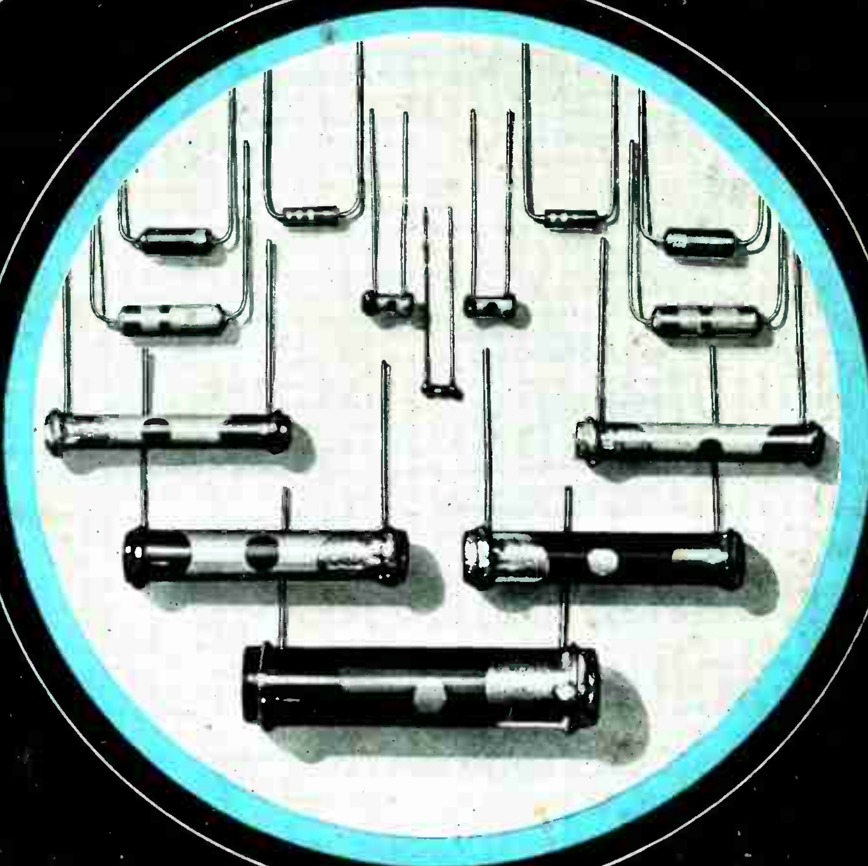
Wireless World

RADIO · ELECTRONICS · ELECTRO-ACOUSTICS



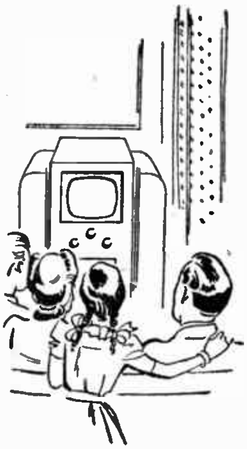
DEC. 1944

1/6

Vol. L No. 12

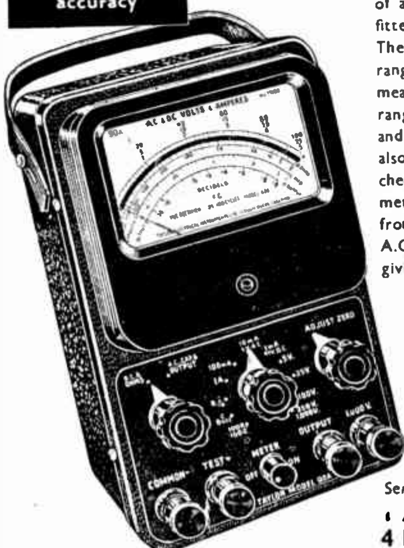
IN THIS ISSUE: FEEDBACK AND THE LOUDSPEAKER


AVO
REGD. TRADE MARK
On Active Service
MODEL 7
UNIVERSAL
AvoMeter
"AVO" Electrical Testing Instruments are maintaining on active service and in industry the "AVO" reputation for precision and reliability. Orders can only be accepted which bear a Government Contract Number and Priority Rating.
AVO
MEANS
ACCURACY



MODEL
90A
40 RANGES
First grade accuracy

TAYLOR UNIVERSAL METER
1,000 OHMS PER VOLT



This new and improved Universal Taylormeter gives a wide range of accurate measurements of both D.C. and A.C. The meter is fitted with a knife edge pointer and mirror and has four scales. The outer scale is 4 inches long and is used for all D.C. and A.C. ranges. The other scales are for Resistance, Capacity and Decibel measurements. The instrument is of First Grade accuracy on all ranges. An internal battery is supplied for Resistance measurements and covers from 1 Ohm to 1 Megohm and in addition a buzzer, also working off the internal battery, is also fitted for continuity checks. Automatic Overload protection is fitted to protect the meter against severe overloads. Three capacity ranges covering from ·0002 μFd. to 100 μFd. are available using an external source of A.C. The instrument reads full scale on 1 mA D.C. and A.C. giving 1,000 Ohms per Volt.

We are very busy supplying large quantities of special test equipment and measuring instruments for the use of the armed forces and our equipment is now in use all over the world.
Our customers will understand why our instruments are now in such short supply and why delivery is often delayed.
Please send us your enquiries for test equipment or measuring instruments and we will be pleased to do our very best in meeting your requirements.

Size 8" x 5¼" x 3⅞" deep
Price £14.3.6
Please write for technical brochure

Taylor electrical instruments ltd.

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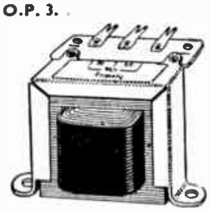
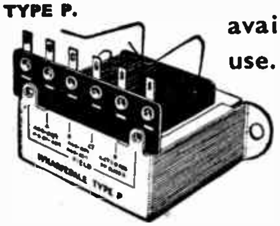
TAYLOR ELECTRICAL INSTRUMENTS LTD., 419-424 Montrose Avenue, Slough, Bucks.
Telephone: Slough 21381 (4 lines) 'Grams: "Taylins, Slough"

Wharfedale
OUTPUT TRANSFORMERS

O.P. 3.



TYPE P.



Are still on National Service and only a small margin is available for Civilian use. These restricted Supplies go to old Customers at the following Prices:—

OUTPUT TRANSFORMERS		Price
O.P. 3	3 ratios	5/6
Type P	4 ratios with C.T.	6/6
G.P. 8	8 ratios with C.T.	9/6
Type 34	6 ratios with C.T.	12/6

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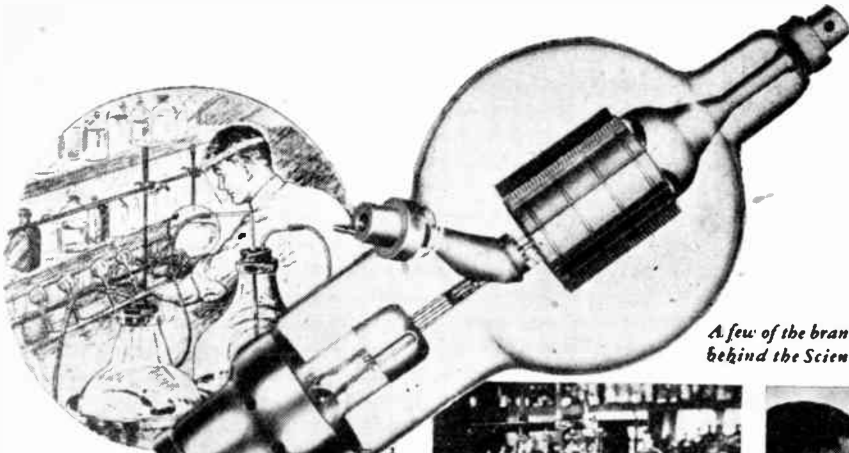
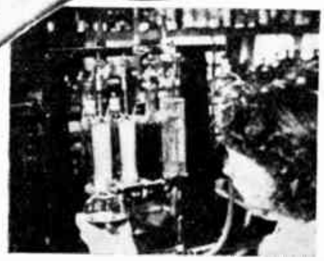
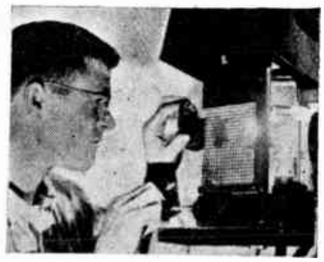


A few of the branches of the Science behind the Science of Electronics



CHEMISTRY—*Making Gas Analysis in the Eimac Laboratory*



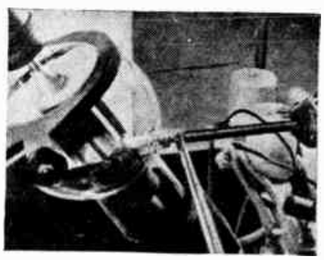
METALLURGY—*Spectrographic Analysis of the Rare Metals Used in Vacuum Tubes*

VACUUM TECHNOLOGY—*Constant Research to Develop Better Vacuum Techniques*

PHYSICS—*Actually Viewing Emission of Electrons with Electron Microscope*

ELECTRONICS—*Determining Facts about and Recording Data on Vacuum Tube Capabilities*

OPTICS—*Studying the Effect Processing has on the Structure of Materials Through Photomicrographs*



GLASS TECHNOLOGY—*Special Equipment and Technique to Produce Complicated Glass Structures*

the *Science* behind the science of electronics

The pattern of progress in the science of electronics is determined by the achievements in creating and developing new and more efficient electron vacuum valves. Therefore the whole complex task of vacuum valve development—involving the intelligent application of many sciences—comprises the real science behind the science of electronics.

To create and produce the modern vacuum valve requires experience and skill of the highest order in these many sciences in addition to complete facilities for their application. The list includes everything from chemistry and metallurgy—the technology of glass fabrication and vacuum pumping—to physics, optics, thermo-dynamics and most important of all—Electronics.

The resources and resourcefulness of Eimac laboratories have accounted for many outstanding contributions to the science of Electronics. A fact which is attested to by the leadership which Eimac valves enjoy throughout the world. These comprehensive facilities are continuously being utilized to achieve better and better results for the users of Eimac valves.

Eimac Engineering is devoted solely to the development and production of electron vacuum valves. However, since the electron vacuum valve is the heart of all electronic devices it is advisable for users and prospective users of electronics to look first to the vacuum valves required. A note outlining your problem will bring advice and assistance without cost or obligation

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SKW. 1 32-mfd. Aluminium Can Electrolytic 320 v. and 25 asstd. T.P. Condensers, Resistors, Trimmers and S/Mica Condensers, **12/9.**

SKX. 1 8-mfd. 400/500v., 1 32-mfd. Aluminium Can Electrolytics, 18 asstd. T.P. Condensers, Resistors, Trimmers and S/Mica Condensers, **19/6.**

SKY. 1 8 × 8-mfd. 450 v.; 1 8-mfd. 400/500 v.; 1 40-mfd. 250 v. Electrolytics, 25 asstd. T.P. Condensers, Resistors, Trimmers and S/Mica Condensers, **35/-.**

SKZ. 1 8-mfd. 400/500 v.; 1 24-mfd. 250 v.; 1 32-mfd. 325 v.; 1 16 × 16-mfd. 350 v. Electrolytics; 6 each Trimmers, S/Mica Condensers and T.P. Condensers, **37/6.**

RADIO MECHANIC'S KIT

3 Spanners, 3 Screwdrivers, 1 coil Insulating Tape, 12 cards Fuse Wire, 3 lengths Systoflex, 1 Instrument Test Lead with clips and plugs, 1 Universal Voltage dropper resistance, 1 465 KC. I.F. Transformer, Iron Cored, 1 set Aerial and Oscillator Coils Litz Wound, 16/2,000 metres. 1 8-mfd. 400/500 v.; 1 8 × 16-mfd. 350/450 v.; 1 8 × 8-mfd. 400 v.; 1 32-mfd. 325 v.; 1 40-mfd. 250 v.; 1 24-mfd. 250 v. Electrolytics; 150 asstd. T.P. Condensers, S/Mica Condensers and Resistors, 6 asstd. Volume Controls (wire wound), **£6.6.0.**

SPECIAL KIT

6 8-mfd. 400/500 v.; 6 32-mfd. 320 v.; 3 16 × 8-mfd. 400 v.; 3 40-mfd. 250 v. Electrolytics; 1 set Aerial and Oscillator Coils; 1 pair I.F. Transformers, 465 KC. Iron Cored; 3 B.A. Box Spanners; 3 Fine Screwdrivers; 1 Test Lead and clips; 2 voltage droppers, .2 and .3; 2 Output Transformers; 1 6 v. Mains Transformer; 6 Wire Wound Volume Controls; 200 asstd. Tubular Paper Condensers, Silver Mica Condensers, Trimmers and Resistors; 24 asstd. 4 7- and 8-pin Valve Holders; 1 reel Insulating Tape; 6 Fuses, **£16.16.0.**

VALVES. American Types at B.O.T. controlled Retail Prices. For replacement purposes only. 6F5, 12F5, 12J5, 12SF5, **9/2**; 5Y3, **25/6**, **11/-**; 6Q7, 12Q7, **11/7**; 6F6, 6K6, 6K7, 6L7, 12J7, 12SJ7, 36, **12/10**; 6A8, 6B7, 6SA7, **14/-.**

Also British Valves at manufacturers' List Prices. AC/ME, **10/6**; 80, 6X5, UU4, UU6, UU7, **11/-**; HL41DD, TDD4, **11/7**; AC/VP2, CL4, EF39, KTW61, Pen 45, SP41, SP42, T41, VP41, **12/10**; D1 diode 1in. Peanut Valve with valveholder, **12/10**; ECH3, FC13, X63, 12Z3, 25Z5, 35Z4, 35Z5, **14/-**; AC6Pen*, EL35, Pen 46*, U21, **18/3.**
* Post Office Permit necessary.
Prices include Purchase Tax. Add 3d. per valve post.

VALVEHOLDERS—AMPHENOL TYPE. International or English Octal, chassis mounting, **1/-.** English Wafer type 4-, 7-, 8-pin, 6 for **2/6.**

CAR AERIALS. Telescopic, scuttle fixing, extending to 4ft. 6in. Ebonite Insulators, nickel finish, **22/6** each.

