, in his view, a two-colour system gave a pleasing and *acceptable* picture.

Other speakers held that colour reproduction should not be attempted until adequate definition was assured, and that the problem of colour should be set as a separate objective, not as an adjunct to existing systems.

In his concluding remarks the chairman (Mr. H. L. Kirke) said that Mr. Jesty was to be congratulated on the success of the demonstrations. Colour television was not likely to become an established service for some years, but when it did it would be of great value, as there were many subjects which could not be adequately portrayed in monochrome. From the æsthetic point of view he thought the subtle improvement over black-and-white of pictures with ordinary sober colours was of greater value than the more striking effects of vivid colours.

2,000 Pictures by Wireless a Month

ONE of the most extraordinary developments in British enterprise during the war has been the rapid development of wireless transmission of photographs, drawings, documents and plans.

Before the war, Cable and Wireless, Ltd., who control the British oversea telegraph services, operated only three phototelegraph circuits, with Melbourne, New York and Buenos Aires. Traffic, however, was negligible, except on the New York circuit, on which about 45 pictures were handled every month.

To-day, although the whole of the London phototelegraph apparatus was lost in the fire which destroyed the Company's Central Telegraph Station at Moorgate in May, 1941, 11 services are being operated with Empire and foreign countries, and nearly 2,000 photographs and facsimile documents a month are now being transmitted and received. Phototelegrams are exchanged over direct circuits between London and Montreal, Melbourne, Capetown, Bombay, New York, San Francisco (relayed from New York by the connecting company, Radio Corporation of America), Buenos Aires, Moscow, Stockholm, Berne and Cairo. A direct circuit in the Londonward direction only is operated with Italy. When Moscow was threatened, the Moscow terminal was moved back to Kouibychev, but was soon returned to Moscow.

In addition to the expansion in the number of circuits, considerable progress has been made in technique. Transmission is now three times speedier, under the system evolved by Cable and Wireless, Ltd., in co-operation with the Radio Corporation of America, than before the war; to-day, it takes about 6-10 minutes to transmit a photograph or document measuring 10 × 6in.

Supplementing the direct circuits is a broadcast system from London, the phototelegrams being received regularly by Stockholm, Berne, Rome, Paris, Brussels, Lisbon, Casablanca, Leopoldville, Johannesburg, Cairo, Bombay and Istanbul. Transmission on these broadcast services is 50 per cent. quicker than on the direct circuits. This increase in speed is a wartime development.

Transmission to-day is by the Sub-carrier Frequency Modulation system (S.C.F.M.). It was not until this system was developed in 1938 and 1939 that the difficulties of propagation could be overcome; hence the rapid development of phototelegraphy during the first five and a half years of war. The S.C.F.M. system was first used for the transmission of photographs of the visit of T.M. The King and Queen to Canada in 1939.

When the apparatus in Moorgate was destroyed, Cable and Wireless, Ltd., acquired replacements from various quarters. Operations were suspended, however, only for about three months. The priority given to manufacture and transport of material required directly for war needs has prevented further development; in particular the Marconi Company's Works, which supplied Cable and Wireless, Ltd. (by whom they are controlled), have been engaged entirely on Government production. The Company plans, however, to instal photograph apparatus at all the more important of its 190 stations and offices throughout the world when the end of the war makes possible the release of materials and manufacturing facilities. During his recent tour of the Mediterranean, Sir Edward Wilshaw, Chairman of the Company, announcing this policy, promised that Cyprus would be among the earlier stations to be so equipped.

A post-war possibility is the development of phototelegraph transmission and reception to enable colour pictures to be reproduced from one country to another.

Practical Hints

Universal Power Supply

THERE are many constructors who possess components such as valves and pieces of apparatus like oscillators or valve voltmeters, which have been designed to work from batteries. If a general conversion to mains operation is intended a metal rectifier unit may be used. However, this cannot later be used in mains-powered units. If a normal power pack is chosen this waste is avoided, and potentiometer control will regulate the supply voltage.

A resistor network is difficult to build up with present shortages of components, and a low impedance output triode may be used to carry the current from the rectifier. Its effective D.C. resistance can be controlled by varying its grid bias. The control does not carry power, and is continuously variable. The voltage regulation is similar to potentiometer control. Should the power pack be required to give 300 v. the triode may be cut out by switches S_1 and S_2.—G. SCAIFE (Yatesbury).

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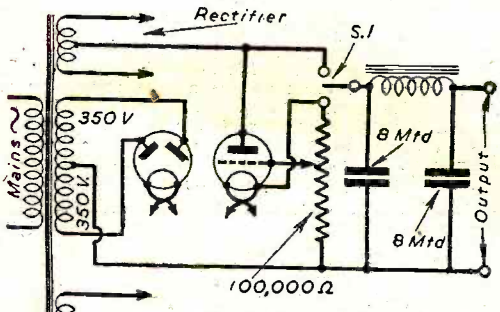
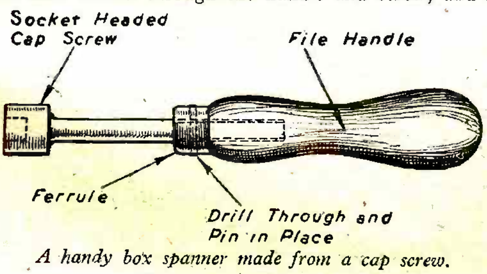


Circuit diagram of a universal power supply unit.

Improvised Box Spanners

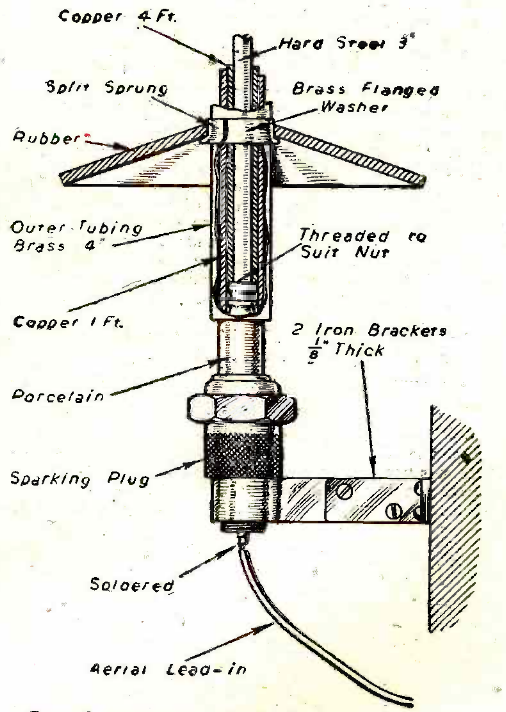
HAVING no B.A. spanners in my kit I used pliers to tighten up the nuts on my radio work, but found this method far from satisfactory, the pliers stripping the corners off the nuts. So I decided to make some box spanners for 2, 4 and 6 B.A. nuts. I found that the hexagonal socket in socket-headed cap screws was ideal for this purpose, so I obtained three of these screws—¼in. Whit. for 6B.A., 5/16in. Whit. for 4B.A., and ⅜in. Whit. for 2B.A. I also obtained three small file handles, and screwed the ends of the cap screws into the handle, as shown in the sketch. A small hole was then drilled through the handle and screw, and a pin driven into this hole, to prevent the handle from turning. The pins were made by cutting off the points and heads of some nails.—N. HORTON (Oakengates).



A handy box spanner made from a cap screw.

An Efficient Short-wave Aerial

I WAS in much need of an efficient short-wave aerial, which was not affected by interference as much as an inverted "L." So I decided that a copper tube straight vertical aerial would be best. After having a look around I found an old sparking plug. This gave me an idea. So I bent an iron strip around the threaded portion of the plug, being unable to obtain a nut of that thread. Then I bent two right-angled brackets after drilling four holes in each. I then obtained various lengths of copper and brass tubing and tightly fitted them into each other as shown. I also plugged the top of the inner tube with a piece of rubber to stop water percolating through. After soldering wire to the sparking point of the plug, and threading the steel rod, I gave the whole, except the porcelain, a good coat of heavy outdoor paint. I found that rain drops were an annoyance as they dripped from the tube to the metal portion of the plug, so I cut a circular disc of rubber from an old car inner tube, and this was pushed on to a brass split ring. On test the aerial gave superior results compared with an inverted "L"-type aerial.—P. D. JENKINS (Cardiff).



General arrangement of a rigid short-wave aerial.

Television Broadcasting Practice in America—1927 to 1944

A Paper Read Before the Institution of Electrical Engineers by DONALD G. FINK

(Concluded from page 295, June issue)

THE remaining standard is the direction of polarisation of the electric vector of the radiated wave. This was chosen as horizontal as early as 1938, and although polarisation has been the subject of intensive investigation by the N.T.S.C. and the R.T.P.B. the advantage of the horizontal direction has been consistently upheld. Here, again, we find a departure from British practice, which favours vertical polarisation. The N.T.S.C. Panel charged with investigating this matter found that horizontal polarisation was superior in respect of the effects of multi-path transmission, and slightly superior with respect to inherent noise, whereas vertical polarisation was preferable in respect of freedom from fading and miscellaneous signal variations, and of the directive properties of receiving antennas. No difference was found in the propagation of signal intensity with transmitting and receiving antennas at the heights normally employed. Faced with this balance of small differences, the Panel found a slight preponderance of evidence in favour of horizontal polarisation, and so the standard was set.

Table 2—AMERICAN TELEVISION CHANNELS

Channel No.	Frequency	Channel No.	Frequency
	Mc/s		Mc/s
1	50–56	10	186–192
2	60–66	11	204–210
3	66–72	12	210–216
4	78–84	13	230–236
5	84–90	14	236–242
6	96–102	15	258–264
7	102–108	16	264–270
8	162–168	17	282–288
9	180–186	18	288–294

(2.5) Rules Governing Allocation of Television Broadcasting Facilities

As the demand for broadcasting facilities has consistently exceeded the supply, it has been necessary for the F.C.C. to set up equitable rules whereby the available portions of the spectrum may be allocated to serve the public interest.