WANDER PLUGS in 2 colours, **3/-** per doz.

ELECTRIC SOLDERING IRONS, 60 watt, 200/250 v., AC/DC. Chrome Plated, usually 13/9, **9/6.**

LOUDSPEAKER FRETS. Coppered brass, 8½ × 7in., **3/6**; 14½ × 9½in., **8/9.**

SCREENED INTERLACED FLEXIBLE MICROPHONE CABLE. Twin, 6 yards for **6/9.**

SPECIAL OFFER. Best Galvanised Bolts and Brass Nuts, 0, 2, 4, 6 B.A. Large assorted packet, **3/6.**

IRON LEADS, with connector, 23/36 Circular Flex, **3/6** each.

LINE CORDS. 3-way heavy duty, .3 amp., 360 ohms, **9/6**; 480 ohms, **13/6**; 600 ohms, **15/9.**

CONDENSER DRIVES, slow motion, ¼in. spindle, 3 : 1, **1/6** each, extension spindle, ¼in., **9d.** each.

FUSE BOXES, twin, best bakelite, with two glass fuses, **2/6** each.

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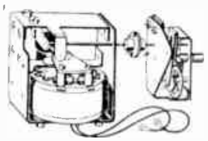

200/250v. A.C. 12 m.a. suitable for electric clocks, etc. Supplied complete with gears, ea. **27/6**

RELAYS complete with circuit breaking switch. 200/250v. A.C. 60/80v. D.C. 300 m.a. 15 amp. switch ... ... each **7/6**

Relay and Metal Rectifier and Mains Transformer complete. Input 200/240v. A.C. Output 12v. D.C. 150 ohm. 20 m.a. **35/-**

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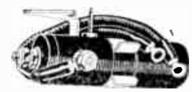
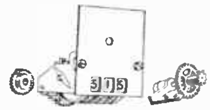


10/15 amp. in Ebonite containers, suitable for Thermostatic control of Electric Water Heaters and relay circuits ... ... each **6/6**

VIBRATORS. 4-pin 6 volt, best quality American ... ... each **15/6**

REVOLUTION COUNTERS



0-999 with gear drive and gears ... each **3/6**

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Heavy duty for 16 m/m film projectors, etc. Input 200/250 volts. Output 50/110 volts, 1,250 watts.

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1-WATT CARBON RESISTORS. Manufacturers' type, values unmarked, but ranging 20,000 ohms to 3 meg. Unique opportunity, **7/-** per 100.

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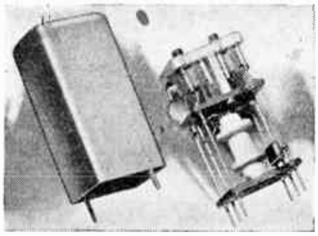

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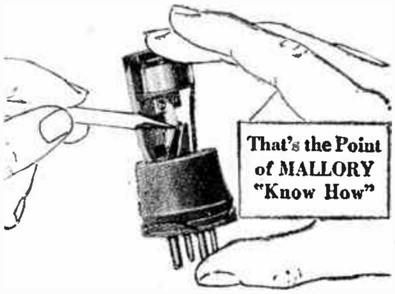

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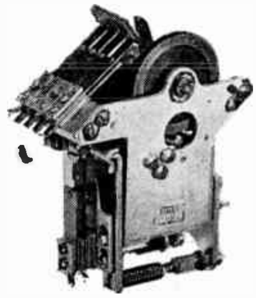

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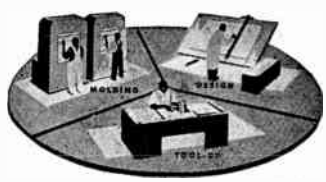

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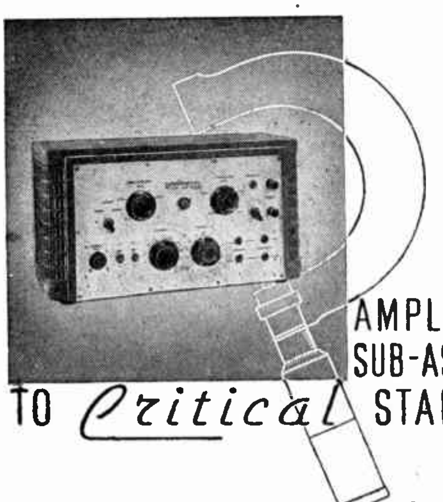

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The Wireless World test report confirms that it is "suitable for serious work."

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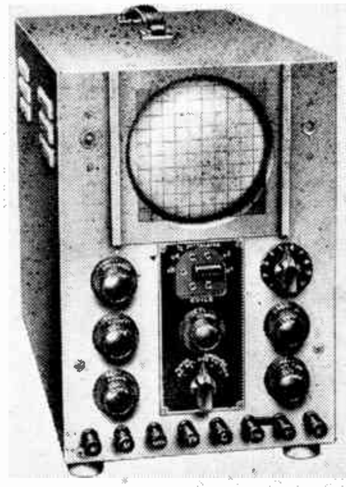

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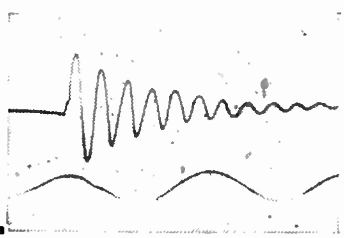

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Wireless World

Radio • Electronics • Electro-Acoustics

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Wireless World

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Monthly Commentary

Post-War Austerity

It would be ridiculous to deny that the elemental needs of life such as food, shelter and clothing must always take precedence over artificial luxuries. When the war ends there will be a shortage of these necessities for the civil population and for men demobilised from the Forces; the diversion of our national resources to meet this shortage must naturally be given the highest priority. No wireless man is likely to be so blinded by his own specialised interests as to claim seriously that matters should be arranged otherwise. He would not plead that, say, broadcast receivers should come before the houses in which they will eventually be installed.

But there seems to be a risk that this idea of post-war austerity may be overdone, so far as the wireless industry is concerned, and that a policy of catering for the bare minimum of public requirements for a long and indefinite period may have disastrous results. The industry is a highly technical one, and perhaps its greatest asset will be the large reserve of highly trained and experienced technical man-power that will be available to it after the war. If, through the policy of the industry or through Government direction, that man-power is unnecessarily diverted into other fields, British radio in all its branches will suffer a loss from which it may take a long time to recover.

Of course, it must be conceded that so far as broadcast receivers are concerned, the industry might well devote the immediate post-war period to the production of simple sets for the replacement market. But, while it is doing this it should be planning more ambitious sets to be put into production as soon as materials and man-power become available. It cannot be too strongly urged that, without a flourishing home market in such specialised apparatus, we cannot expect to secure a reasonable share in export trade.

It has long been a matter for reproach that too many sections of the broadcast receiver industry have tended to ignore the specialised type of set, and with few exceptions, have concentrated their efforts on productions of basic uniformity which depend for their individuality on external or superficial details. This theme is expanded elsewhere in this issue by a contributor who describes in some detail the various types of receiver for which he considers a large demand will exist. It cannot be denied that if a general manufacturing policy on the lines described could be successfully embarked upon, the home market should be able to "carry" a large and flourishing export trade.

✦ ✦ ✦

Radio Heater Interference

Elsewhere in this issue a contributor makes some constructive suggestions for controlling the radiation of interference from radio-frequency heating equipment. Though this method of heating may well become industrially the most important of all the offshoots of wireless technique it is likely to suffer many setbacks unless the question of interference is tackled vigorously and rationally from the outset. That the problem is a serious one cannot be denied, from both the technical and legal aspects.

In effect, our contributor pleads for a spirit of sweet reasonableness in the official control of radiation, and that each case should be taken on its merits. With that contention few will disagree; the technique of radio heating is so new, and its applications so little explored, that any attempt to frame strict regulations would inevitably hamper its development.

One of the proposals is that the location of the radiating apparatus, as well as the radiated field of interference, should be taken into account. To take a very simple hypothetical case, a higher level of radiation on a frequency of 500 kc/s (the international maritime distress call frequency) would be permissible from apparatus installed at an inland factory than from equipment working at a site near the coast.

Until fuller experience of the working of radio heaters is gained, a "code" such as that proposed by our contributor should, we think, enable the radiation of interference to be kept within reasonable bounds, provided that those responsible for operating the gear are alive to their responsibilities. But, before any code can become fully effective and its administration be practicable, we think that steps must be taken to establish the principle that interference from a radio heater with legitimate wireless reception is a "nuisance" in law.

FEEDBACK AND THE LOUDSPEAKER

A Little is Good : More May Not Necessarily be Better

By S. W. AMOS,
B.Sc. (Hons.), Grad.I.E.E., A.M.Brit.I.R.E.

Due to the variation of loudspeaker impedence with frequency and the consequent change of voltage across the speech coil, negative feedback may result in loss of "top." This article points out the pitfalls and shows how they may be avoided.

IT is well known that if a moving-coil loudspeaker is driven by a pentode or tetrode valve (or any other type of generator which may be regarded as a source of approximately constant current) an excessive high note response results. It is customary to overcome this tendency by the use of negative feedback or by means of a condenser connected across the output transformer primary. It is instructive to enquire the reason for this excessive "top lift." It is due to the fact that the speech coil of a moving-coil loudspeaker is not a pure resistance but has inductance also. In order to understand the mechanism of the process consider the diagram of Fig. 1, which illustrates a somewhat simplified version of the full electrical equivalent circuit of a moving-coil loudspeaker.* In this R and L represent respectively the resistance and inductance of the speech coil. Using the conventional electro-acoustic relationships L_m is intended to represent the mass of the diaphragm together with that due to the air load (the "accession to inertia" of McLachlan) and C_s represents the "compliance," i.e., the reciprocal of the total stiffness (that of the centring spider, the surround of the speaker diaphragm and the added stiffness supplied by the air load). Lastly, and this is most important for the solution of our problem—a certain additional resistance R_r is "reflected" into the electrical impedance of the loudspeaker which represents the actual power which is radiated by the loudspeaker in the form of sound. We could call it, in fact, the "radiation resistance" of the loudspeaker. The power developed in the resistance R of Fig. 1 is sheer waste : it serves only to heat up the wires of the speech coil. The only useful power is that developed in the radiation resistance, and in order to solve our problem we have only to decide how the current in R_r varies with frequency for triodes and pentodes.

The impedance measured across the terminals AB in Fig. 1 varies somewhat as shown in Fig. 2, which is taken from "Radio Designers' Handbook" by F. Langford Smith (p. 20). The figure commonly quoted for the impedance of a loudspeaker is the value at 400 c/s at which frequency the impedance is approximately a pure resistance. At very high frequencies, say 10,000 c/s, the impedance is predominantly inductive. Suppose the impedance is 2 ohms at 400 c/s and 12 ohms at 10,000 c/s. The usual matching rule for triodes is that the load should be twice the valve impedance, at 400 c/s ; this calls for a generator resistance (r_a in Fig. 3) of 1 ohm. This will be the value of the anode AC impedance of the triode reflected in the secondary side of the output transformer. The current in the circuit is thus : $\frac{E}{1+2} = \frac{E}{3}$ at 400 c/s and $\frac{E}{1+j12}$ which is roughly equal to $\frac{E}{12}$ at 10,000 c/s. Hence at 10,000 c/s the current falls to one quarter of its value at 400 c/s. This naturally tends to cause a falling-off in the radiation from the loudspeaker at high frequencies, but this is off-set by several factors. One is that L_m gets smaller, so increasing the current in the secondary circuit of Fig. 1 as the frequency rises, for the area of the diaphragm which radiates effectively gets progressively smaller until ultimately at 10,000 c/s only the inner radius of the cone (if any part at all) is useful. Also, as frequency increases the radiation from the loudspeaker becomes more and more concentrated into a beam along the axis. This also tends to increase the apparent output at these high frequencies. It is interesting to consider how the PD across the speech coil varies with frequency. At 400 c/s the PD developed across the speech coil is $\frac{E}{3} \times 2 = \frac{2E}{3}$ volts and at 10,000 c/s this becomes $\frac{E}{12} \times 12 = E$ volts. At 10,000 c/s, therefore, the PD increases to 1.5 times its value at 400 c/s. This is a slight increase, and may very easily be masked in practice by the usual falling-off in output transformer performance at such high frequencies. If for any reason one applies negative feedback to a triode ("gilding the lily," of course) the output voltage will become constant and so the current will fall at 10,000 c/s to even less than its normal quarter of the value at 400 c/s. We shall therefore lose "top" and the loss will be 20 log 1.5 = 3.5 db.

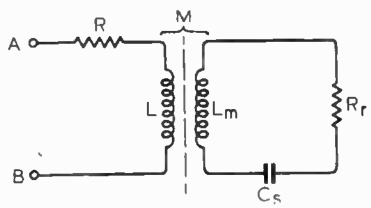


Fig. 1. Equivalent electrical circuit of moving-coil loudspeaker.

If the generator feeding the loudspeaker is a pentode, then at 400 c/s the impedance at the transformer secondary will, in practice, be about five times that of the loudspeaker, i.e., about 10 ohms. Thus the current will be $\frac{E}{10+2} = \frac{E}{12}$. At 10,000

* *See* "Fundamentals of Radio," by F. E. Terman, p. 433.

c/s this falls to $\frac{E}{10 + j12} = \frac{E}{16}$ roughly, so that the change in current is in the ratio 4 : 3. The current is then very roughly constant, which means that the current in the radiation resistance at high frequencies is far more than is necessary to produce the required effect. This, then, is the reason for the excessive high-note emphasis given by pentodes. It is due to the fact that the reactance of L_m is too small, compared with the effective R_a of a pentode at the secondary of the output transformer, to reduce the current to the right proportion. For the triode the ratio was 1 : 4 so that the audible difference between their respective performances at 10,000 c/s is given by 20 log $4 \times \frac{3}{4}$ = 20 log 3 = 9.5 db. which agrees well with aural estimates of the superiority of the pentode over the triode as far as "top" is concerned. The PD across the speech coil, for the pentode, rises from $\frac{E}{12} \times 2 = \frac{E}{6}$ at 400 c/s to $\frac{E}{16} \times 12 = \frac{3E}{4}$ at 10,000 c/s, a rise of 4.5 times. If considerable feedback is used here, sufficient in fact to keep the PD constant, then the audible loss of top will be 20 log 4.5 = 13 db. To reduce the top to the level given by a triode, a loss of 9.5 db. is called for. So here again excessive feedback causes frequency distortion. Evidently there is an optimum degree of feedback to apply to a pentode; it is that value which reduces the R_a of a pentode to a value typical of a triode. If it is reduced below that value then "top cut" occurs. This "top cut," though it is not a severe loss (only 3.5 db. in the above calculation), seems to be very obvious in the reproduction from amplifiers using output pentodes and considerable feedback. There is a peculiar "deadness" about the quality which is very depressing, and some means of counteracting it is desirable. There are two possible courses to adopt: either one can calculate the necessary degree of feedback to give the right amount of high note loss, or else—and this is possibly the better way—one can use a large degree of feedback (thus achieving considerable damping and great reduction of harmonic distortion) and apply "top boost" artificially, either by including tone control circuits outside the feedback loop or making the feedback frequency discriminating.

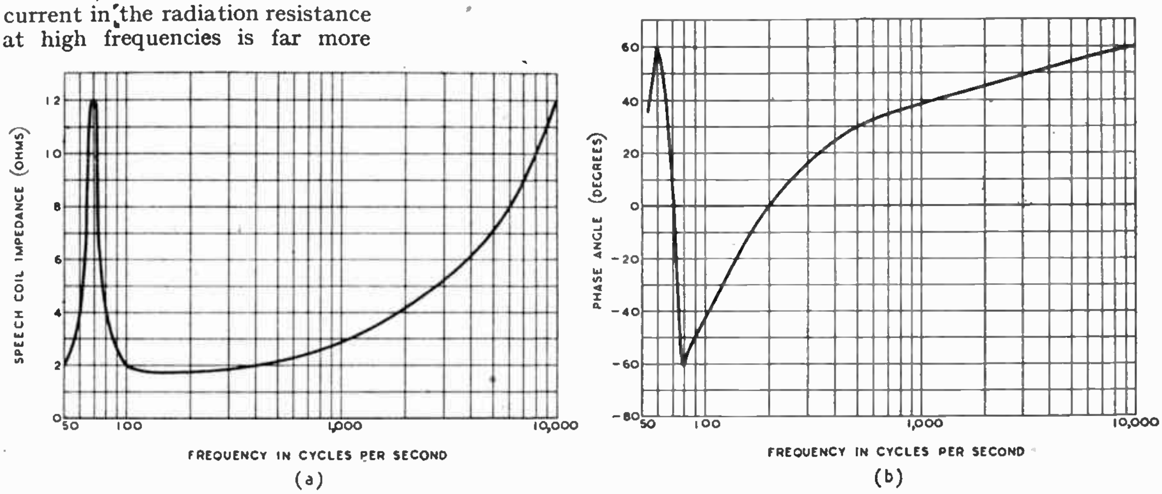


Fig. 2. Variation with frequency of speech coil impedance (a) and phase angle (b) of moving-coil loudspeaker.

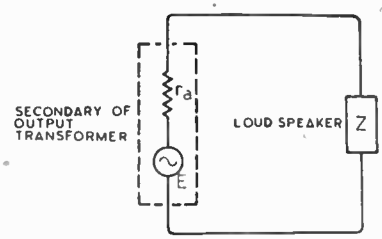


Fig. 3. Essential elements of output circuit; r_a and E are the equivalent valve AC resistance and EMF appearing at the secondary of the output transformer.

There is also a rise in loudspeaker impedance at a low frequency, as shown in Fig. 2(a). This may be explained very easily with reference to Fig. 1. It is clear that maximum current flows in the secondary circuit at the resonant frequency of the tuned circuit formed by the inductance L_m and the capacitance C_s. This is known as the bass resonant frequency of the loudspeaker, for it usually occurs between 50 c/s and 100 c/s, and at this frequency the rise in impedance is of the same order as the rise at 10,000 c/s, i.e., it is about six times the value at 400 c/s; but there is this difference about the low-frequency resonance, namely, that the impedance of the speech coil becomes purely resistive at this frequency. This rise in impedance has the same consequence as the high-frequency rise, namely, that an increase in the PD across the speech coil occurs, the increase being small in the case of a triode generator and considerable for pentode or tetrode output valves. As in the case of the high-frequency impedance rise, this increase in impedance brings about a fall in output power when the generator is a triode and an increase in power when a pentode is used. The drop in power with a triode is generally offset by the increase in efficiency of the loudspeaker which occurs at the bass resonant frequency. It follows, therefore, that pentodes give an abnormally high output power at the bass resonant frequency. Any undue rise in output power here is undesirable, of course, so that

Feedback and the Loudspeaker—
there is no question of there being an optimum value of feedback to cure it. The more feedback the better as far as the low frequency resonance is concerned. Suppose we wish to apply negative feedback to an amplifier with the circuit diagram given in Fig. 4. This has a push-pull output incorporating two pentodes. Let us suppose that these are of the PEN 45 type, which can accept a maximum input peak signal of 8 volts. If the HT supply is, say, 250 volts, then the anode potentials of each valve will probably swing from 50 to 450 volts (peak value 200 volts) when the valves are delivering their maximum power utput. This represents an amplification of $\frac{200}{8} = 25$ times. The phase-splitter will probably give a stage gain of $\frac{4}{5}$ times and the preliminary AF stage, if the valve is of the SP41 type, can be made to amplify 200 times*, so that the overall gain, from first grid to final anode, is $200 = \frac{4}{5} \times 25 =$ 4,000 times. The necessary peak input for maximum power output is hence $\frac{200}{4{,}000} = 0.05$ volt. We want to apply negative feedback.

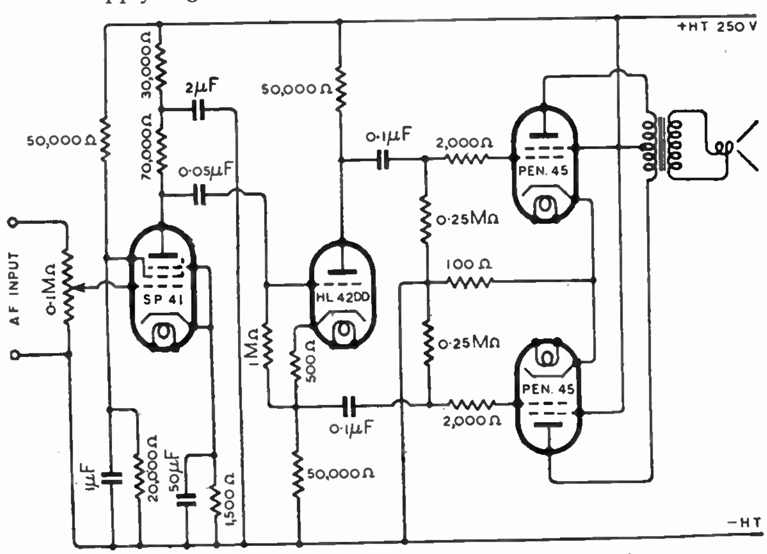


Fig. 4. Basic circuit of the amplifier used by the author.

One way of applying feedback is as shown in Fig 5, in which for convenience the circuit has been considerably simplified. Suppose we decide to use the optimum degree of feedback. It is known that the anode AC resistance R_a of a valve is effectively reduced by the use of negative feedback according to the expression:

$$R_a' \text{ (}R_a\text{ with feedback)} = \frac{R_a}{1 + M\beta}$$

in which M = amplification without feedback and β = feedback fraction.

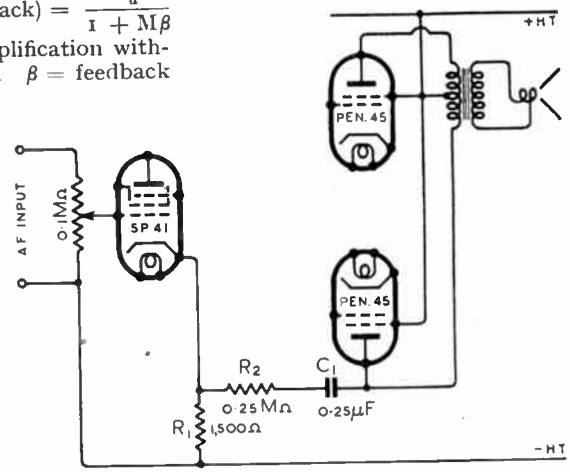


Fig. 5. One method of applying optimum feedback to the amplifier of Fig. 4.

Rearranging this, we have

$$\beta = \frac{R_a - R_a'}{MR_a'}$$

and putting R_a = 50,000 ohms, R_a' = 2,000 ohms and M = 4,000 for the problem under consideration we find

$$\beta = \frac{50{,}000 - 2{,}000}{4{,}000 \times 2{,}000} = \frac{6}{1{,}000}.$$

The input then necessary for maximum output will be approximately $\frac{200 \times 6}{1{,}000} = 1.2$ volts peak, which is quite a convenient value. This represents a considerable degree of feedback and reduces all forms of distortion in the ratio of

$$\frac{1}{1 + M\beta} = \frac{1}{25}$$

so that the performance of the amplifier can be considered satisfactory.

Suitable values for R_1, R_2 and C_1 to give the calculated degree of feedback are 1,500 ohms, 250,000 ohms and 0.25 μF respectively. The author has been using for some time an amplifier employing the circuits of Fig. 4 and Fig. 5 and using the values of feedback components just quoted, and its performance is particularly pleasing.

As the degree of negative feedback has been calculated to give a level frequency response, there is no point in including condensers across the primary of the output transformer. If these are included, then frequency distortion will be introduced.

If it is desired to take the feedback voltage from the secondary of the output transformer, then the above calculations can be repeated for the new value of voltage gain. Suppose the output valves are rated to give 8 watts and that the nominal speech coil impedance is 2 ohms. Then the RMS voltage developed across the speech coil is $\sqrt{2 \times 8} = 4$ volts, so that the peak value is $1.414 \times 4 = 5.656$ volts and the voltage gain of the amplifier is 113 times. By repeating the calculations using this new figure we find that the optimum degree of feedback is given by :—

* See "RF Pentodes as AF Amplifiers," *Wireless World*, July, 1944.

$$\beta = \frac{50{,}000-2{,}000}{113 \times 2{,}000} = \frac{1}{5}$$

approximately.

This can be arranged as shown in Fig. 6. The resistance R_1 in conjunction with the bias resistor R_2 (which is not shunted with the usual bypass condenser) forms a potential divider which applies one-fifth of the output voltage back to the input of the first valve. The reduction in the value of the grid bias resistor brought about by the circuit is very small and may be neglected.

Consider now degrees of feedback other than the optimum value. If more than optimum feedback is used, some "top boost" will be required: if less, then "top cut" will be necessary.

Suppose the whole of the secondary winding of the output transformer is included in the cathode lead of the first valve, thus giving far more than the optimum degree of feedback. Using the figures quoted, it is easily shown that the R_a of the output stage is reduced to roughly 600 ohms by this means, hence a small amount of "top cut" will occur. On the other hand, if a particularly sensitive amplifier is required and it is therefore decided to use a degree of feedback smaller than the optimum value, then "top lift" is inevitable. To compensate for this frequency distortion we can use frequency discriminating feedback. It is extremely difficult however to calculate the constants for feedback circuits of this type, for not only do they introduce attenuation which varies with frequency, but they also introduce phase-shifts which are a function of frequency. It is not proposed, therefore, to describe the design of such systems in detail here: but it is interesting to note that if a condenser is connected in parallel with the 1,500 ohms bias resistor in Fig. 4 then "top lift" results. On the other hand, if an inductance is connected across it then "top cut" results. Incidentally, a convenient means of obtaining "bass lift" is by reducing the value of the condenser in the feedback chain. The author uses a 0.1 μF component instead of the 0.25 μF condenser of Fig. 5 in order to compensate for the bass loss inevitable with a small loudspeaker baffle.

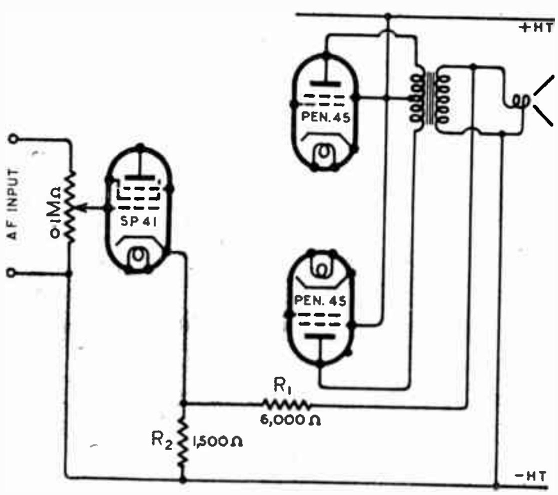


Fig. 6. Another method, the feedback voltage being taken from the secondary of the output transformer.

Perhaps a better way of counteracting small degrees of frequency distortion—it is certainly more amenable to calculation—is to use a frequency discriminating network in the amplifier placed outside the feedback chain. Suitable circuits for "top cut" and "top lift" are shown in Fig. 7 (a) and (b) respectively. They are connected in the input circuit of the first AF amplifier.