The basic allocation, shown in Table 2, consists of 18 channels, each 6 mc/s wide, from 50-56 mc/s to 288-294 mc/s. Channels as high as 78-84 mc/s have been assigned thus far to commercial stations, but little experience has been gained on higher frequencies, except in relay service.

A conflict in allocation arises, by definition, when interference occurs among stations. The interference is defined in terms of (1) the signal level required to give satisfactory service in an area from the station serving that area, and (2) the level of signal which creates interference in that area, arising from another station on the same channel in an adjacent area. The problem of interference between stations in the same area but assigned to adjacent channels must also be considered.

The basic level of service is defined as a field strength which must be equalled or exceeded over 50 per cent. of the distance along a radial line from the transmitter. The field strength thus specified for built-up city areas and business districts is 5 mV/m. For residential and rural areas the specified field strength is one-tenth as great, or 500 μV/m. These figures properly surpass the figure of 100 μV/m. commonly regarded by engineers as the lower limit for "marginal service," in the absence of man-made sources of noise.

The applicant for a television construction permit or licence must show that his proposed transmitter will offer service in accordance with the above rules, and must estimate the population lying within the 5-mV/m. and 0.5-mV/m. contours.

The coverage of the transmitter is specified in terms of a field-strength contour map. It is desirable to have, in addition, a simple figure representative of transmitter performance for purposes of comparison. The power of the output stage of the transmitter, commonly used in medium-wave broadcasting, is an inadequate index in the v.h.f. region. In its place a quantity known as "effective signal radiated" (e.s.r.) had been set up by the F.C.C. to take account of the antenna gain and antenna height as well as the output power of the transmitter. It is defined as the product of the square root of the peak power input (kW) to the antenna, the

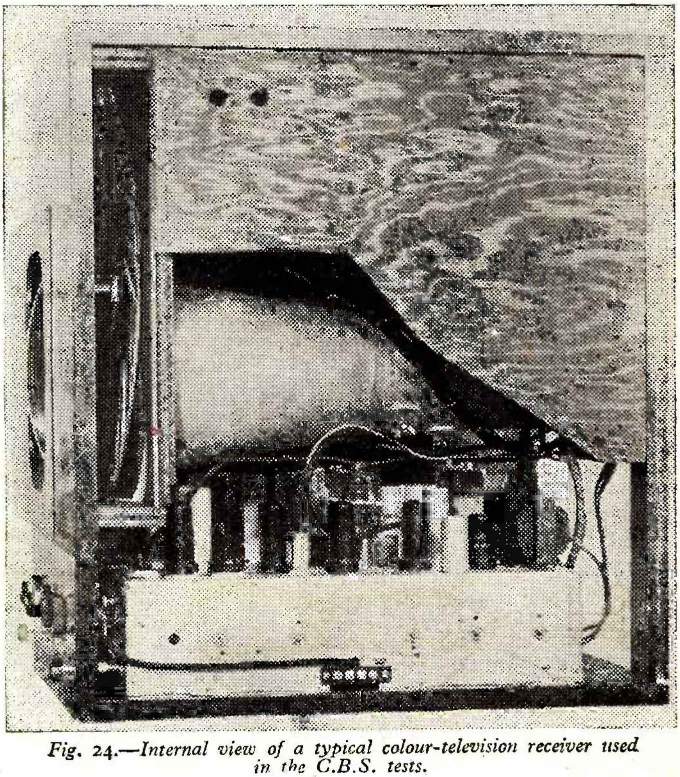


Fig. 24.—Internal view of a typical colour-television receiver used in the C.B.S. tests.

antenna field gain, and the antenna height in feet above ground level. Thus a transmitter delivering 5 kW. peak power to an antenna of field gain 2.0 at a height of 500ft. has an e.s.r. of $\sqrt{5} \times 2.0 \times 500 = 2,230$. The e.s.r. figure has admitted limitations in indicating the comparative performance of transmitters, but it is superior to a simple statement of output power.

The interference ratio (ratio of desired signal to undesired signal) which must be equalled or exceeded within the service area has been set at 100 : 1 for stations on the same channel and 2 : 1 for stations on adjacent channels. This is in keeping with the commonly-held engineering opinion that an interfering signal must be at least 40 db below the desired signal if it is to have negligible effect. For adjacent-channel interference, the selectivity of the receiver circuits will introduce sufficient additional rejection if the interfering signal voltage does not exceed one-half the desired signal voltage. It is the practice of the F.C.C. to avoid assigning adjacent channels in the same metropolitan area; otherwise the 2 : 1 ratio could be met in but a small portion of the normal service area.

The problem of finding sufficient facilities for television without interference is most critical in the highly populated areas along the eastern seaboard. In general an allocation plan to provide sufficient service to the cities of Boston, Providence, Hartford, New York, Philadelphia, Baltimore and Washington (combined

Table 3.—COMMERCIAL TELEVISION BROADCAST STATIONS IN THE U.S.A.
(As of the 5th May, 1944)

Location	Call letters	Licensee	Frequency	Effective signal radiated
			Mc/s	
New York, N.Y., Empire State Building	WNBT	National Broadcasting Company ..	50–56	1 800
New York, N.Y., Chrysler Building ..	WCBW	Columbia Broadcasting System ..	60–66	1 000
New York, N.Y.	WABD	Allen B. DuMont Laboratories ..	78–84	—
Schenectady, N.Y., New Scotland ..	WRGB	General Electric Company	66–72	3 100
Philadelphia, Pa., Springfield Township	WPTZ	Philco Radio and Television Corporation	66–72	500
Chicago, Illinois	WTZR	Zenith Radio Corporation	50–56	1 270*
Chicago, Illinois	WBKB	Balaban and Katz Corporation ..	60–66	550
Milwaukee, Wisconsin	WMJT	The *Milwaukee Journal*	66–72	1 200*
Hollywood, Calif., Mount Lee	KTSL	Don Lee Broadcasting System	50–56	5 600*

* Construction permit only. Licence to cover permit not yet issued.

Table 4.—EXPERIMENTAL TELEVISION RELAY BROADCAST STATIONS IN THE U.S.A.
(As of the 5th May, 1944)

Location	Call letters	Licensee	Frequency	Power		Associated station
				Visual	Aural	
			Mc/s	W	W	
Area of New York ..	W2XBU	National Broadcasting Company ..	282–294	15	—	WNBT
Area of New York ..	W2XCB	Columbia Broadcasting System ..	346–358	25*	—	WCBW
Area of New York ..	W2XBT	National Broadcasting Company ..	162–168	400	—	WNBT
Area of New York ..	W10XKT	Allen B. DuMont Laboratories ..	258–270	50	—	WABD W2XVT
Schenectady, New York	W2XGE	General Electric Company ..	162–168	60	50	WRGB
New Scotland, New York	W2XI	General Electric Company ..	162–168	50	—	WRGB
Area of Philadelphia ..	W3XP	Philco Radio and Television Corp.	230–242	15	—	W3XE
Area of Philadelphia ..	W3XPA	Philco Radio and Television Corp.	230–242	15	—	WPTZ W3XE
Area of Philadelphia ..	W3XPC	Philco Radio and Television Corp.	230–242	15	—	WPTZ W3XE
Area of Philadelphia ..	W3XPR	Philco Radio and Television Corp.	230–242	60 (peak)	—	WPTZ
Area of Chicago ..	W9XBT	Balaban and Katz Corporation ..	204–216	40	—	W9XBK
Area of Chicago ..	W9XBB	Balaban and Katz Corporation ..	384–396	10	—	W9XBK
Area of Los Angeles ..	W6XDU	Don Lee Broadcasting System ..	318–330	6.5	50	W6XAO
Area of Los Angeles ..	W6XLA	Television Productions Inc. ..	204–216	100* (peak)	—	W6XYZ

* Construction permit only. Licence to cover permit not yet issued.

Table 5.—EXPERIMENTAL TELEVISION BROADCAST STATIONS (OTHER THAN RELAY) IN THE U.S.A.
(As of the 5th May, 1944)

Location	Call letters	Licensee	Frequency	Power	
				Visual	Aural
			Mc/s	W	W
New York, N.Y.	W2XMT	Metropolitan Television Inc.	162–168	50 (peak)	50
Passaic, N. J.	W2XVT	Allen B. DuMont Laboratories ..	78–84	50	50
Philadelphia	W3XE	Philco Radio and Television Corp. ..	66–72	10 000 (peak)	11 000
Washington	W3XWT	Allen B. DuMont Laboratories ..	50–56	1 000	1 000*
Cincinnati, Ohio	W8XCT	The Crosley Corporation	50–56	1 000	1 000*
West Lafayette, Indiana ..	W9XG	Purdue University	66–72	750	750*
Chicago, Illinois	W9XBK	Balaban and Katz Corporation ..	60–66	4 000	2 000
Chicago, Illinois	W9XPR	Balaban and Katz Corporation ..	384–396	10	—
Chicago, Illinois	W9XZV	Zenith Radio Corporation	50–56	1 000	1 000
Iowa City, Iowa	W9XUI	University of Iowa	50–56 210–216	100	—
Los Angeles, California ..	W6XAO	Don Lee Broadcasting System ..	50–56	1 000	150
Los Angeles, California ..	W6XYZ	Television Productions Inc.	78–84	4 000	1 000

* Construction permit only. Licence to cover permit not yet issued.

metropolitan population in 1940 about 20,150,000), will take care of all other population centres in North America. A suggested allocation proposed by the R.T.P.B. Television Panel is described at the conclusion of this article and illustrated in Fig. 27.