The circuit of Fig. 7 (a) gives an attenuation of $\frac{R_3}{R_1 + R_3}$ times at very low frequencies when the reactance of C_1 is infinite. At very high frequencies this becomes $\frac{R_3}{R' + R_3}$ in which

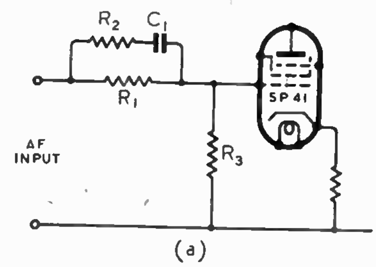
$$R' = \frac{R_1 R_2}{R_1 + R_2}.$$

In this the reactance of C_1 has been assumed zero. We thus get that the degree of top lift is given by

$$20 \log \frac{R_3}{R' + R_3} - 20 \log \frac{R_3}{R_1 + R_3}$$

$$= 20 \log \frac{R_1 + R_3}{R' + R_3}$$

Suitable values for a lift of 3 db. are $R_1 = 100{,}000$ ohms, $R_2 = 70{,}000$ ohms and $R_3 = 100{,}000$ ohms. The capacitance of the condenser C_1 decides at what frequency the boost begins. A



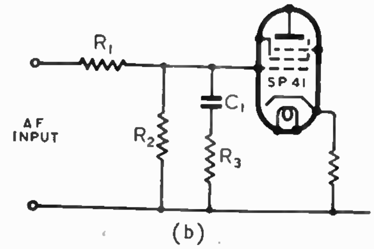


Fig. 7. Suggested tone-control circuits for "top boost" (a and "top cut" (b)

suitable value is 0.01 μF, but it should be pointed out that exact compensation for the "top cut" due to feedback is probably impossible. The corresponding formula for the "top cut" introduced by the circuit of Fig. 7 (b) is:

$$20 \log \frac{R'}{R_1 + R'} \cdot \frac{R_1 + R_2}{R_2}$$

in which

$$R' = \frac{R_2 R_3}{R_2 + R_3}$$

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8,000,000 NEW BROADCAST SETS

What Should They be Like?

By R. W. HALLOWS, M.A., A.M.I.E.E.

WHEN the war is over the wireless industry of this country will find itself in a truly enviable position: it will in a word be presented with something like a clean slate upon which to write its own future. No such far-reaching opportunity has ever before occurred or is likely to occur again. During the long years of the war the industry has had perforce to devote nearly the whole of its activities to supplying naval, military and air needs; its normal function in meeting the requirements of the civil population has lain dormant. When peace returns it will be reborn with almost limitless opportunities. Will it seize those chances with both hands and make the fullest use of them? Or will it be content to drift taking the comfortable line of least resistance, as in the past it has too often been inclined to do? Devoutly as one hopes that the rebirth of the industry will see a vigorous forward policy, it is difficult to answer these questions now, for there are as yet no certain indications of what is likely to happen.

It has been said that the saddest thing that can happen to a young man is to be left by the will of some well-meaning but misguided relative an income just sufficient to live on. After the war our wireless industry will be very much in the position of the young man with the legacy, for even if it makes no effort its livelihood will be assured, not indefinitely it is true, but for a long time to come. So great and so urgent will be the demand for receiving sets that anything turned out by the factories for some little time will be certain to find its market, so long as it works, is fairly easy to operate and is housed in a cabinet that is not positively repulsive to the eye.

Let us consider some facts and figures. Of the ten million or more wireless sets in use in this country alone only a very small proportion will be less than five years old, for comparatively few were in stock when the war broke out (the autumn production drive was not under way in September, 1939), and since that time there has been but a thin trickle from the factories, while imports have been on the most restricted scale. Probably, then, at the very lowest three out of every five listeners—I should say that four out of five would be nearer the mark—are looking forward to the time when their present sets, which have given such long service and are now showing signs of senile decrepitude, can be replaced by new ones. That gives a potential immediate market in the home country for between six and eight million sets; and there are the needs of the Empire to be thought of as well.

If the policy adopted is to concentrate on the production of low-priced sets of mediocre performance business will undoubtedly be brisk—for a time. But it is equally certain that there will be a day of reckoning. Ours is not the only country with a wireless industry, and, were our own firms to be largely content with a non-progressive policy, those of other countries would soon begin to take a larger and larger share of the home and Empire markets. I do not for one moment believe that anything of the kind will happen; but the temptation will be there and it will be strong.

What do I suggest that the wireless industry should write on the clean slate which it will have when the war is over? Well, first of all I want to see the public educated up and not down. There can be little question that such education as came its way from the industry before the war was definitely of the downward type: not only the man of modest means but also many of those better blessed with this world's goods had come to believe that there was little point in spending more than twelve or fifteen pounds on a wireless set, unless a radiogram was required. For such a sum you could take your choice of many makes, each capable of bringing in a number of foreign stations (if you wanted them) on the long, medium or short waves; each with the simplest of controls, and each giving reproduction which, if falling a good deal short of what a musical ear would have liked, was not actually unpleasant and was, at any rate, quite up to the standard that you had been brought to expect from the wireless loudspeaker.

Parallels have often been drawn between the history of wireless and that of motoring. In many respects they have run on much the same lines; but there has been this big and important difference.

One of the things for which the author of this article pleads is an adequate short-wave tuning system—a rarity even in the best of pre-war broadcast receivers. Here is one of the exceptions; the Murphy A76, which gave many of the refinements of a "communication" receiver at moderate cost.

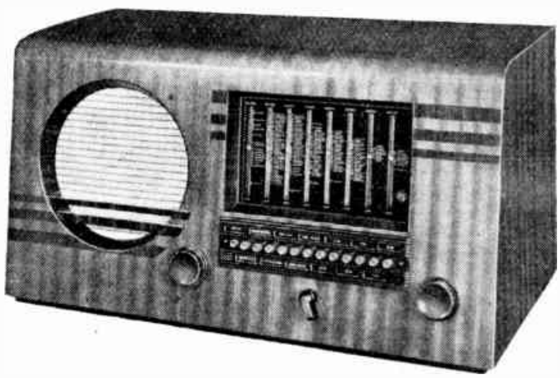
8,000,000 New Broadcast Sets—

The motor car industry supplied the little man with cheap, reliable cars that gave him the service that he needed; but it did not stop there. It educated those who could afford to pay more up to the special merits in their own ways of the sports car and the luxury car. On the other hand, the wireless industry has too often gone off at half-cock in such sporadic attempts as it has made at upward education.

There was, if you remember, some kind of effort in the early days of broadcasting to teach the listener that better quality than he had been used to could and should be his. "Bring out the bass" was the cry that year. The public responded eagerly and much might have been done then and in the future to develop a taste for genuine quality; but it wasn't done and the man in the street came to accept as right and proper the invisible carpet-beater that was apparently installed in the cabinet of his new receiver.

Then there was the slogan about the world's being your oyster if only your receiver had a short-wave range to act as the opening knife. Again the public showed itself ready and willing to grasp what was promised. But the process of opening the oyster with the kind of knife provided proved so difficult that in the majority of instances the short-wave range was little used after perhaps the first fortnight of ownership. Given reasonably simple tuning arrangements a large section of the public might well have adopted short-wave listening as a hobby, especially if there had been some helpful propaganda at the time. But give the ordinary man or woman jerky, backlashy tuning and a pointer as thick as a poker moving over a scale on which the whole of the 19-metre band occupies less than a quarter of an inch, and the process of finding a desired station is too difficult to be fun. It is still more difficult and still less fun when second-channel reception of short-wave stations occurs inside the limits of the band on which they are working.

"But," I hear someone object, "how on earth can you expect velvet-smooth tuning, band-spreading and second-channel suppression in an "all-wave" receiver costing £15 or so?" I don't, and that's the whole point. I no more expect to find these things in such a set than I expect to find terrific acceleration and the ability to top 80 m.p.h. in a saloon car costing a couple of hundred pounds and designed for family use. No motor car manufacturer has ever led me to believe that such things are possible. But if I do want to break road records and perhaps my own neck they have taught me that the sports car is available at a fit and proper price. Or if I feel that I desire something combining both the comforts of the saloon car and the acceleration and speed of the sports model, they have taught me that it can be supplied but that it will cost a great deal of money. In other words, the pre-war motor car industry (and the same will no doubt be true of this industry after the war) produced a variety of vehicles to suit all tastes and all purses. It was emphatically not content to concentrate on the cheap car of moderate all-round performance and it had so educated the public that the purchaser knew what qualities were expensive to produce. The bulk of motorists probably bought the best car that they could afford of the type that they wanted and looked forward to the day when they would be able to lay out more money on something better.



Another "semi-communication" set introduced just before the outbreak of war was the Pye "International." Thanks to the use of a band-spread tuning system, it made short-wave work a practical possibility for the ordinary listener.

It is on lines like those that I hope that the wireless industry may get to work when it makes its fresh start after the return of peace. I would like it to take the man in the street into its confidence and to say something like this to him: "The wireless set used for general entertainment in the home is or should be a musical instrument. As in the case with most other musical instruments it is neither difficult nor expensive to make something which will produce sounds acceptable to the ear. Good entertainment can be obtained from a modestly priced cottage piano or a violin costing no great amount of money; but no one would suggest that the tone of either made even a distant approach to perfection. To make instruments such as these of really good tone is a costly business. Similarly, we can provide you with an inexpensive wireless receiver which will give passable reproduction. This may be all that you need or can afford, but if you want something better we can furnish it; at a higher price, of course, for don't forget that the obtaining of high quality of reproduction is by far the most expensive thing in designing and making a wireless set."

Anyone who has experienced the reproduction by a high-fidelity receiver of music transmitted on the television wavelength will remember what a revelation it was to him the first time that he heard it. In fact, until you do hear such reproduction you can have absolutely no idea of the lovely sounds that can come from the wireless loudspeaker. The B.B.C. was anxious before the war to transmit the whole of the national or regional programme daily in this way; after the war the wireless industry must see that they do so and must produce *de luxe* receivers that will enable the discriminating listener who can afford the best of sets to have not the shadow

8,000,000 New Broadcast Sets—

but the substance of great music.

The man in the street should also be given opportunities to learn the truth about long-distance reception, particularly on the short waves. What he should know is that though it will bring in some of the "easier" stations, the low-priced family receiver is not and cannot be the ideal instrument for the purpose. He should certainly be educated out of the evil habit of judging the merits of a domestic set by the number of foreign stations that it can receive! If we are to retain the inexpensive "all-wave" family set (as I think probably that we must), there must also be higher-priced models available with greater sensitivity and far better tuning arrangement on the short-wave range. I would also like to see more "sports models" in the form of simplified versions of the communication receiver.

For the home market I suggest the following range of wireless receiving sets. I can give no indication of their prices, since I do not know what post-war production costs are likely to be nor for how long purchase tax may be retained. Neither makers nor users, though, should any longer have to be shy of increased numbers of valves: the lessons learnt and the plants installed during the war should make for the reduction of the cost of replacement valves.

(1) The Radiovisiogram *de luxe*. This instrument would be the finest product of the wireless manufacturers' art. The audio-frequency side, designed to provide true high-fidelity reproduction, would have separate high-pass and low-pass circuits, each operating its own loudspeaker and each with its own volume control. Automatic contrast expansion would be available at will. On the RF side different circuits, each designed for its own special job, would be used for local and distant reception. Bandspreading and smooth, easy tuning would be features of the short-wave range.

(2) The Radioceiver *de luxe*. Designed for those who want the best that wireless can give in sound reproduction combined with good long-distance performance when required. The same instrument as No. 1, but less the gramophone mechanism and the vision section.

(3) and (4). Instruments selling at about half the prices of (1) and (2) and of good, though not superlative performance.

(5) A modified communication receiver with the following features: (a) at least two signal frequency stages and complete second channel suppression; (b) separate AVC or manual control at will on SF and IF stages and manual on AF as well; (c) separate local oscillator valve and oscillator amplifier and other precautions to ensure freedom from drift; (d) BFO available if required; (e) complete waveband coverage from 10 to 80 metres; (g) accurate calibration of dials.

(6) A smaller and simpler long-distance receiver.

(7) A simplified domestic version of the Radiovisiogram selling at a modest price.

(8) A family "all-wave" radiogram.

(9) A family "all-wave" receiver.

Nos. 1 to 5 and No. 7 would, of course, be mains-operated instruments. Though we shall no doubt see an immense increase in the number of homes with mains supplies of electricity, there will be for years a demand for battery-operated sets. Nos. 6, 8 and 9 might well be made in battery-operated form, a clockwork device being of course used for the radiogram.

I do not for one moment suggest that every wireless manufacturing firm should turn out the whole range of instruments. On the contrary, I would like to see firms specialising in *de luxe*, medium-priced and low-priced sets, just as motor car manufacturers do in the different types and grades of cars.

Space has allowed me to touch only on wireless sets made for use in this country; but the demands of the Empire, too, will be enormous after the war. We had allowed other countries to capture far too much of the vast Empire trade in wireless equipment that was developing before the war, largely because our own industry could not or would not cater for its special demands. Now that the opportunity for a completely fresh start is approaching it is earnestly to be hoped that we may recapture the lost Empire trade. It is most important that the necessary effort should be made, for upon our exports will largely depend the future prosperity of this country.

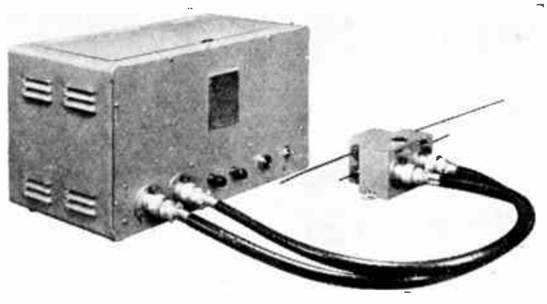
HELPING THE WAR-MAIMED

Wireless, it has been said, is always "on the side of the angels." One can, alas, think of a few exceptions to that rule, but it is a heartening thought to many of us that our technique has, in its short history, done much to save human life and to alleviate human suffering.

There is now a promise that wireless may be able to help victims of the present war in a new way. Experiments have already been made in applying the principles of radiolocation to aid the blind, and now Sir Ian Fraser, the Chairman of St. Dunstan's, is engaged in attempting to apply electronic principles—or at least principles that will probably turn out to be electronic—to providing the means for playing bridge to blinded men who have also lost their arms. In the classified advertisements of this issue Sir Ian invites the co-operation of a technician who has ideas on how this problem might be solved.

SALFORD RF CRACK DETECTOR

Designed for the detection of surface cracks in bar stock materials, this instrument makes use of the tendency of RF eddy currents to concentrate near the surface of a conductor. The photograph shows (left) the RF generator and (right) the measuring head through which the rod under test is passed at speeds up to 1ft. per sec. When fitted with a meter, the instrument can be calibrated to measure the depth of the crack.