Other F.C.C. regulations which govern the operation of commercial television stations have to do with the minimum hours of programme service and the question of multiple ownership of stations. In the immediate pre-war period, each commercial station was required to offer at least 15 hours of programme per week. Currently this requirement has been reduced to 4 hours per week, as a war measure, to take account of man-power and equipment (particularly photocell replacement) shortages. No single organisation can own, operate or control more than three commercial television stations.

(2.6) Stations Currently Licensed

Tables 3, 4 and 5 list American television transmitters at present authorised. The commercial transmitters listed in Table 3 are required to offer regular programme service to the public. The geographical distribution of these stations is shown in Fig. 12 (see May issue). The experimental stations are listed as "relay stations" (used in conjunction with other broadcast transmitters) and "other than relay stations" (operated for research and the development of the art). The geographical distribution of the experimental stations is shown in Fig. 13 (see May issue).

(2.7) Studio Methods and Equipment

Typical scenes taken in the N.B.C. and C.B.S. studios are shown in cover of April issue and Fig. 14 respectively. The April cover shows three cameras in use on separate portions of the set; they operate simultaneously and independently. The output of the desired camera is switched to the line circuit by a control operator in an adjacent booth. Green lights on the front of the camera housing warn the performers that the camera is "on the air."

The cameras are predominantly of the iconoscope variety for studio work, and are provided with bias lighting. Several stages of the camera pre-amplifier, blanking and horizontal deflection circuits are included in the housing. The cable between camera and control booth contains 32 conductors, including the video coaxial line. The microphone is manipulated by an operator on a boom which was first developed for sound motion-pictures.

The lighting consists of groups of six 500-W "bird's-eye" reflector lamps. About 75 kW. of lighting is available, the heat being conducted from the studio by an extensive, but practically noiseless, air-conditioning system. The direction of each group of lamps is controlled by a rope-and-pulley mechanism manipulated by a lighting engineer at the side of the studio. Large banks of fluorescent lamps are employed in the C.B.S. studios, one of which is visible at the upper left in Fig. 14. A typical high-fidelity image is shown in Fig. 15.

Associated with the studio is the control element of the system, the synchronising signal generator. The action of this device begins with a 31,500-c/s. sine-wave oscillator, which is frequency-controlled by an a.f.c. discriminator to maintain a rigid relationship with the 60-c/s. mains frequency. The output of the oscillator is divided into four counter-circuit stages by factors 7, 5, 5 and 3 (total division by a factor of 525). The output frequency of the last counter stage is accordingly 31,500/525 = 60 c/s. This frequency is compared with the mains frequency in the discriminator previously mentioned. A further and separate division by two of the output of the oscillator provides pulses at 15,750 c/s. The two frequencies, 15,750 c/s. and 60 c/s., are respectively the line scanning frequency and the field (British "frame") scanning frequencies which control the synchronising pulse-forming circuits. These pulse-forming circuits produce groups of horizontal pulses and vertical pulses of the proper shape and frequency which are intermixed in accordance with the standard shown in Fig. 10. The intermixing is accomplished by so-called keying pulses which block the horizontal pulse during the vertical pulse but allow the equalising and serrated pulses to pass in this interval. The generator is a highly complex electronic maze judged by pre-war standards,

(*Continued on page* 343)

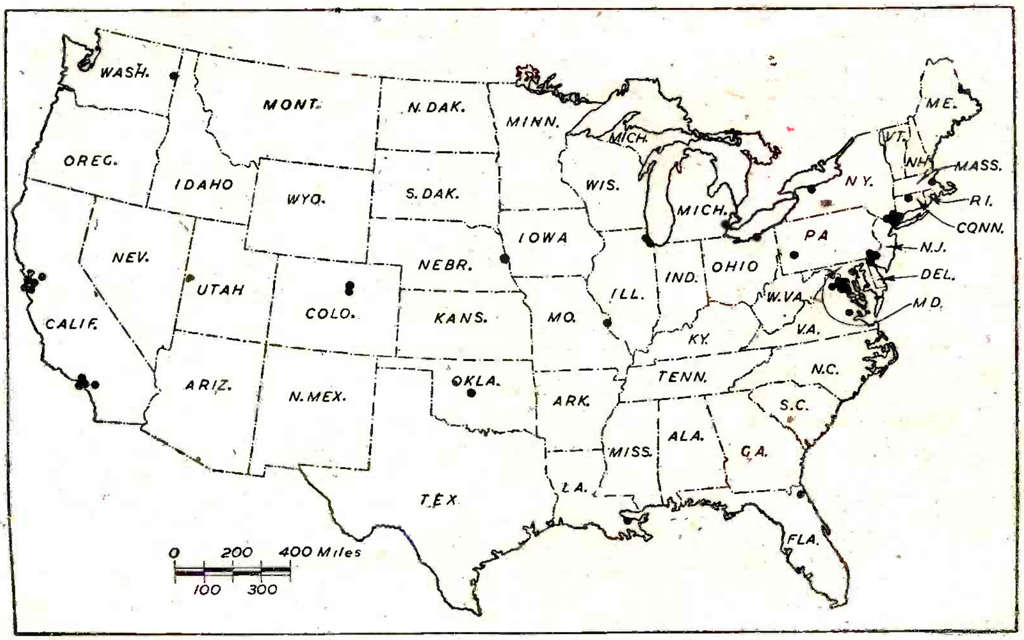
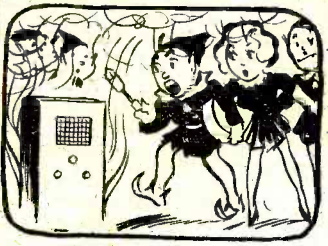


Fig. 25.—Geographical distribution of post-war television stations for which licence applications are now pending before the F.C.C. (as of May 5th, 1944).



'The "Fluxite Quins" at Work.

" Good Gracious ! Our radio's alight,
We shan't hear the Brains Trust to-night——"
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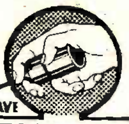

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TYPE C.	100 ma. Ratings as type A ..	34/6
TYPE D.	100 ma. Ratings as type B ..	34/6
TYPE E.	120 ma. Ratings as type A ..	37/6
TYPE F.	120 ma. Ratings as type B ..	37/6
TYPE H.	200 ma. Three L.T.s of 4v. and 4v. for rectifier. Ratings as required ..	47/6
TYPE I.	200 ma. Three L.T.s of 6.3v. and 5v. for rectifier. Ratings as required ..	47/6
	Secondaries 500-0-500 volts.	
TYPE J.	200 ma. L.T. windings as type I	52/-
TYPE K.	200 ma. L.T. windings as type H	52/-
TYPE L.	250 ma. L.T. windings as type I	56/-
TYPE M.	250 ma. L.T. windings as type H	56/-
	Secondaries 250-0-250 volts.	
TYPE N.	200 ma. L.T. windings as type H	47/6
TYPE O.	200 ma. L.T. windings as type I	47/6
TYPE P.	300 ma. L.T. windings as type H	60/-
TYPE Q.	300 ma. L.T. windings as type I	60/-
	Secondaries 400-0-400 volts.	
TYPE R.	120 ma. 4v. 3a., 4v. 2½a. ..	40/-
TYPE S.	120 ma. 6.3v. 5a., 5v. 2½a. ..	40/-
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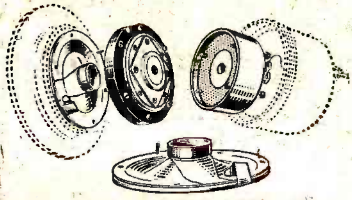

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although quite simple when compared with more recent developments in the radar field.

(2.8) Mobile Pick-Up and Relay Equipment

The outstanding example of mobile pick-up equipment, and virtually the only one of its type in use in America, is the N.B.C. mobile unit shown in Fig. 17. The unit consists of two 10-ton vans. One houses the video equipment, cameras, pre-amplifiers, synchronising generator, mixers, etc. The other, housing a 400-watt transmitter operating on the relay carrier channel of 162–168 mc/s, is surmounted by a multi-element stacked antenna array. Power for the unit is obtained from mains supply, a circumstance which prohibits the use of the equipment while the vans are in motion. Two complete camera "chains" are available to permit quick switching from one scene to another. The cameras are equipped with 250ft. of multi-conductor cable to enable them to be set up at a distance from the vans. It is common practice to use the orthicon camera for maximum sensitivity on one chain and the iconoscope for maximum resolution on the other. A typical use of the orthicon camera, during the Republican National Convention in Philadelphia in June, 1940, is shown in Fig. 18. The large long-focus lenses shown were necessary to obtain telephoto shots without resorting to special illumination. The vans were driven to Philadelphia on this occasion, and the video signal was relayed to New York by coaxial cable, as previously described. The N.B.C. mobile unit has originated some of the most important programmes thus far broadcast in America.

Another relay installation, of much simpler design, is shown in Fig. 19. This is a transportable relay transmitter employed by the Don Lee System of Los Angeles. It is housed in a tent and is set up in advance at the point of origin of a programme.

A typical point-to-point relay receiver-transmitter, developed before the war and installed at Hauppage, Long Island, is shown in Fig. 20. Parabolic receiving and transmitting reflectors are enclosed in the cylindrical wooden structure at the top of the tower. The relay equipment and monitoring facilities are housed at the base.

(2.9) Transmitting and Radiating Equipment

Three different approaches to the transmitter problem are represented in the N.B.C., C.B.S. and General Electric stations. The N.B.C. transmitter generates the carrier by crystal control at a sub-harmonic frequency, followed by doubler stages to produce the carrier frequency of 51.25 mc/s. The final R.F. stage is grid-modulated by a high-level video amplifier stage, conductively coupled to the grids of the final R.F. power amplifier. A peak R.F. power of 7.5 kw is achieved.

The C.B.S. transmitter is somewhat similar, but employs a transmission-line-controlled oscillator in place of the crystal control, followed by a buffer stage, an intermediate stage and a final R.F. amplifier, grid modulated as in the N.B.C. transmitter. The peak picture-signal power is somewhat less than that of the N.B.C., owing to the higher carrier frequency (61.25 mc/s). Coaxial filters are employed in these transmitters to suppress a portion of the lower sideband, in accordance with the standard channel.