The standard model works from AC mains, but a DC model is also available. The makers are Salford Electrical Instruments, Ltd., Silk Street, Salford, Lancs.

SUPER-REGENERATION

Some Unusual Applications of this Sensitive Method of Reception

By O. J. RUSSELL, B.Sc.

THE super-regenerative principle presents an exceptional number of interesting features. The performance of this type of apparatus is especially remarkable in view of the extreme amplification and performance obtained with the minimum of circuit components. Attractive features are the combination of the ultimate limit of sensitivity with ease of tuning due to the low selectivity (which has been of the utmost value for operation upon very high frequencies), and a very marked limiting action upon signals exceeding a certain small minimum value, which results in both an effective AVC action, and discrimination against noise of the ignition interference type. As all these advantages may be obtained from a simple single valve circuit, it is not surprising that the initial development of very high frequencies depended largely upon the use of the super-regenerator, especially as unstable and frequency-modulated signals may be received that are too broad for selective receivers of more advanced design. In short, the super-regenerator provides a simple, compact, highly sensitive receiving arrangement, which has been aptly described as a "compactum of radio dynamite." Emergency networks, especially the American A.R.P. amateur-operated networks rely largely upon the super-regenerator.

A brief description of the super-regenerator, and some unusual points of interest are presented in this article. In general, the circuits described are for high and very high frequencies, though the principle is still effective upon the lower frequencies, and the celebrated "police helmet" receivers were of the super-regenerative type, using Hivac midget valves. A single-valve receiver of this kind, using a four-inch diameter frame aerial, gives excellent Continental reception on the medium broadcast band, although the requisite low-quench frequency employed gives considerable distortion.

For our purposes, a simplified explanation of the operation of the super-regenerator will suffice. Basically, the super-regenerator consists of a regenerative receiver, which is rapidly swept in and out of a state of oscillation. Such a condition may be achieved by applying to an oscillating detector, at a considerably lower frequency, modulating oscillation of such amplitude that the detector stage is swung in and out of oscillation. This may be effected by any of the usual recognised modulation methods. This process of starting and stopping the oscillations is appropriately termed "quenching." In the absence of disturbance, the radio-frequency oscillations would stop and start at perfectly regular points during the cycle of modulation, the burst occurring at the modulation frequency. However, the presence of other voltages, as from an external signal, may either advance or retard the exact instant at which oscillation commences. As the oscillations increase rapidly in amplitude in an approximately exponential fashion, until the quenching oscillations cause them to cease, the oscillations may build up to a bigger value if they commence earlier; or if the commencement of oscillation is delayed they cannot build up to such a high value as their normal undisturbed amplitude.

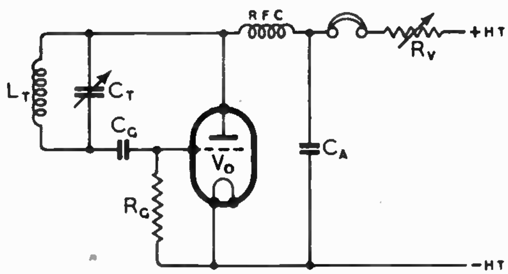


Fig. 1. Simple VHF receiver with saw-toothed quenching waveform. L_T and C_T, values to suit appropriate VHF band; C_A, 0.01μF; C_G, 0.0001μF; R_G, 100,000ω to 1 MΩ; R_V, 50,000ω, max.; V_O, see text.

It is easy to see that if the external signal is modulated, and hence varies in amplitude, the exact moment of onset of the oscillation of the super-regenerator will vary, which will result in their amplitude varying in sympathy with the modulation of the impressed signal. The anode current will therefore contain a fluctuating component reproducing the original modulation variation and this may be reproduced as an audio signal in the usual way. In actual practice, the sensitivity of the arrangement is such that the random fluctuations of electrons in the grid circuit are sufficient to disturb the hypothetical perfect regularity of operation we have postulated in the above simplified explanation, and in the absence of external signals the output of a super-regenerative receiver consists of the hiss typical of amplification to the limit of usable sensitivity set by the fact that electricity exists in the discrete particles called electrons.

When a very weak signal is received, the modulation is first heard superimposed upon the hissing noise, but if the signals are increased in strength, the hiss is rapidly suppressed, and only the modulation is heard. Reasonably strong unmodulated signals are recognised by the suppression of the hissing sound when the receiver is tuned to them. The strong hiss output obtained when a super-regenerator is not tuned to a signal has created the impression that these receivers are in-

Super-regeneration—

herently noisier than other types. This is not so, and any type of receiver having the same sensitivity, bandwidth and thermal noise in its first stage, will produce the same amount of noise output. This point, together with a fuller discussion of the super-regenerative principle, is dealt with in an article by Scroggie.[1]

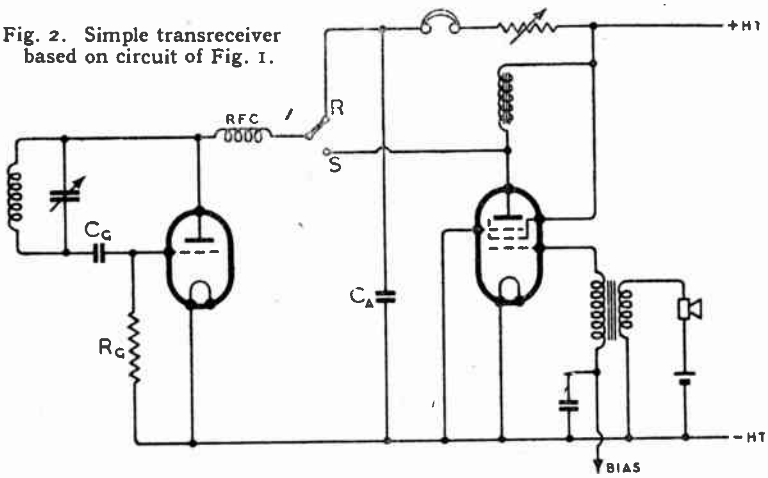


Fig. 2. Simple transreceiver based on circuit of Fig. 1.

The actual frequency of the modulating or quenching oscillation deserves some little attention. As has been stressed, it must obviously be of lower frequency than the frequency of reception, in order to allow the bursts of radio-frequency oscillation to build up adequately. Conversely, as the growth of the oscillations is roughly exponential, after a certain time the growth of oscillations will be very slow, and consequently a very low quenching frequency is of no great advantage.

We might expect some rough relationship between the frequency of reception and the quenching frequency, and this appears to be confirmed by various investigators. At ordinary broadcast frequencies, the quench frequency is usually chosen so as to be near the top of the audible band, say about 10 kc/s. For short-wave and ultra-short wave use, the frequency is higher, and values of from 30 to 100 kc/s are employed. The use of frequencies higher than 100 kc/s for ultra-short wave use has been recommended, but as the exact amplitude of the quench frequency used appears to be more critical as the quenching frequency is increased, little use of quenching frequencies higher than 100 kc/s has been made.

The above description has not specified the waveform of the quenching frequency. Normally, of course, a sinusoidal frequency is supplied when a separate quenching oscillator is used. However, it would appear that the use of peaky quenching waveforms, such as a sawtooth waveform, is advantageous. The use of the simple circuit of Fig. 1, which has been previously described by the author,[2] provides a sawtooth waveform for the quenching, and obviates the use of a separate quench oscillator. The circuit operates as a squegging oscillator.[3] It is found in actual practice that the quench frequency of the squegger is given as a rough approximation by the reciprocal of the time constant of the grid condenser and grid leak, although other factors may vary the frequency appreciably. It should be noted that the condenser C_A, which should be approximately 0.01 μF is essential for proper squeggering. Condensers of this value were frequently specified for RF bypass purposes in VHF oscillator circuits, and invariably resulted in squeggering. The mistake of specifying such a large and unsuitable capacity for purely by-passing VHF oscillations, although frequent in the past, is now seldom encountered.

The circuit of Fig. 1 may be made the basis of a simple transreceiver circuit: if the condenser C_A is disconnected, the circuit then becomes a simple oscillator suitable for modulation for use as an unstabilised transmitter. A transreceiver circuit of this elementary type is shown in Fig. 2. The valve is preferably a medium-impedance triode type having a fairly high mutual conductance. The battery types such as the Marconi-Osram LP2 or the Tungsram LP220 and P215 are suitable; for mains operation the MH4, the 6C5 and especially the 6J5 may be used, while the use of the acorn types of triode extend the operating range to 300 Mc/s, or even higher. Normal valves will operate up to 120 Mc/s, depending largely upon the reduction of stray lead inductances. The use of a series tuned arrangement is helpful, and, if decapped, ordinary tubes will operate to a limit of about 170 Mc/s.

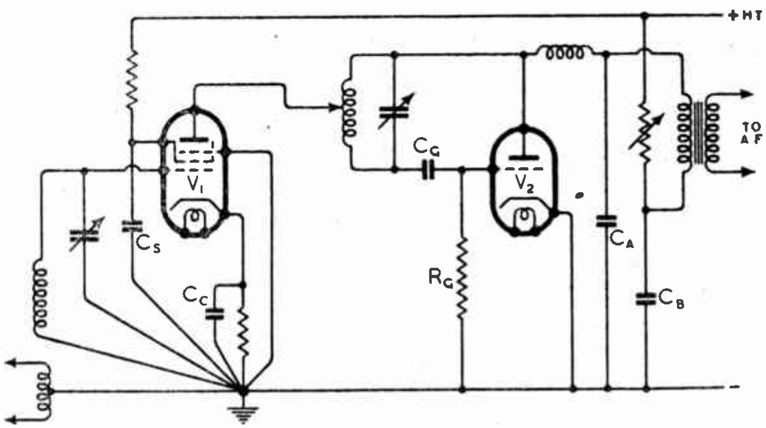


Fig. 3. Super-regenerative receiver with simple buffer stage to reduce re-radiation. V_1 and V_2 preferably acorn types.

Conversely, at sunspot maximum, the addition of a single stage of AF amplification gives world-wide loudspeaker reception on 30 Mc/s. Optimum operation is obtained by fairly heavy loading of the tuned circuit, especially at the lower frequencies. With an acorn-tube receiver, using an RF stage, it was found necessary to wind the super-regenerative detector coil for the ten-metre band with fine wire to increase the damping, before correct operation was obtained. This effect seems to be due to the radio-frequency oscillations being of too great an amplitude to be effectively quenched by the squegger. The symptoms are that the usual hiss is absent or very weak, but increasing to the normal volume when the tuned circuit is loaded as by touching with a damp finger, or by coupling an aerial to it. This effect should be remembered when attempting reception on the lower frequency bands, when, in general, a larger grid leak may be employed in order to lower the quench frequency, and thus to improve the selectivity.

The super-regenerator, being essentially an over-modulated oscillator, can radiate an interfering signal, and a buffer RF amplifier is essential to prevent this. The RF amplifier adds little or nothing to the fundamental sensitivity, but gives a worthwhile improvement in selectivity. The RF stage can be of any normal type, but the arrangement of Fig. 3 is a neat and effective way of adding such a stage.

A further point, resulting from the fact that modulation frequencies are present together with the quench frequency in the anode circuit, is that the quench frequency is actually modulated by the audio signals. An auxiliary receiver tuned to the quench frequency, or a harmonic of it, and lightly coupled to the super-regenerator, will reproduce the received signal. Receivers have, in fact, been constructed using amplifiers tuned to the quench frequency followed by a demodulator.

A method of reception, which in some aspects is an inversion of this principle, was introduced in America under the name of the "superinfragenator."[4] This combines the excellent selectivity of the superhet with the very good AVC and noise-limiting properties of the super-regenerator. Double frequency changing was employed, the first IF frequency being low enough to give excellent selectivity. The second detector converted the signals to a high frequency of about 20 Mc/s, and these were demodulated by a super-regenerative third detector. The block schematic of Fig. 4 illustrates the arrangement employed. A simplified version of this principle, designed to improve the selectivity and to reduce the re-radiation of the simple super-regenerator when employed on 120 Mc/s, uses a frequency changer converting signals to an IF of 20 Mc/s, which, after a single stage of amplification, is demodulated by a super-regenerative second detector. This simplified version, suitable for reception of unstable transmitters, was developed for the American amateur-operated wartime emergency networks.[5]

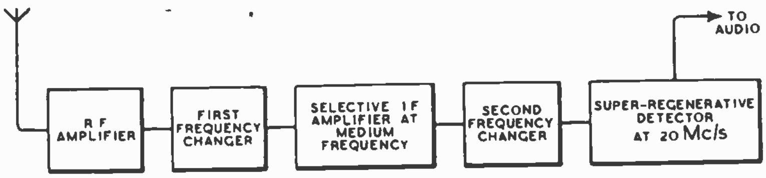


Fig. 4. Block diagram of "superinfragenator."

An interesting consequence of the extreme sensitivity of the super-regenerator has been previously discussed by the writer.[6] Briefly, if a super-regenerator tuned to a very high frequency, say 50 Mc/s, is operated in the vicinity of a low-powered oscillator, tuned to say 60 Mc/s, then a station operating on the difference frequency of 10 Mc/s may be received. The local oscillations, and the lower frequency signals are rectified by the receiver, and if it is tuned to either the difference or sum combination of these frequencies, treats them as a normal VHF signal. The high sensitivity of a super-regenerator is normally necessary to disclose this rectification effect.

It is thus quite feasible to construct a receiver using this effect to give an expanded "Single-Span" effect, enabling continuous coverage over the short-wave spectrum and into the ultra-short regions on the dial without waveband switching. A further use would be to enable a master warning station on an entirely different frequency to interrupt a receiver tuned to a high-frequency programme for emergency purposes, while not interfering with reception of the programme sta-

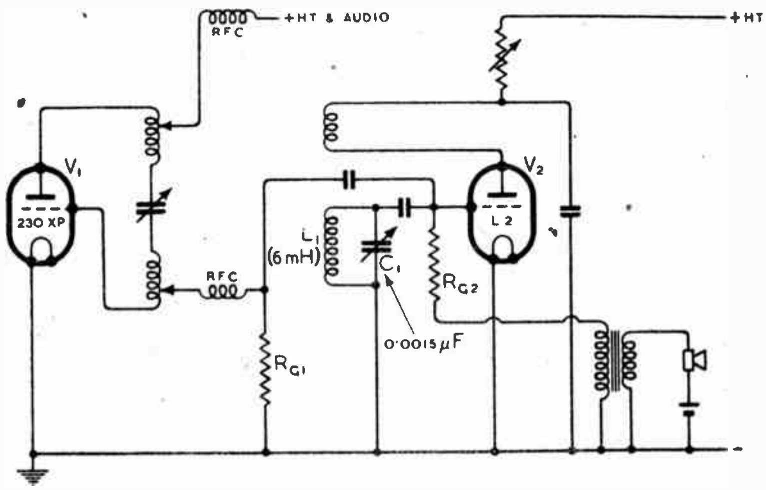


Fig. 5. Duplex radio telephone circuit. V_1, VHF oscillator; V_2, quench oscillator.

Super-regeneration—
tion upon ordinary receivers. Four years after the writer's letter on this effect, an independent announcement of this phenomenon was made in Russia by N. V. Osipov,[7] followed by a further article[8] giving a mathematical treatment of the effect. The conclusions reached by Osipov are similar to those given above, although he adds that the sensitivity is superior to that of a normal reacting detector circuit.

A further interesting development of the super-regenerator is the duplex radio-telephone system evolved by W. B. Lewis and C. J. Milner.[9] This two-valve circuit, suitable for connection to normal telephone line systems, provides simultaneous two-way speech transmission and reception, or even multi-way or "conference" communication. A series tuned oscillator circuit (originally due to Gouton and Touly) operates on about 100 Mc/s, and a second valve is used as a sinusoidal oscillator for injecting a quenching frequency into the grid circuit of the VHF oscillator. The VHF oscillation is radiated, modulated by the quench oscillator. A similar receiver nearby will cause a beat note between their separate quench frequencies, if they are different. The quench oscillators may be tuned to zero beat with each other, when they will lock in step. If the quench oscillator of one receiver is modulated by an audio signal, this is detected by the other receiver, and simultaneous two-way transmission and reception is possible. Over appreciable distances the locking-in of the two oscillators is complicated by the slight time delay in transmission over a distance, and a suitable quenching frequency is chosen so that the quenching oscillation is in the correct phase at both ends of the transmission path for stable locking. This is ensured by making the quench oscillators tunable to select a suitable frequency. Using small battery valves, the designers maintained communication on 100 Mc/s over non-optical paths of up to thirty miles in mountainous country. A simplified version of their circuit is shown in Fig. 5.

Other applications may be briefly mentioned. The automatic limiting action of the super-regenerator has been utilised as the basis of a wide-range logarithmic voltmeter, indicating from 10 to 10,000 microvolts. This is mentioned in the article by Scroggie.[1]

A suggested use of super-regeneration is for automatic VHF relaying. Signals are received from a dipole connected to the grid circuit, and are re-radiated in amplified form by a dipole coupled to the anode circuit. As a super-regenerator is already in a state of oscillation, it is suggested that no screening of the output and input dipoles is necessary, and even that the space-coupling between the dipoles could provide the necessary feed-back to maintain oscillation.

Finally, the squeggering type of super-regenerative receiver may be used as a time-base. A good saw-toothed output with a rapid flyback can be readily obtained, and has found considerable application in television receivers, where in general a vapour discharge triode charging circuit may be replaced by a hard triode squeggering oscillator.[10, 11]

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11 O. S. Puckle, "Time Bases," Published by Chapman and Hall.

PACKING RADIO EQUIPMENT

THE importance of producing wireless apparatus and components capable of withstanding the difficult climatic conditions prevailing in the Far Eastern and Pacific theatres of war has long been stressed. It is now being realised that the manufacturers' responsibility does not end there; the packing of apparatus and the observance of special precautions for its protection in transit is also of vital importance. Packing and protective methods that are entirely satisfactory for the temperate zone are useless for the Far East.

To help manufacturers of war equipment in solving packing problems, the Anglo-American Packaging Committee of the Ministry of Production recently opened an exhibition to show some of the methods that are recommended. These methods range from the elaborate protection of a combined transmitter and receiver, in which the containing case is packed within a moisture and vapour-proof outer covering containing a dehydrant, to the packing of a pair of 'phones which are contained in a carton padded with bituminised crepe cellulose. The carton is wrapped in greaseproof paper, the whole being dipped in molten wax; a dehydrant is also used in this case. Even a simple article like insulating tape is sealed into a tin of the key opening type.

It is believed that this exhibition will be of interest not only to manufacturers of war equipment but also to firms concerned with export trade. The exhibition, which will remain open for some considerable time, is at the Central Ordnance Depot, Feltham, Middlesex. Manufacturers may obtain invitations to see it by writing to the Commandant of the Depot.

THE WIRELESS INDUSTRY

WE extend our congratulations to Wright and Weaire, who recently celebrated the twenty-fifth anniversary of the foundation of the firm. Is there any other manufacturer of wireless components and accessories with an equally long record of activity?

The title of the business of N. Partridge (founded by the late Dr. Partridge, whose death by enemy action we recently announced) has been changed to Partridge Transformers, Ltd. The address is unchanged—76-78, Petty France, London, S.W.1.

"Electronis Telesis" is the title of a very attractively produced 64-page booklet explaining the fundamentals of electronics in simple language. Free copies are obtainable from the makers of Eimac valves; Eitel McCullough, Inc., 893, San Mateo Avenue, San Bruno, California, U.S.A.

We are informed that Ersin activated flux solder has been submitted to the A.I.D. for test by the manufacturers, Multicore Solders, Ltd., and has been granted approval under the conditions of test laid down in the Ministry of Aircraft Production's Specification D.T.D.599.

An illustrated leaflet describing the manufacture of instrument cases has been prepared by Alfred Imhof, Ltd., 112-116, New Oxford Street, London, W.C.1. Copies will be sent to those interested on receipt of 1d. to cover postage.

ARMY SETS

Details of Some Radio Gear

SO far very few details of the sets which have formed the main link in the Army's communication system have been published. The ban is now lifted, and we reproduce on this and the following page photographs and some details of a representative selection of the sets. Space does not permit the inclusion of more than brief details, and it is hoped to give fuller descriptions of one or two of the more outstanding receivers in future issues.

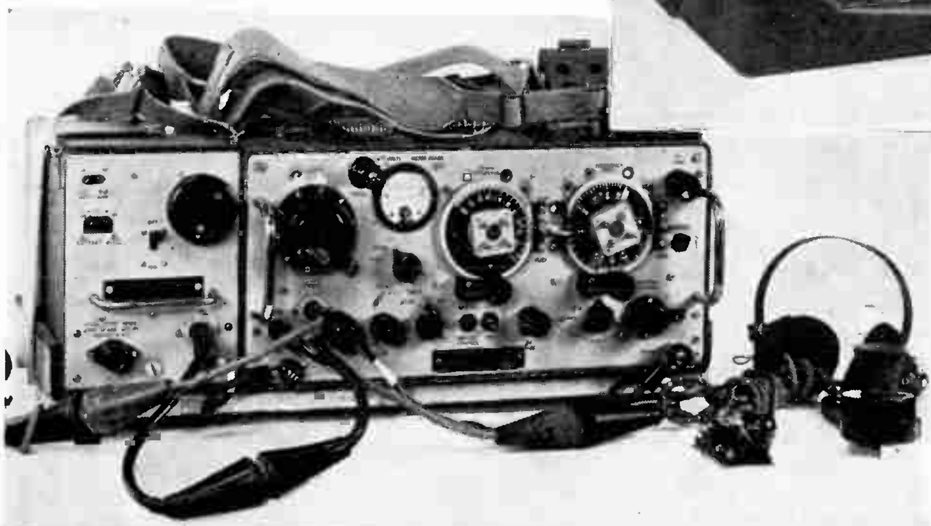
Two good examples of the type of set used by infantrymen in the forward areas are the No. 38, for use between a platoon and its company headquarters, and the No. 18, used for maintaining a link between company and battalion headquarters.

Both of these transceivers (sets in which some of the components are common to both transmitter and receiver) are designed for use by those whose technical training is very limited. Extreme simplicity of operation is, therefore, essential.

Four of the five valves in the 38 set are used in the superhet receiver—a metal rectifier provides detection and AVC—and three are operative for transmission. Frequency coverage is from 7.3-8.9 Mc/s—the IF being 285 kc/s. This pack set, which is designed for short-range RT working, is extremely light, weighing only 6¼ lb.

The No. 18 set is a much heavier transceiver, weighing 32 lb. complete, and is not intended to be operated by the carrier when on the move. The fre-

Crystal control of the transmitter frequencies (1.75—2.9 Mc/s) is provided in the No. 68 P transmitter-receiver (above).



Remote control up to half a mile is provided in the 13-valve transceiver No. 22 (left) which employs three pentodes in parallel in the output stage.

Sets are dropped by parachute, with valves *in situ*, in this container.

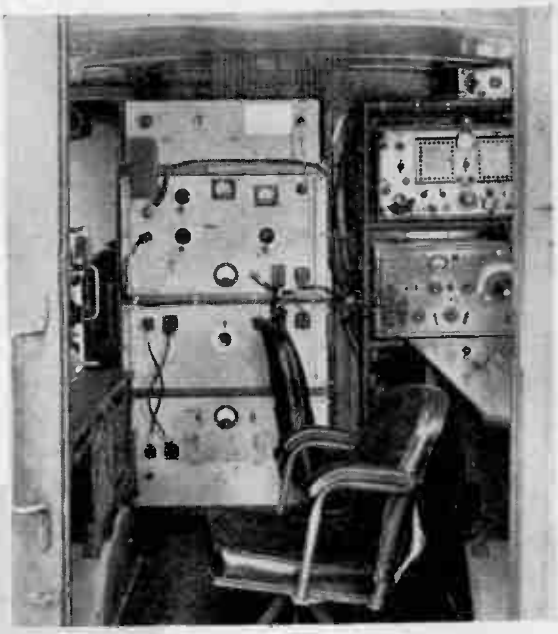
Army Sets—
quency coverage of this set is from 6-9 Mc/s.

Almost all communications forward of brigade are by radio telephony, while in the rear of brigade headquarters telegraphy is more widely used because with skilled operators a large volume of traffic can be handled. All the sets, therefore, used for brigade and divisional communications are operated by men of Royal Signals, whose training permits the use of complex equipment.

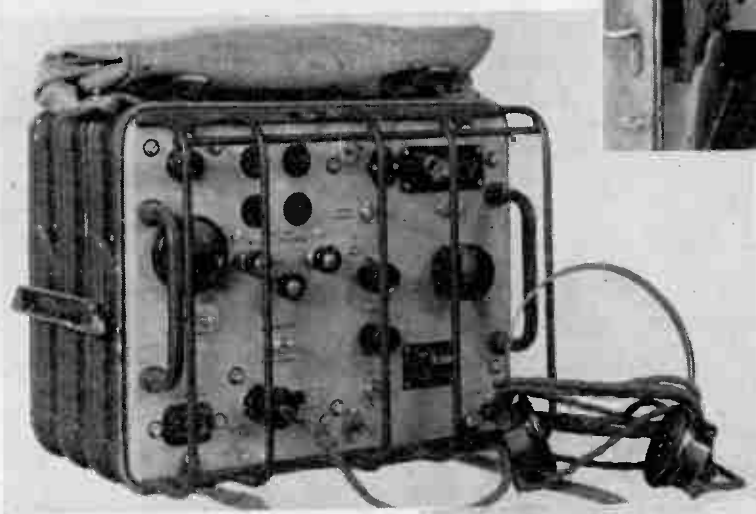
One of the most versatile sets is the No. 19, which has been one of the main links in the Army's communication system in the field. It comprises three sets in one—a transmitter-receiver, providing RT, MCW and CW communication between troop and base, a UHF transceiver for linking vehicles in a unit and an intercommunication amplifier for the crew. The main set, which employs 9 valves, six of which are used in the receiver, and six for transmission, covers the frequencies 2.1-8 Mc/s in two ranges. The four-valve UHF transceiver works in the 229-241 Mc/s band.

In addition to being used in armoured vehicles and tanks, the No. 22 set is adaptable for use as a three-man pack, as a mule pack, on a handcart, and for dropping by parachute.

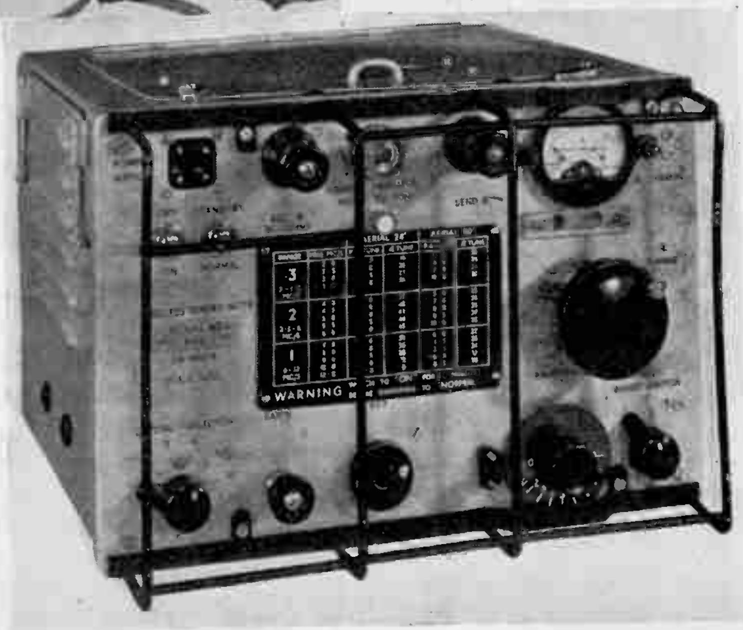
Some sets are developed for purposes outside the normal chain of communications. Such is the No. 76 set originally designed for Commando formations likely to be working in isolated groups and therefore requiring an efficient means of communication over considerable distances. The set is crystal controlled on six frequencies between 2 and 12 Mc/s and has a power of 20 watts. A lightweight 80-watt charging unit is dropped with the set in airborne operations. The 76 set was used in the airborne landings in Holland, when communication was maintained with this country.