The modulation of high-level stages, illustrated in these examples, imposes a practical upper limit on the peak power output by virtue of the difficulty of obtaining high voltage levels at the output of the video modulating amplifier. High voltage output may be obtained over the band of vision frequencies only if the modulating valve can supply heavy peak currents to compensate for the necessarily low value of coupling impedance. But such valves are large and inherently possess large capacitance between elements and to earth, which requires still lower values of coupling impedance and still larger currents. A practical upper limit is quickly reached in this series of requirements. With pre-war valves it was considered impossible to obtain much more than 10 watts of R.F. peak power by high-level methods of modulation.

An alternative approach to the high-power case is the low-level modulation scheme adopted by the General

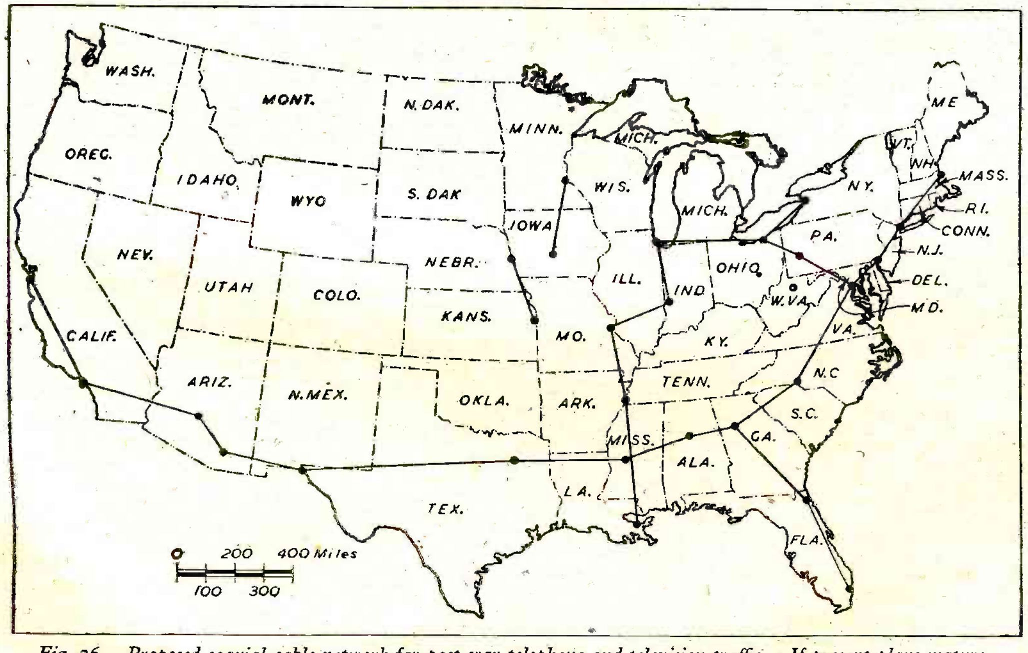


Fig. 26.—Proposed coaxial-cable network for post-war telephone and television traffic. If present plans mature, this system will be completed by the American Telephone and Telegraph Co. by 1950.

Electric station, WRGB. In this transmitter the vestigial-sideband characteristic is introduced in the studio transmitter, which relays the programme to the transmitter proper on the 162–168 mc/s channel. At the transmitter the relay carrier signal is heterodyned to the final carrier frequency of 67.25 mc/s in a low-level (10-watt) stage, and thereafter is amplified in nine successive stages of class B amplification at carrier frequency. An extreme degree of linearity is required of these class B stages to prevent re-insertion of the attenuated sideband, but this requirement has been satisfactorily met. The peak power of the final power amplifier is about 40 kw, or roughly five times that of comparable high-level transmitters.

The radiators used for picture and sound transmission take various forms, of which two examples are shown. The first (Fig. 21) is the crossed dipole arrangement, employed by the C.B.S. transmitter in the Chrysler Building, New York. The upper elements radiate the picture signal, the lower the sound signal. An approximately circular radiation pattern is obtained by proper phasing of the four dipoles in each array. The second antenna (Fig. 22) is that of the N.B.C. transmitter at the top of the Empire State Building, New York. The upper structure consists of four folded dipoles bent into circular shape for radiating the sound signal. A circular radiation pattern is thus obtained and no mutual coupling is experienced with the picture radiator below. The picture radiator is essentially two dipole radiators, arranged at right angles in "turnstile" fashion. The dipoles are fed in quadrature to produce a circular pattern of radiation. The unusual bulbous shape is used to effect a wide-band radiation characteristic. The impedance of this radiator is essentially constant over the assigned range from 50 to 55.75 mc/s, over which it must radiate without discrimination.

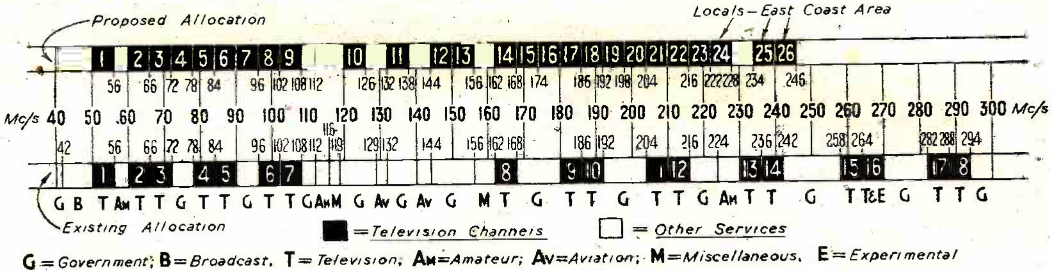


Fig. 27.—The existing allocation of television channels, and a post-war allocation proposed by the Television Panel of the R.T.P.B.

(2.10) Television Receivers

Present receiver practice is typified by pre-war equipment, no receivers having been manufactured since 1941. In the pre-war allocation, channels as high as 102–108 mc/s were contemplated but no specific allocations were made above 78–84 mc/s. None of the pre-war receivers provided channels higher than 84–90 mc/s and many of the inexpensive sets were limited to two or three channels. Few of the pre-war sets were built with frequency-modulation detectors, but most of them could be adjusted to receive frequency-modulated transmissions by tuning the sound carrier to one slope of the I.F. band-pass characteristic. Maximum sensitivity to the picture signal was seldom better than 100μV, and no R.F. amplifier stage was employed prior to the frequency-converter stage. The most commonly used intermediate frequencies were 12.75 mc/s for the picture and 8.25 mc/s for the associated sound carrier. In sets employing small picture tubes (5in. diameter) the I.F picture channel was usually limited to a maximum band-width of about 2.5 mc/s, since this figure corresponded to the spot size of the picture tube, relative to the picture size. Amplifications of 10 to 15 per stage were possible with this band-width, using high-slope valves ($Gm = 9{,}000\ \mu$A/V). In the cheaper receivers three stages of I.F. amplification usually sufficed. The more expensive receivers, with 12in. cathode-ray tubes, used an I.F. band-width of about 3.5 to 4 mc/s, with four or five stages at an amplification of about eight per stage. Electric deflection was the rule for picture tubes of diameter less than 7in., and magnetic deflection for larger tubes. Second-anode voltages varied from 2,000 for small electrically deflected tubes to 7,000 for large magnetically deflected tubes. No projection-tube receivers were offered to the public.

(2.11) Colour Television

Intensive development of colour television has been undertaken by the Columbia Broadcasting System under the direction of Dr. Peter Goldmark. Experimental broadcasts from W2XAB began in August, 1940, and were continued over WCBW throughout 1941. The N.T.S.C. and R.T.P.B. standardisation committees, after considering colour television at length, decided that it was not possible to set standards so early in the development. Presumably, therefore, colour television will not be a factor in the immediate post-war activity, although its eventual importance cannot be doubted.

The C.B.S. colour television system is a synchronised colour-disc system. The initial scanning standards employed were 120 fields per sec., 343 lines. When the black-and-white standard was raised from 441 lines to 525 lines in 1941, the colour standard was raised a similar amount to 375 lines. The colour disc at the transmitter causes successive fields to be scanned in successive primary colours in the sequence red, blue, green. At the end of three fields (1/40 sec.) all three colours have been presented to the eye. Consequently the basic colour frame is reproduced at a rate of 40 per sec. This rate is high enough to avoid visible flicker, provided the picture brightness is not too high. A given element of the picture is passed over by the three colours, each in 1/20 sec. To avoid pairing of the interlaced lines very careful shielding of the cathode-ray tube is required.

Linear camera tubes are used to simplify the problem of colour balance. An image dissector is used to televise colour slides and film. An orthicon of special design (employing thicker mica to reduce the mosaic capacitance and hence allow more complete discharge of the mosaic during a single scansion) is used for direct pick-up. The colour disc at the transmitter uses Wratten filters numbered 47, 58 and 25, whereas the disc in the receiver uses filters numbered 47, 58 and 26. Additional overall filtering is needed at the transmitter to remove excessive infra-red rays from the light source.

Several very impressive demonstrations of this system were viewed by technical people. The majority opinion was that the presence of colour did much to off-set the lack of detail in the images, but that the lack of detail was evident. It was also evident that the colour pictures offered satisfaction only when the colours were in proper balance. Separate gamma controls were provided for each colour and switched synchronously with the colour sequence. This "colour mixing" circuit proved essential to the system, but it was not always successful in coping with wide ranges of brightness.

(*To be continued*)

Impressions on the Wax

Review of the Latest Gramophone Records

H.M.V.

IT is fitting that the high-light of H.M.V. latest releases should be a recording of outstanding merit, in the musical and technical senses, by the San Francisco Symphony Orchestra. At the present time, the ears of the whole world are turned to that city for news of the New World which we all hope to see emerge from the chaos and destruction of the past five odd years. Even so, it is a sign of no small significance that our ears can still welcome and appreciate music which goes far to sweep away the hideous sounds of war, and their echoes left in our minds. The two *H.M.V.* records *DB*6182-83 come at an opportune moment. They are first class examples of the performance given by the San Francisco Symphony Orchestra under the baton of Pierre Monteux. *DB*6182 is "Gigues" (No. 1 of "Images" for Orchestra by Debussy), while *DB*6183 is "Rondes De Printemps" (Spring-time Rounds) which is No. 3 of "Images" for Orchestra by the same composer.

A record which is a striking example of the great versatility of Peggy Cochrane and Jack Payne and his Orchestra, is *H.M.V. C*3428. On this, they have recorded the "El Alamein Concerto" by Albert Arlen, and I strongly recommend it for your hearing. Miss Cochrane, who takes the solo pianoforte part, gives a splendid performance of a very striking work, and she is ably supported by Jack and his Orchestra whose rendering of this unique Concerto places the whole recording on a very high level.

In the H.M.V. 10in. series, there are three vocals catering for as many different musical tastes. For example, *B*9414 will be welcomed by those who enjoy a good musical show, and an artiste as talented and popular as the one and only Evelyn Laye. On this record, Miss Laye has recorded two of the featured numbers from "Three Waltzes," namely, "Forever" (The Second Waltz) and "How can Words Content A Lover?" (The Third Waltz). She is accompanied by The Princess Theatre Orchestra, conducted by Herbert Griffiths, and both recordings are good, though, personally, I think "Forever" is the better.

For those who delight in listening to a fine tenor, I recommend the second of the three vocals as I am sure they will appreciate Robert Wilson's rendering of "This Is A Ladye" and "The Maid Of Kenmore." These two ballads are sung in English, with orchestra accompaniment and the artist has made a delightful recording. The record is *H.M.V. BD*1103.

The third record is by "Hutch" and he has selected two film features, "I Promise You" from "Here Come The Waves," and "In The Middle of Nowhere" from "Something for the Boys." Two popular numbers presented in typical "Hutch" style, on *H.M.V. BD*1102.

Jack Payne with his Orchestra has also selected items from the first of the two films mentioned above for his recording on *H.M.V. BD*5883. He offers, and I recommend, to dance enthusiasts, "Ac-cent-tchuate The Positive"—fox trot—and "I Promise You"—Beguine. A good recording.

Joe Loss and his Orchestra have a fine record in *H.M.V. BD*5881, on which they have recorded "A Little On The Lonely Side," a fine foxtrot, and "American Patrol," a tempting quickstep.

Tommy Dorsey and his Orchestra, on *H.M.V. BD*5884, have two rather "hot" pieces in the form of "Swing High," a foxtrot, in which Ziggy Elman shows how a trumpet can be played, and "Opus No. 1," also a foxtrot, which is, at least to me, a distinctly unusual composition.

Columbia

FOUR 12in. records—Nos. *DX*1187-90—stand out in the Columbia releases. They form a superb recording of "Quintet for Clarinet and Strings in A Major," by Mozart (*K*581), made by Reginald Kell and The Philharmonia String Quartet. The work consists of four Movements—Allegro, Larghetto, Minuetto and Trio—and, finally, Allegretto con Variazione; and represents a delightful example of Mozart's skill in exquisite blending, supreme orchestration and delicate beauty. The performance leaves nothing to be desired. Reginald Kell reveals a perfect understanding of Mozart, and absolute mastery of the clarinet.

Harry Davidson and his Orchestra have another Old Time Dance record this month, it being Nos. 10 and 11 of this very popular series. The dances selected are "The Boston Two-Step" and "Progress Barn Dance," and, believe me, they are two very live y tunes, which will make tired feet desire to be up and doing. The record is *Columbia DX*1191, and, as usual with this series, I strongly recommend it, as light music of this type is very cheerful, bright and gay.

A truly delightful record in the "light music" class is *Columbia DB*2168. It is by Albert Sandler and his Palm Court Orchestra, which, in itself, is a guarantee of good entertainment. They have recorded "When Day Is Done" and "Fascination," two charming little pieces nicely presented.

For Hawaiian enthusiasts Felix Mendelssohn and his Hawaiian Serenaders—featuring Harry Brooker—offers "Intermezzo" and "Caprice Viennois," two topping numbers, well orchestrated and performed. The record is *Columbia FB*3105.

Victor Silvester and his Ballroom Orchestra—of strict dance tempo fame—play, and very nicely, too, "Silver Shadows, Golden Dreams"—waltz, and "Like Someone In Love"—a quickstep from the film, "Belle of the Yukon." Paula Green and her Orchestra (directed by Peter Akister) have recorded "More and More" and "Love Is a Kiss" on *Columbia FB*3106.

On *Columbia FB*3108 Jimmy Leach and his New Organolians choose for their contribution this month "A Little on the Lonely Side" and "The Sun Never Sets On My Dreams," the vocals being taken by Cyril Shane. The tunes are fine for dancing, the rhythm being nicely accentuated.

Parlophone

RICHARD TAUBER gives a good performance on *Parlophone RO*20538, on which he has recorded, in English, "Love Is My Reason" from "Perchance to Dream," and "We'll Gather Lilacs," also from the same play by Ivor Novello. Of the two recordings I prefer the former, but both are good examples of Tauber's skill and pleasing voice. "A Dream World Is Waiting" and "Don't Fence Me In" are the titles of two fine foxtrots played by Geraldo and his Orchestra on *Parlophone F*2068. I recommend this record for dancing.

The Victor Feldman Trio—with string bass and guitar accompaniment—can be heard playing "Zanzibar" and "Cooling Off" on *Parlophone F*2070. These recordings should have a wide appeal to those who like rather unique arrangements.

On *Parlophone R*2968 Billy Penrose Quartet play two pieces by Billy himself, the titles of which are "Bogie in the Grove" and "Lazy Bogie." These form Nos. 19 and 20 of The 1945 Super Rhythm-Style Series, and they certainly possess rhythm.

Regal

THIS month's Regal contribution is by Gene Autry, the yodelling cowboy, who sings "Paradise in the Moonlight" and "Blue Hawaii." Both numbers have a Hawaiian instrumental accompaniment.

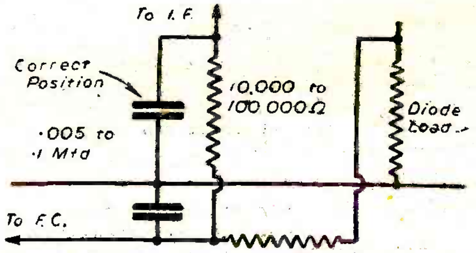
Open to Discussion

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

Instability in Superhets

SIR,—I wish to point out an obvious error in Fig. 3 of my article "Instability in Superhets," January issue; the condenser marked .005 to .1 mfd. should be connected to the other side of the A.V.C. decoupling resistor marked 10,000–100,000 ohms, as shown.

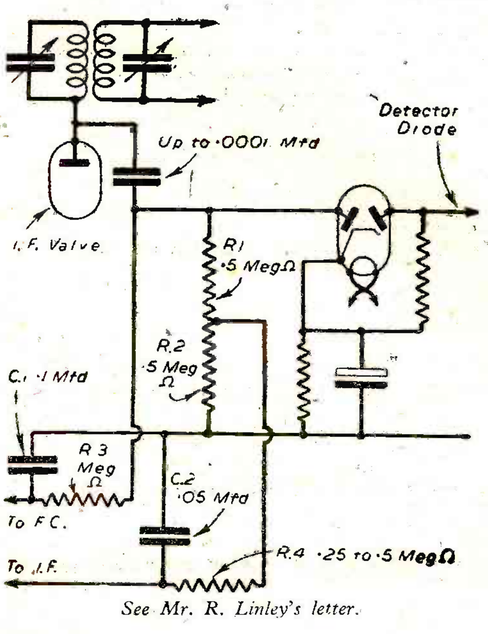
The article described the simplest possible A.V.C. circuit as the risk of instability is not so great with a simple arrangement. However, when the set has been completely stabilised, a slightly more complicated A.V.C. circuit may be used with advantage, the real benefit being in the removal of the shunting effect of the A.V.C. circuit from the detector diode, thus elim-



Instability in superhets. Decoupling A.V.C. circuit (Fig. 3). See Mr. R. Linley's letter.

inating what can prove a considerable source of distortion. Average suggested component values: R1, .5 meg.; R2, .5 meg.; R3, 1 meg.; R4, .25–.5 meg.; C1, .1 mfd.; C2, .05 mfd.

The I.F. voltage at the anode of the I.F. valve will produce an A.V.C. bias of up to twice that obtained with the original circuit and so the bias for the I.F. value is tapped down the diode load. This circuit also almost completely eliminates "side-band splash," which can be so annoying when tuning in local stations; this is because the A.V.C. circuit now has one tuned circuit less than the detector diode circuit and so the A.V.C. circuit is not so selective as the detector circuit.—R. LINLEY (Dagenham).



See Mr. R. Linley's letter.

Cycle Dynamo on A.C. Mains

SIR,—I have read in the June issue a letter from Mr. K. Painter (Staffs.), in which he seeks information on the working of a cycle dynamo from a bell transformer.

Although I have never tried out a cycle dynamo on A.C. mains, I see no reason why it should not operate.

The ordinary cycle dynamo comprises a permanent magnet rotor in the form of a solid steel drum which is free to rotate between the stator poles. The stator is provided with a coil which in this particular case is connected to the bell transformer, which feeds it with alternating current.

The general construction is therefore similar to the synchronous motor, and will function in the same manner.

Such motors are not self-starting, and some form of starter is necessary to give the rotor an initial spin. The speed of the spin must be at least equal to the synchronous speed, as this type of motor will not pull up into step.