Interior of a "thin-skinned" wireless lorry (right) showing the No. 12 high-power (250 watts) transmitter above the bench. The units in the centre are, from top to bottom, the aerial coupling unit, RF amplifier, modulator and power supply unit.



The R109, 8-valve general-purpose superhet receiver (below) has a built-in loudspeaker.



The crystal-controlled 76 transmitter provides for CW operation only.

RANDOM RADIATIONS

By "DIALLIST"

A Good Sixpenn'orth

THE sixpenny trays of bookshops always attract me, for there is no saying what they may yield. I remember as a hard-up young man putting down my sixpence at a village fair for a first edition which I afterwards sold for as many pounds. Miracles of this kind are not frequent, but I have had a pretty useful number of real bargains. The other day I picked up a brand-new copy of "Edison," by George S. Boyan, an accurate and well-written life of the great man which has given me a lot of spare-time pleasure. What a strange personality he was! Neither a good physicist nor a competent mathematician, he was full of ideas, and he possessed the happy knack of seeing how the apparently impossible could be accomplished. Nothing deterred him once he had made up his mind to tackle a line of invention. In 1879 he decided to attack the problem of what was then known as "subdividing the electric light," or, in other words, of producing small lamps that could be run in parallel to take the place of an arc lamp. Amongst others, Sir William Preece (later a friend and admirer) stated categorically that "the subdivision of the light was an obsolete *ignis fatuus*." Edison never doubted that he would succeed in his quest. After many thousands of tests and experiments he produced his glow lamp, and, incidentally, discovered the "Edison effect" which years later was to be the basic principle of all wireless valves.

□ □ □

Wiring Noises

SOME friends having complained that wireless reception, particularly on the short waves, was very noisy in their home, I took a hasty look at the wiring of some of the lighting and power circuits. What I saw then interested me so much that I said I'd spend a day on the job and do it thoroughly next time I was home on leave. That day was an eye-opener. I'm not surprised that their reception was noisy; in fact, it must be due to some special intervention of Providence that they haven't been electrocuted or their homes burned down before this. The wiring appeared to have been done by complete nit-wits, who had not only treated the I.E.E. rules with a fine, free disregard, but had also gone out of their way to evolve examples of crazy folly. There were as many switches in the neutral as in the live wire; frequently the "black" was the live, and the "red" the neutral wire; lead-covered cables had been largely used, without proper bonding or earthing; many joints and "tees" were made without the use of junction boxes. In one or two cases "flex" had been used for quite long runs—one such length of "flex" lay under the floor-boards of a corridor, sharing grooves in the joists with a gas main!

Don't Take It For Granted

This is the worst instance of bad and dangerous wiring that I've come across, but I suspect that there is a great deal of it about, especially in houses built in the 1920s, when far too much of this kind of work was done by what was euphemistically called semi-skilled labour. Some of the older houses, too, are not now in very good order as regards their power and lighting circuits. When I bought my present abode (built in 1909) I went carefully over the wiring and was so horrified by its condition that I gradually re-did the whole of it on modern lines and with modern materials. What the state of the circuits must be in houses that were wired 50 years ago and haven't since been re-done I can't think. I do, though, remember one friend, who had bought an old house, saying to me quite casually: "Queer thing about my house; the electricity meter keeps on turning even when everything's switched off"! Definitely, one's electric wiring should not be taken for granted. I've known many cases of radio noisiness that were directly traceable to defects in the household circuits. And not a few of these defects were such as to give rise to really dangerous conditions.

□ □ □

A π Query

ONE correspondent, after expressing admiration of the ways of remembering π to umpteen places of decimals which readers have produced, asks what is the use of them, anyway? Does anyone employ such a string of figures as 3.14159265358979 in any kind of calculations? Frankly, I don't know. I can't think who could do so or for what purpose. Possibly astronomers (this is suggested by the fact that Sir James Jeans is responsible for one of these aids to memory) need very accurate values for π in some of their more elaborate calculations. But one would imagine that even they could hardly need to go to 30 or more decimal places. Eleven places of decimals would give you the circumference of a sphere whose diameter equalled that of the earth correct to a ten-thousandth of an inch. There are, I believe, not many engineering jobs in which 3.1416 isn't a sufficient good approximation and for most electrical and radio calculations 22/7 is near enough. One marvels at the misplaced industry of the π-chasers who succeeded in slogging out values running to hundreds of places.

□ □ □

Sad

SPEAKING at an official function the other day, one of the big men in the British radio industry gave a foretaste of future policy which makes sad reading to those of us who had hoped that when peace returned the wireless and television receivers produced in this country would hold their own against any in the world. Here are some of the rather tragic things that were said. Television receivers, made at first to minimum requirements (able, that is, to deal with the sound and vision transmissions radiated by television stations, but not designed for sound reproduction on other wavelengths) were likely to sell at about £30 and within four years the price would drop to little more than half this. As for "broadcast" receivers—those, that is, which don't cope with television—his view was that the industry should aim at meeting the maximum demand, which was for a set priced at 12 guineas. In other words, the opportunity of showing what wonderful reproduction can be obtained from the high-fidelity sound transmissions accompanying television is to be flung away; you couldn't do it in a £30 set, and certainly, even in four years' time, not in one costing £17.

Production of simple and cheap sound broadcast sets may be—indeed, probably will be—a necessity for the immediate post-war period, but I hope that the "austerity" era will not endure for a day longer than our national needs may demand.

Price No Obstacle

Now *why* try to keep the price of television receivers down to £30? *Why* make the halving of that price your main aim as the years go by? Surely our radio manufacturers ought to know by this time that it was not the cost of receiving equipment which prevented the public from installing television in its homes in pre-war days. Some manufacturers had that idea in 1937, when sales were microscopic. Very well, they would show 'em! They would give the public the cheap television receivers for which it had obviously (their "obviously," not mine) been waiting. And they did. That is, they produced the cheap apparatus right enough, in 1938. There were plenty of television receivers then at round about the £30 mark and you could buy television "adaptors" for use with broadcast receivers for £22 10s. or a bit less. And did they sell? They didn't. The man in the street showed unmistakably that price was not the obstacle. He's quite prepared to accept television as a luxury and if one thing is certain it is that if he has a television receiver at all he wants a good one. And then receiving sets. It's the manufacturers, not the public, who have fixed the twelve-guinea set as the standard. Had the public been taught, as it should have been and still could be, that the twelve-guinea receiver was only for those who couldn't afford anything better, the story would have been very different. As it was, the manufacturers rammed into the head of the man in the street the idea that, unless he wanted a lot of quite unnecessary fal-lals, twelve guineas was all that need be paid for "the world's best wireless set," "radio's finest performer," or "the last word in receiving set technique." Before the war this specialisation in mediocrity cost the wireless industry of this country the loss of far too large a part of the Empire markets. It will be tragic if after the war, when we shall need our export trade as we have never needed it before, the same stupid blunder is repeated.

SCHOOL OF SIGNALS DEVELOPMENTS

Technical and Tactical Training

Wireless World recently had the opportunity of revisiting the School of Signals in the North of England, the functions and organisation of which we described in our issue of December, 1942.

As would be expected, considerable progress has been made in the intervening two years, in both the methods of training and the instruction given. During the past year approximately 8,000 students passed through the school, the primary function of which is to train signal instructors for all arms of the Service, other than the Royal Armoured Corps, and provide higher technical training for officers and N.C.O.s of Royal Signals. It should be pointed out it does not train recruits.

The school is organised as a Headquarters, including a Publications Section for the production of training manuals, and the following four Wings:—

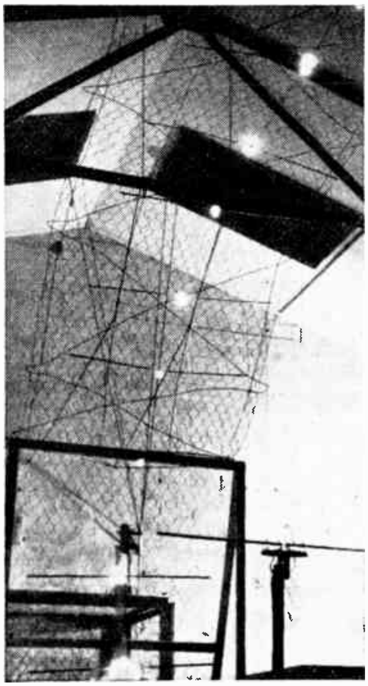
(1) The Royal Signals Wing, which provides a high standard of technical training in wireless and line equipment and line construction as well as undertaking the initial Army tests of new signals equipment;

(2) The Regimental Wing, which trains officers and N.C.O.s of R.A., R.E., Infantry and R.E.M.E. as instructors and assistant instructors in signalling;

(3) The Tactics Wing, which deals mainly with the tactical aspect of communications, and runs refresher courses for officers.

(4) The Administrative Wing.

A feature of the training is the use of practical demonstrations as opposed to lecturing. During a tour of the demonstration rooms various visual aids to facilitate training were to be seen. These have been designed by the staff and in many instances constructed by the students.



Apparatus for demonstrating the radiation from a dipole aerial.

One of the demonstration sets illustrates the exponential curve obtained when a condenser is charged or discharged through a resistance; as well as showing that damped oscillations occur if there is inductance in the circuit. Provision is made for the discharge of the condenser by a neon lamp or a valve connected across it.

To demonstrate Fourier's analysis five oscillators working at frequencies of 1, 2, 3, 4 and 5 kc/s are used. The relative phase and magnitude of the output of each of these may be varied, the phase variations covering at least one cycle. The outputs are connected in series to a cathode-ray tube which illustrates the result of combining a number of sinusoidal wave forms. Particular wave forms may thus be built up. In order to demonstrate aurally that a gradual change in the relative phase of two frequencies cannot be detected by ear, a loudspeaker may be connected to the output.

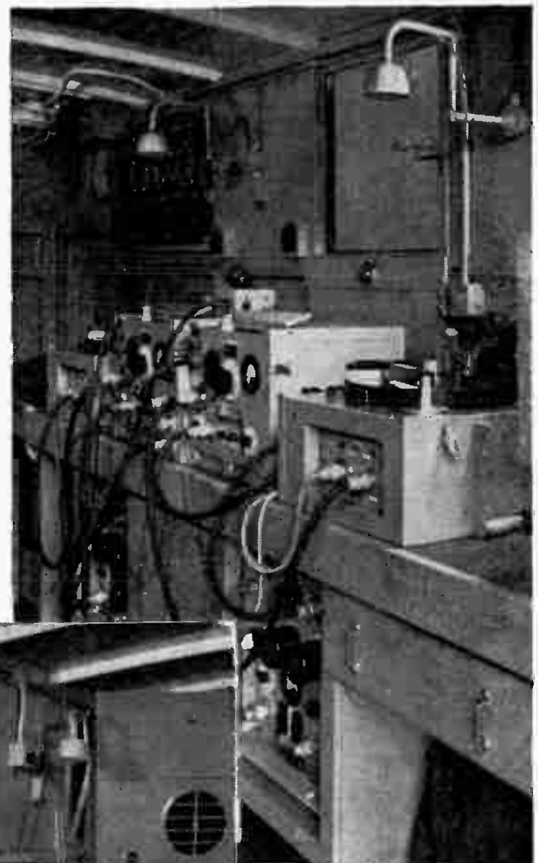
The importance to the Signals student of a sound knowledge of wave propagation and aerial characteristics cannot be over-estimated. It is not surprising, therefore, to find that one of the most elaborate demonstrations is that dealing with aerials. By means of flash lamp bulbs in series with miniature aerials which are excited by an oscillator working at a frequency of 150 Mc/s, horizontal and vertical polar diagrams can be visually demonstrated. The fundamental facts of radiation from dipoles—with and without reflectors and directors, vertical rod aerials, three-quarter-wave end-fed aerials and transmission lines can all be demonstrated.

One of the major Signals problems in modern warfare is the accommodation of a large number of sets using different frequencies within the allotted band without mutual interference. In the battle of El Alamein 6,000 sets were employed! It is obvious, therefore, that one cannot divorce tactical from technical training and the task of the Signals School can be summed up as that of teaching the application of signals technique to tactical problems.

WAR REPORTING

Some of the B.B.C.'s Mobile Recording Gear

BY providing regular eye-witness accounts from the widely dispersed war fronts the B.B.C. War Reporting Unit has done a good job of work. For such a diversity of tasks as, for example, the recording of sound pictures of a raid on Germany and the landing of paratroops in Normandy, a variety of equipment is used by the war correspondents for recording their reports and transmitting them to this country. The photographs on this page show two of the many types of recording outfits employed. In addition to these outfits midget disc recorders weighing only 35 lb., which were described in our May, 1944, issue, and the saloon car recording equipment, which was in use before the war, are also employed. On the whole the B.B.C. relies on gear which is designed, and not infrequently built, by its own Engineering Division.



In the largest type of recording van employed by the War Reporting Unit two disc recording channels are fitted. The mains-operated channel is illustrated above and battery operated on the right.

The roof of the recording van provides an elevated observation point for the reporter.

For use in the field, battery-operated recording equipment is mounted in a Jeep trailer. The microphone mixer can be seen above the amplifier in the photograph below. The power supply unit is obscured by the operator.

STANDARDISED COMPONENTS

1—Properties of Resistors

By THOMAS RODDAM

The significance of wartime measures for standardising the properties of radio components was discussed in last month's issue, and it was pointed out that this standardisation may profoundly affect the industry's post-war work. A more detailed examination of the characteristics of resistors as standardised is made in the present article

IN an introductory article in last month's *Wireless World* the new specifications now being published in the BS/RC series[1] were explained. We now continue with our examination of some details of the specifications. It will be assumed that the specifications are drawn up to provide the best possible components which can be produced in adequate quantities by modern methods. The figures given are thus assumed to represent the behaviour of perhaps the worst 10 per cent. of the production, and in designing equipment we must remember that we cannot normally demand any better performance than that described in the specifications. In an ideal engineering world, indeed, the component maker would be careful *not* to make the components any better, if to do so would cost any more.