This, I think, explains the reason why the dynamo pulley merely "judders," and will not rotate. To start the motor, therefore, first connect to the current supply and then spin the rotor up by a mechanical starter to synchronous speed when it should continue to run.

I think it will be found that the motor has very little power, and care will be necessary not to overload it, as a drop in speed will cause it to stop.—WILFRED G. ROWNER (Hexham).

The 4-valve Short-waver

SIR,—I agree that in no way can the valves of a set be damaged by omission of a switch to isolate H.T. when the set is not in operation, but I would like to point out that the output valves in the 4-valve short wave set (May issue) may become damaged, the reason being that no provision has been made to switch off G.B. This means a continual leak through the 50,000 ohm potentiometer, which, in a very short time, will mean the lowering of G.B. voltage. As a result of which the A.F. valves will be underbiased, and may become seriously damaged. Not only this, but constant renewal of the G.B. will be necessary, and, therefore, a three-point switch should be substituted for the existing S.P.S.T. type. The other contact should be taken to the grid bias positive on the battery.

I trust that I am not too late in bringing this matter to the attention of your readers.—M. BIMFORD (Macclesfield).

SIR,—I have just completed the construction of the "Four-valve Short Wave Set" as described in the May issue of PRACTICAL WIRELESS. I have, too, tried out the receiver, and I know you will be interested in the results I have achieved. In short, I have been able to tune in stations from all round the globe, including Melbourne, in Australia.

The first station I tuned in was the Canadian International Broadcasting Station, broadcasting from Canada. This station did not, however, give much detail about itself. The programme was a review of world news. I then tuned in Schenectedy, New York; then Boston, Mass. After this I have at various times

(*Continued on page* 348)

in the evenings tuned in Moscow, Madrid, Santardes (both Spain). Other stations include "All-India Radio" (India), Switzerland, and Leopoldville in the Congo, i.e., Belgian Congo. When I have calibrated the receiver I shall be pleased to send you a detailed log, with times of transmission, frequencies and types of programme if you are interested.

My greatest satisfaction was as a result of tuning in Melbourne, Australia. I might add that this is no fluke, as I have tuned in this station on two nights running—both occasions were received on the loud-speaker. This station announces that there are two beam transmissions to England daily. The time I have listened is at 6.15 p.m. to 6.45 p.m. The wavelength is 31 metres. To-night (Wednesday May 2nd) there was news, followed by some of our Forces there speaking to their relatives in England. This was followed by music.

The set is easy to handle, and free from dead spots on the 25–40 metres. I would add that I have had most success on the 25, 31 and 40 metres. Below this I have tuned in several stations only. It seems, however, that evening listening is more suitable to the longer wavelengths, i.e., lower frequencies.

I am using a 30ft. indoor aerial, slung across my bedroom. I found that, in my case, an earth was necessary for good reception. (It mentions in PRACTICAL WIRELESS that an earth can possibly be dispensed with.)

I would further add that I have constructed the receiver as near to the detail as possible, i.e., as contained in PRACTICAL WIRELESS. That is, I have used a wooden baseboard. I think the mounting of the condensers on brackets a good idea. My valveholders were purchased at Webb's, and are mounted on three insulated legs, which brings the valve about 1in. above the baseboard. The octal base coilholder is also raised 1in. above the baseboard by two insulating pillars from "Premiers." —W. TOZER (Bow).

SIR,—Having recently constructed a slightly modified form of the suggested four-valve circuit described in the series "Short Wave Radio," and which appeared in the February issue of PRACTICAL WIRELESS, I should like to say how interesting and helpful the series of articles has been to me. I should also like to congratulate you on the general high standard of the journal. Some recent articles I have enjoyed particularly, namely those on "Miller Effect" and "Negative Feedback." I include a list of some of the stations logged on the set with a 35ft. inverted "L" aerial pointing north-south: SBC Berne, 29.02 m.; Belgrade, 49 m.b. (news in English 3.30 p.m. D.B.S.T.); Madrid, 30.43 m.; Rio de Janeiro: Leopoldville, 30.66 m.; Brazzaville, 25.06 m.; Montevideo, 31.35 m.; Swedish Bc. Corp., 27.94 m.; T.A.P. Arkana, 31.7 m.; N.B.B.C., 41 and 48 m.b.; North American Service of B.B.C.; Radio Centre, Moscow; Radio Shonan, 31.42 m.; All India Radio VUD-3, 31.28 m.; Voice of the Italian Social Republic, 35.3 m.; Radio Algiers, 25 m.b. Also WBOS, WRUL, WRUW, WCRC, WCBX, WRUS, WRUA, WOOC, WOOW, WRCA, WRNI, WNRX, WNBI, WGEO, "CHTA" Sackville, Canada, 19.71 m., and the following war correspondents and reports: "AFHQ Italy," calling Blue Network, 3 p.m., Wednesday, May 9th; Chester Wilmot calling B.B.C., 31 m.b.; American 1st Army calling C.B.S.; General Bradley's H.Q. calling C.B.S.; Winfrid Vaughan Thomas calling B.B.C. from Elbe Front, 4.10 p.m. D.B.S.T., Monday, April 23rd, 49 m.b.

I should be very grateful for any information regarding the N.B.B.C.—G. W. M. (Skegness).

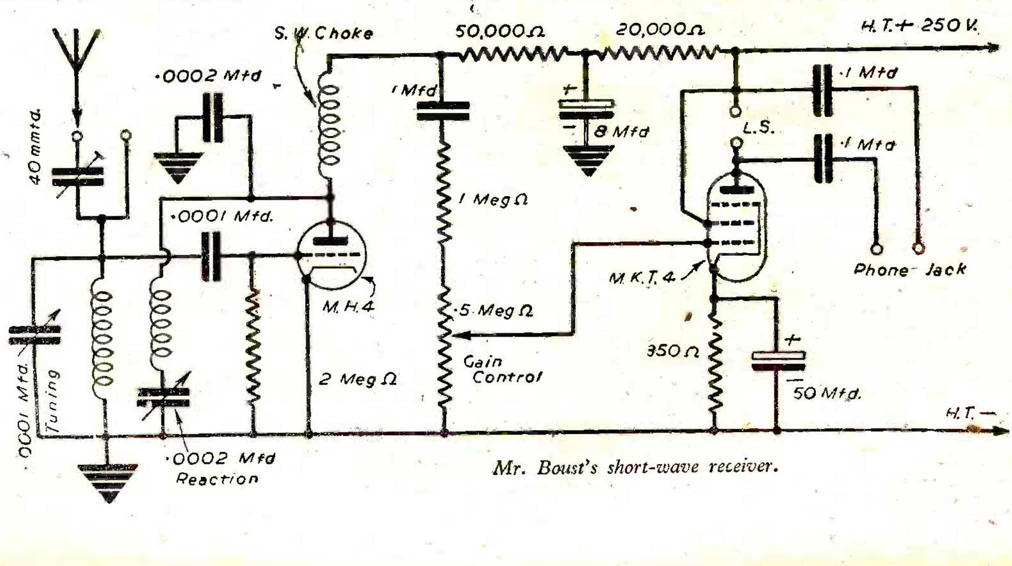
A Short-waver

SIR,—I have just received my copy of PRACTICAL WIRELESS for March, and I want to thank you and Mr. Borland and Mr. Garstang, for the information published in the latest pages of "Open for Discussion." Readers who have received station CHTA on 19.71 metres may be interested to know that I have logged same on my two-valve rig. Has any reader heard Polish Radio Lublin on the 49 metre band; this station emits a news bulletin in English at 6.30 p.m. B.S.T. approx., putting out a fine business signal. Other stations received recently are TAP, 31.7 metres, WRCA, 25.3 metres, and on 16 metre band, Radio Brazzaville, 31 metre band and Allied Forces H.Q., Italy, calling Press Agencies, London and New York on the 23 metre band. The B.B.C. does not seem to give out call signs and this often proves confusing and I would like to support Mr. Aldridge's suggestion about a S.W. Stations List.

I am sending the circuit of my S.W. set, it may interest some new beginners who, like me, had trouble to get a simple but efficient circuit. I used good parts, including an excellent slow-motion dial, eliminating usual bandset and spread.—J. H. BOUST (Beds.).

Log Corrections

SIR,—I am writing to correct some details of the log recently submitted to you by me. It appears that the Madrid 40 kw short wave station has moved permanently to a wavelength of 31.43 metres, a frequency of 9,550 kc/s. Their timetable has been altered to the following: 15.00 hrs. G.M.T., German broadcast; 15.15 G.M.T., Italian; 15.30 G.M.T., French (also on 377.4, 280.9 and 352.9 metres); 16.15, English; 17.00, Portuguese; 17.30, Arabic (also on 42.75 metres); 18.00, concert for Europe, announced in German,



Mr. Boust's short-wave receiver.

Italian, French, English and Portuguese; 18.30, close down. FET1, Valladolid, 6 kw, 42.83 metres (7,006 kc/s), appears to have discontinued its relays of the French and English broadcasts temporarily, owing to technical troubles on the relay line.

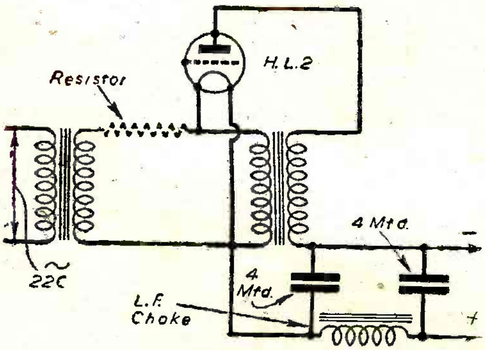
Since writing my last letter I have received no new stations of value. Before closing I should like to thank Mr. Camm for supplying L.A.C. Barlow, of Tangmere, with my address. I hope that a fruitful correspondence will be the result.—K. DOBESON (Chichester).

First Home Radio

SIR,—*Re* Page 246, PRACTICAL WIRELESS for May, 1945, and your article on "First Home Radio."

I think there must be some serious mistake in the dates given by Hugo Gernsback.

As one of those working at wireless from its earliest days (my experience goes back to 1898), I should like



H.T. battery eliminator.—M. E. O'Dowd (Galway).

to suggest that there could not have been such a thing as a *small portable* transmitter and receiver in 1903. The only form of transmission was by spark telegraphy, and for this a 10in. induction coil and a fairly high and long aerial was required to get any range. The coil alone weighed 12 to 15lb.

Reception at that date was either by coherer or magnetic detector. In either case the receiving outfit was not very small, and was fairly heavy; also, *all* communication was by Morse code.

The earliest form of C.W. by which radio telephony could be used was with the "Poulsen Arc" transmitter, which was first used between 1910 and 1912. This in itself was a heavy piece of apparatus, and could not be called portable. The first valve transmitter was used about 1912, but even then only large valves were used, and the small valve transmitter was not in use until after the 1914–1918 war. (I am not referring to a very few special experimental sets which may have been tried from about 1912 onwards.)

By 1906 there might have been a few so-called "Perikon" crystals about, but only in experimental form. The crystal did not come into general use until about 1908. The electrolytic receiver was also being tried out about this time. This receiver, although very sensitive, had to use very fine platinum wire and pure sulphuric acid, and soon dropped out owing to danger from acid and difficulty in making the electrolytic points required. Of each 12 of these made probably only three or four would be any good. Also, the points were not very robust, and were easily knocked out by strong signals. As for Mr. Gernsback's remarks about wireless having been going strong for several years, the first introduction of wireless for general use was in 1899, when a few R.N. and passenger ships were fitted, mainly for the purpose of gaining experience with the apparatus. I should not call this having "been going strong for several years."

As for the remarks about amateurs. I think that might be ignored. I am afraid that most of us were amateurs at that time.

I am afraid this letter is longer than I intended. Of course, it should be realised that my remarks apply to Great Britain, but, at the same time, I think it would be rather difficult even for an American to use spark telegraphy for radio 'phone work.—GEORGE F. HOWELL (Portsmouth).

H.T. Eliminator

SIR,—For some time it has been almost impossible to obtain in Eire a suitable eliminator for operating a battery receiver from A.C. mains. I have devised a unit made from easily obtained parts which is capable of an output of 120 volts at 14 m.a. suitable for most four valve receivers. The transformers are pentode O.P. from service stock. The rectifier is a battery triode, such as a H.L.2 valve. Smoothing is obtained by L.F. choke and two 4 mfd. condensers. If the secondary winding of input transformer gives more than 2 volts, it is easily adjusted by altering the winding or inserting a suitable resistor.

I wish to congratulate you on your most instructive magazine, PRACTICAL WIRELESS, which, in my opinion, is the best value money can buy.—M. E. O'DOWD (Galway).

Church Bells

SIR—Those of us who have been privileged to roam through the quiet streets of London on a Sunday morning, carried away an undying memory of one of London's sweetest sounds, "Church Bells."

What writer could adequately portray a melody words that could interpret the wealth of beauty in the sound of church bells from a southern English village rippling across the rustic serenity of meadows, streams, and woodlands. The bells, far from disturbing the peace of the countryside, only emphasise, in no unmistakable manner, a peace and calmness which is the birthright of any great Christian country's Sabbath morning, most of all England's.

The B.B.C. made a grand choice when they used the bells of one of London's famous churches as an interval signal. A signal which reaches the remotest parts of the Empire, bringing to many millions of British hearts a Christian melody, that comes from, and is, an integral part of its own heart; the heart of the Empire.

And "if England means to Thermion, what England means to them," he will stop grumbling about church bells, thus leaving more space for his really interesting paragraphs.—M. S. O'HANLON (London).

[*In spite of this flowery eulogy, I don't like bells.*—THERMION.]

CKXA

SIR,—As a member of the Club, I would like to inform you of some new short-wave stations I have received lately. The first is a new one. It is a Canadian short-wave station, call sign CKXA, and its wavelength is 25.6 metres. Can you give its location? This station broadcasts the Voice of America from New York and other programmes. It comes on the air about 10.10 G.M.T. Other stations heard: WQV calling ICG, and GIK testing.—R. WILLIAMSON (Antrim).

Servicing

SIR,—In reply to Mr. Skelton's letter in the June issue, I would like to protest against his distinction between the servicing of sets where you just expect to get the signal through (that, according to him, being our job), and servicing the modern high fidelity receivers.

I would like to point out that we are all given an extensive course on radio theory right from the beginning before even touching Service equipment.

Even on reaching the stage where we deal with Service receivers, some of them, especially the "R.C.A., jobs," having such refinements as "crystal gates" and "noise limiter controls," which to my knowledge have never even yet shown themselves in commercial sets in this country.

I would like to point out that I was not a radio engineer in civilian life, and in fact knew nothing about radio before joining the Forces.

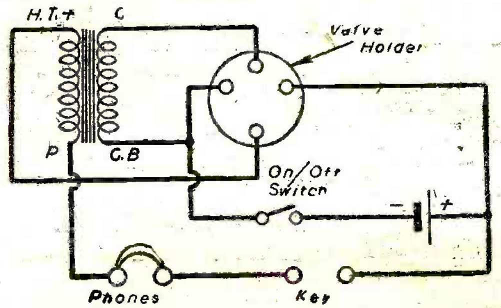
As a postscript it might perhaps surprise Mr. Skelton if he could learn how much Service engineers (especially in the R.A.F.) know about television.—C. PINNINGTON (Liverpool).

[*Servicing Service receivers is not servicing.*—ED.]

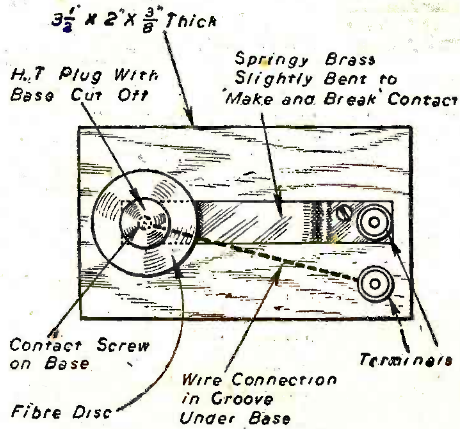
Oscillator

SIR,—I have seen the oscillator circuit in the April issue of PRACTICAL WIRELESS and have enclosed one which needs less components. This oscillator does not need a H.T. battery, but runs from a 2 volt accumulator. To alter the pitch a G.B. battery is used as shown. The morse key is home-made on a wooden base, as in diagram. I have tried eight or nine different 4-pin valves in it, but only one gives good results; some will not go at all.

To alter the pitch remove connection from key to + side of accumulator and connect to + side of 9v. G.B. battery. The – lead to G.B. comes from switch. If the valve fails to oscillate reverse the connections to the primary of the L.F. transformer.—G. ASHLEY (Sussex).



Connections.



The key. See letter from G. Ashley (Sussex).

Carlisle Amateur Radio Society

SIR,—A Radio Society has been formed in Carlisle town, and is known as the Carlisle Amateur Radio Society. The first meeting took place on April 14th. Those present included G3SY, 2ARW, 2DWG, 2AYH, and 3BW and YL.

It is proposed to hold fortnightly meetings, and any readers will be welcome. Any further information can be obtained from the address given below.—W. NICHOLSON, 2AYH, Cammick House, Brisco, Carlisle.

Radio Centre, Moscow

SIR,—I enclose a list of English transmissions audible in the United Kingdom from the Radio Centre, Moscow; these are official and up to date. (Times and G.M.T.): 0630-0644, 28.72, 48.15, 25.79 m.; 1140-1219, 25.79, 28.72 m.; 1700-1729, 41.1, 48.15 m. 1800-1814, 41.1, 48.15; 1900-1929, 41.1-48.15; 2000-2029, 41.1 m.; 2100-2129, 41.1, 48.15 m.; 2200-2215; 41.1 m.; 2247-2325, 25.11, 41.1 m.; 2315-2325, 42.98, 48.15 m.

Perhaps one of your readers would give me information on Mozambique P., East Africa? Wishing you and your paper every success.—F. J. WALTERS (Bristol 8).

Meter-range Multipliers

SIR,—I should like to join with others in an expression of appreciation for the high standard PRACTICAL WIRELESS maintains in these difficult times.

It is very seldom that I don't find something in an issue of benefit to me personally; but the April issue I found full of good features. The article by 2CHW on "Meter-range Multipliers" was exceptionally good; it is clear and explained in such a way as to be quite easily absorbed, and had it been written for my special benefit it couldn't have filled the bill better.—A. B. HAYES (Swinton).

Absence of L.T.

SIR,—I notice in the "Open to Discussion" page of the May issue a query regarding the "Absence of L.T." in which F. Brook (Maidstone) attempts to correct S. B. (St. Albans) when he himself does not know what he is talking about. More damage will result in a valve when H.T. is connected before applying L.T. than L.T. on and no H.T. In case he cannot understand how this is so, let me take this opportunity of informing him for future reference.

If L.T. is applied when there is H.T. already on the anode, the sudden attraction before the heaters or filments are "warmed-up" is responsible for the flaking that occurs of the thorium or oxide coating and so damages or reduces the life of the valves. It is *far* safer to have L.T. on before H.T. is applied to the anode of any valve.—J. SHINE (Bury St. Edmunds).

Old Sets

THERMION,—I read with interest your paragraph in the May issue of PRACTICAL WIRELESS concerning simple sets of 10 years or so ago. The following are details of an old set I modified a few months ago and keep as a stand-by receiver.

The set is a two-valve A.C. mains made in 1929 or '30 for use with separate speaker—original valve sequence, DHFW rectifier, AC/HL, PM24A output.

Modifications: Triode detector changed to screen grid (Marconi M54B) as per P. W., April 1942. Mazda ACP valve fitted in place of PM24A.

The set will now work an 8in. PM moving-coil loudspeaker at quite a respectable volume, and will separate each station, although it will only get four or five. I am still using the original rectifier, which still tests out O.K. The only new component purchased was a 700 ohms resistor for the bias on the ACP valve.—L. KEEN (Upminster).

Identification Wanted

SIR,—Has any short-wave fan information about or heard a station broadcasting in Portuguese on approximately 27 metres?

I heard this station broadcasting in the Portuguese-Brazilian style. It closed down at 9 p.m. D.B.S.T. with chimes. The words "Emissora Nacional." were frequently repeated. This transmission was sandwiched between WCBN, 26.9 m., and CSW6, 27.17 m. (CSW6 also repeats the words "Emissora Nacional.")

I would be greatly obliged if anyone has any knowledge of this station.—J. M. EALEY (Swindon).

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RADIO and Electrical Engineers' ex. Government Side Cutters, 22/6 ½ doz.; long nosed insulated pliers, 22/6 ½ doz.; 42/- doz. prs. Carriage paid. Guaranteed brand new Mains Transformers, 4v. or 6v. Heaters, 80 ma., 28/6; 120 ma., 37/6. Multi Output Transformers, standard size, 6/6. Carriage paid orders £5. S.A.E. for list Radio-Spares.—A.D.S. Co., 261-3-5, Lichfield Road, Aston, Birmingham, 6.

SYNCHRONOUS MOTORS, "Sangamo," 200-250 volts A.C., 50 c., self-starting, fitted Reduction Gears. **Ideal Movements for Time Switches, Industrial, Dark Room, Electric Clocks, etc., Rotor Speed 200 r.p.m. Final Speeds available, 1 rev. 12 mins., 22/6; 1 rev., 30 mins., 25/-; 1 rev., 60 mins., 25/-.** Consumption 2½ watts. Size 2½x2½x1½.

15 Amp. Mercury Switches, enclosed bakelite tubular cases, 2½in.x½in., fitted swivel saddle, connector block, etc., 5/6 each.

Electro Magnets, 200-250 volt A.C., resistance 300 ohms, 1½x1½in., 3/6 each.

Wire-wound Non-Inductive Resistances, 2 watt. Ideal for Meter Shunts, Resistance Boxes, etc., 2½ per cent. accuracy, wound on bakelite bobbins, ⅞x⅛in. One of each of the following ratings, 25, 50, 100, 200, 400, 600, 1,000 and 2,000 ohms, 5/6 per lot, postage paid, quantities available.

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Projection Lenses, 1in. Focus, ideal for 9.5 or 16 mm. Films, Soundheads, etc. Oxidised Mounts, 1½in. long, 9/16in.diameter, 5/- each. Terms cash with order.

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STOLEN.—£15 reward for information leading to the recovery of either: 17-valve Midwest radiogram, Garrard single gramo. Large square multi-colour tuning dial, model C.T.-17, horn in baffle box. Also 15-valve McMurdo silver C/P chassis, separate power amplifier, and 45lbs. Jensen horn. Valves in tuner 7/56s. 1/57 3/58s in amplifier 2/45 2/80s.—Mackenzie Ross, Villina, Angmering-on-Sea. Sussex.

NEW components: British and U.S.A. valves. Tubulars, .0001-.01 mfd., **8d.**; .1 mfd., **10d.** Resistors, 1 watt, **10d.**; ½ watt, **8d.** Volume controls, **4/6**; with switch, **5/6.** "P" type coils, A. and H.F., M.W., **4/-** per pair. Droppers, .2 amp., **5/-**; .3 amp., **5/6.** Push-back wire, **3d.** per yd. Single bell wire, **2d.** per yd. Bulb holders, **6d.** Valveholders, **9d.** Systoflex, **3d.** per yd. Bias electrolytics.—Johns, 56, Hughes Avenue, Horwich, Lancs.

WANTED, new or second-hand, two "Wearite" iron-cored coils, type T.G., and one ditto, type A.D.—Particulars to 70, Enborne Road, Newbury.

FOR SALE, new and second-hand components, valves and books. Send S.A.E. for list.—137, Randall Avenue, Cricklewood, N.W.2.

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Full constructional details, circuit, and full-size prints of assembly and wiring plans, of Tested and Guaranteed Designs.

JUST RELEASED. A Real Midget all-dry batt. Two-valver. Powerful phone results. 9v. H.T. Size 5½ x 5½ x 3½ins. The ideal Set for personal listening. No. LO/M. **2/6.** Three-valve Push-pull Amplifier. Batt. Quality output. No. LO/Q3. **2/6.**

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AMPLIFIERS. 6-8 Watt A.C./D.C. Portable. Neg. Feed-back; P.P. Output. No. LO/QA4, 3/6; 3½ Watt A.C., ideal for P.U., etc., 2/6; Two-valve (Batt.), **2/6.**

SHORT WAVE. A Super battery-operated Two-valver for DX work, **2/6.** Sets (with coil details): Crystal Set (LO. 1), **1/6**; "Straight" Three Batt. (LO. 3), **2/-**; A.C. Two-valver (LO. 5), **2/6.**

Please include stamp with orders, inquiries or for full List.—**L. ORMOND SPARKS (P), The Constructor's Consultant, 9, Phoebeth Road, Brockley, S.E.4.**

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WANTED.—Regentone Remote Control Unit, also R.K.62 gas-filled triode.—Potter, 27, Kingsfield Drive, Manchester, 20.

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SERVICE KITS. No. 1: One 8 mfd. tub. 450v.; one 2 mfd. 25 v. can. 6, 05 tubs. **11/6.** No. 2: Two 16 mfd. tubs. 450 v.; one 100m.a. choke, one doz. asstd. conds., one mains dropper, **30/6.** No. 3: Four 8 mfd. tubulars 450 v.; two 2 mfd. Mansbridge, 24 asst'd tubs. and ceramics, **32/6.** Rotary Converters 11 v. in 480 v. out at 40 m.a., **35/6.** Heavy duty smoothing chokes (ex H.M.V.), **12/-** ea. Celestion speakers 6in. P.M. with trans., **26/6** ea.; 8in. less trans., **21/-** ea. Rola mains energised, 1,000 ohm field, **30/-** ea.

TUNING Condensers: Midget 2-gang, **13/6**; 3-gang, **10/-**. Short-wave precision job on ceramic base, **8/6.** Yaxley type switches, 4-pole 2-way, 3-pole 4-way, **3/9** ea.; 2-pole 2-way, **2/6** ea. Yaxley replacement wafers 2-pole 4-way, **6/6** doz. Volume controls, ¼, ½, 1, 2 meg. with switch Centralab **6/-** ea. Dubilier less switch, all values, **3/-** ea.

LITZ wound M.W. coils P type A. and H.F., **5/6** pr. Push-button units ex R.D.G. with all-wave coils, pads and trimmers (faulty), **15/-** ea. Sleeving 1 mm., **2/-** doz. yds.; push-back wire, **2/-** doz. yds. Mansbridge condensers ex G.P.O. 2 mfd. 350 v., **2/-** ea.; 1 mfd., **1/-**. Dials: Marconi, glass three band, **1/6** ditto; ditto vertical type, **2/-**. Ivorine dials Home, Forces, etc., **2/-** ea. Paper dials for Midgets, **8/-** doz.

THIS MONTHS SPECIAL OFFER: 110 kc. I.F. trans. and osc. coils, ex Ekco, **5/-** per set. Send S.A.E. for latest list; now available. Terms: Cash or c.o.d. over £1.—**Charles Britain Radio** (temp. address), "Eureka," Surrey Gardens, Effingham, Surrey.

THE SIMPLEX FOUR. Constructional details of this most successful midget 4 valve, T.R.F. receiver (total cost of construction, £9), comprising theoretical, and full-scale layout wiring diagrams, together with instructions, per copy, **4/6.**

MIDGET COILS, midget aerial and H.F. medium wave, T.R.F. high gain coils, **9/-** pair, midget short wave aerial and oscillator coils, I.F. at 465 kc/s, **5/6** pair, ditto medium wave coils, **9/-** pair. Standard M. and L. wave coils, with reaction, boxed with circuit, **12/6** pair.

MIDGET CHASSIS, de luxe, sprayed grey, drilled for 4 valves, 10½×6×2in., **9/6.** The "Simplex" midget chassis, drilled for four valves, with all component fixing holes, together with cut out for speaker mounting, etc., electro zinc finish, 11×4½×2in., **7/6.**

MIDGET chokes, and speaker transformers, **7/6** each.

MIDGET dials, medium wave, station names, etc., ivorine, 4×3½in., **2/-**.

MIDGET knobs, black and brown, and standard knobs, **9d.** each, **8/-** doz.

PUSH BUTTON 6-way units, complete with knobs and escutcheon, **5/6.**

DROPPERS, 800 ohms, 0.3 amp., with fixing feet, and two variable sliders, **5/6**; superior quality ditto dropper, **7/6.**

AMPLIFIER cases, comprising chassis, undrilled, with grilled cover, detachable, sprayed dark battleship grey, overall size, 17½×8½×10in. the quality housing for quality amplifiers, **57/6.**

LINE CORD, superior quality, 3-way, 60 ohms per foot, 0.3 amp., **6/6** yard, ditto 2-way, **5/-** yard.

CONDENSERS, electrolytic, 250 mfd., 25 V.W., **4/6**; tubular paper, 9.1 mfd., and 0.01 mfd., **9d.** each; silver mica, 0.002 mfd.; and 0.0023 mfd., **6d.** each.

VOLUME CONTROLS, long spindle with switch, 50,000 ohms, 1 meg. and 2 meg., **6/6** each.

CHOKES, heavy duty, 120 m/a, 200 ohms, **15/-**; 80 m/a, 500 ohms, **12/6.**

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