With this in mind, let us consider the properties defined for resistors. In Fig. 1 is shown diagrammatically the way in which resistors are classified. Our principal interest will, of course, be the carbon resistor, which is easily the most common single kind of component in use. Carbon resistors are classified in two ways: by method of manufacture and by performance. The reason for this classification is somewhat obscure, because as far as the writer is aware all Grade 1 resistors are carbon film types, and all carbon film resistors are intended to be Grade 1, and are too large for Grade 2 anyway. However, in the documents two grades, 1 (high stability) and 2 (medium stability) are introduced. Later we shall see what this means. Three methods of construction are described: carbon film, carbon composition and composition film. The last of these is probably the oldest type of mass-produced cheap resistor. In primitive language, it consists of a glass tube which has been black-leaded and then baked until the carbon composition forms a hard film on the tube. This resistance element is enclosed in a ceramic or bakelite covering and leads brought out. This type has long met much competition from the carbon composition resistor. A mix of carbon black, resin and other materials is moulded under pressure into a rod, which is then ground to a cylindrical "pin." The ends are coated with copper, around which (in the larger sizes) wires are wrapped, soldered, and the resistor is painted. The smaller sizes are often enclosed in ceramic cases, and recently very small types in bakelite coverings have appeared. Unprotected types down to very tiny sizes are made. A full description of the manufacturing process appears in the April, 1943, number of the *Post Offie Electrical Engineers' Journal*. The carbon film resistor is, as a bread-and-butter component, relatively new in this country. A ceramic rod (or glass rod or tube) is exposed to hydrocarbon vapours in a heated chamber. A thin film of more or less pure carbon is deposited on the rod. In preparing resistors of high values a spiral is cut in the carbon film to provide a long narrow track of the relatively low resistivity material. The resulting resistor is very stable in value. It is normally protected by a tube or lacquer film from moisture and mechanical damage. These resistors are usually larger in size than composition resistors of the same wattage dissipation.

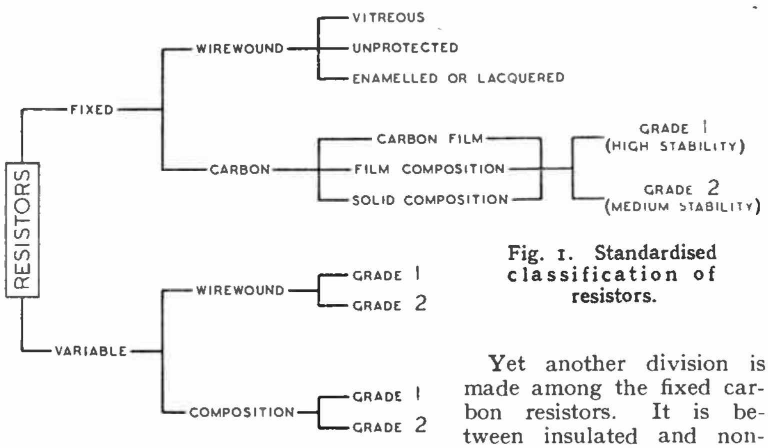


Fig. 1. Standardised classification of resistors.

Yet another division is made among the fixed carbon resistors. It is between insulated and non-insulated types. Insulated types are those resistors which are encased in ceramic or bakelite and can therefore be allowed to touch metal panels and the like without danger. Resistors which are covered only with paint should not be used in this way, even if a test with an ohmmeter suggests that the paint is an insulator. This distinction is even more important with wire-wound resistors, as the high temperatures at which these can be run result in a very con-

[1] *The Services Radio Components Book*, published by The British Standards Institution.

siderable lowering of the insulation resistance.

In Fig. 2 is shown the permitted changes in value of a Grade 2 resistor. As supplied, it has a normal tolerance of 20 per cent.: for this we are prepared. But this is not all. An ageing effect may produce a drift of up to $2\frac{1}{2}$ per cent. in six months, and this drift is most rapid when the resistor is new. Soldering the resistor into position may also produce $2\frac{1}{2}$ per cent. change, and under normal load conditions, which are quite generous, a further 3 per cent. drift is possible. These changes are apparently non-reversible. To them must be added the effect of temperature, which may cause a change of up to 6 per cent. Another effect is a non-linearity commonly called voltage coefficient: the value of the resistance is not independent of the applied voltage and resulting current, but changes by an amount dependent on the voltage applied. It is found that changes of up to $7\frac{1}{2}$ per cent. may be produced by this effect. If we examine the figures closely we see that a resistor in position in a set may, when the set has once been operated, have a value differing by 9 per cent. from its initial value, and consequently by up to 29 per cent. from its nominal value. Further, when the set is working an additional change of up to $13\frac{1}{2}$ per cent. is possible. Tropical conditions may introduce a shift of 3 per cent. In the fixed resistor guide a statement is made that the permanent drifts are usually towards increased values of resistance while the cyclic changes are towards reduced resistance. If this is so, a self-balancing action will tend to prevent such large changes as we have envisaged. As most circuits would go on strike if such enormous changes as the specification permits actually took place, we can assume that the picture is perhaps a little gloomy.

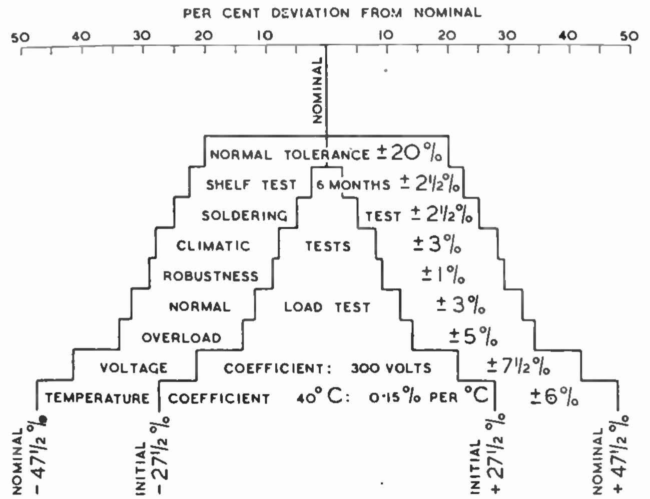


Fig. 2. Grade 2 carbon resistors: specified permissible deviations from nominal rated values and actual initial values.

If we now look at Fig. 3, which represents the specified behaviour of a Grade 1 resistor, we see that the normal changes associated with soldering, robustness, loading and life amount only to 2 per cent. Such resistors are therefore very constant in value, so long as they are not run at any appreciable loading. The chief source of change is still voltage coefficient, with temperature coefficient coming second, and the two together amounting to $7\frac{1}{2}$ per cent. Thus the stability of a resistor is very closely dependent on its circuit use. If it is run at its full rating it is likely to differ appreciably from its tested value. As the change due to voltage coefficient takes place immediately, circuit drifts with high-stability resistors will be comparatively small, as only the temperature coefficient of 0.04 per degree Centigrade has any "slow drift" effect.

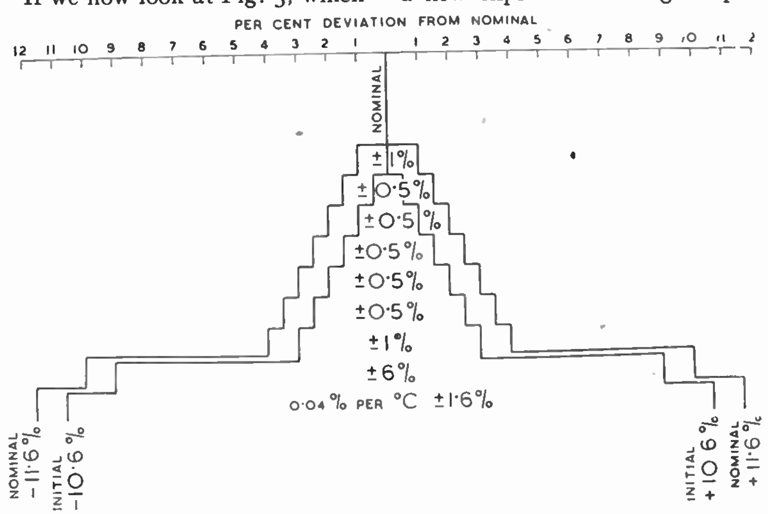


Fig 3. Specified performance of Grade 1 carbon resistors; nature of the various tests as in Fig 1.

Before we leave carbon resistors, two points are of interest. The noise voltage appearing across the terminals of a resistor when a current flows through it is considerably greater than the normal Johnson noises. The formula given for this carbon noise is $2 + \log_{10}\frac{R}{1{,}000}$ microvolts per volt applied. This is plotted in Fig. 4. In addition, the noise level given by Christensen and Pearson[2] is plotted with constants chosen to make curves touch at 10,000 ohms. It will be seen that there is not a great deal of difference, and it is difficult to see why a new expression having no possible theoretical justification has been used. The I.S.C.Tech.C. formula offers us a silent resistor of 100 ohms value! Fortunately

[2] *Bell System Technical Journal*, April, 1936.

Standardised Components—

this is of little importance, for most uses of carbon resistors do not involve current flow at points where the noise level is of importance.

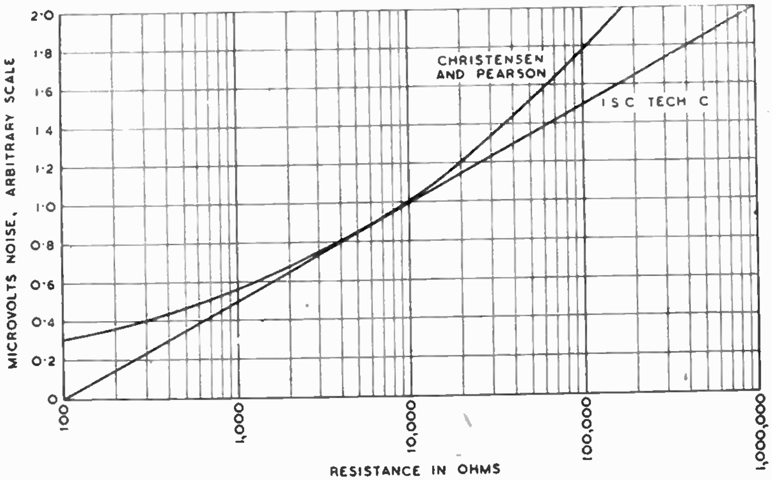


Fig. 4. Curves for noise level of resistors.

The effect of high frequencies is also of interest. A note on this appears in the guide. Sometimes known as the Boella effect, the apparent fall in resistance due to distributed capacitance has been thoroughly explored. The capacitance being distributed, it cannot be tuned out. The actual behaviour of a resistor can be predicted from Howe's curve,[3] which is reproduced in Fig. 5.

Wire-wound Resistors

So much for carbon resistors. There is no need to say much here about wire-wound resistors, as these are remarkably well-behaved and straightforward components. One point of some interest which stands out in the specification, however, is the effect of the temperature coefficient. A temperature rise of 180 deg. C. with a coefficient of 0.025 per cent. per degree involves a change of 4½ per cent. Thus a wire-wound resistor will probably never be more than about 5 per cent. different from its initial value. Indeed, the only disadvantages of wire-wound resistors appear to be their inductance and their cost. For anything except audio-frequency work, the inductance is likely to be important and, in general, wire-wound resistors cannot be used at frequencies where the product fR (f in kc/s, R in ohms) exceeds about 10^6 unless the inductance of the resistor can be used as a circuit element.

This survey of the specifications to which the bulk production of fixed resistors will be made is not complete. It is felt that by keeping to the broad outlines light has been shed on certain rather dark passages in these documents. But the writer would urge that the I.S.C.Tech.C. should itself take over the work of explaining the implications of their specifications. By the publication of guides of adequate length and full authority the life of the equipment designer could be greatly eased. For example, the guide on fixed resistors does not draw attention to the wide variations in value which can take place with carbon resistors, yet this is of paramount importance. Further, those responsible for the specifications may know that the extreme range of 27 per cent. which the specifications predict is, in fact, never reached and that perhaps 10 per cent. is a safer figure. These things must be known; they deserve full publicity.

Variable Resistors

We shall not devote much space to variable resistors. These, as will be seen from Fig. 1, are split up into composition track and wire wound, and each type is then divided into two grades. The only difference between them is apparently in insulation, and it appears unfortunate that a Grade 1 composition variable resistor should have high insulation resistance, when it is Grade 2 among the wire-wound variable resistors which has the higher insulation resistance. The stability of Grade 1 composition variable resistors is

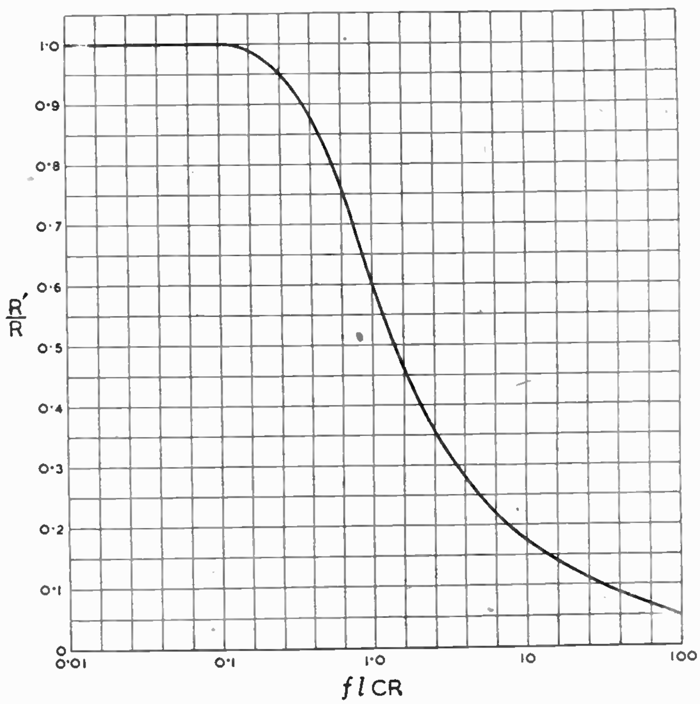


Fig. 5. Effect of high frequencies.

[3] *Wireless Engineer*, June, 1935.

not high; no higher, in fact, than that of Grade 2 fixed resistors. Thus the term "Grade" loses its meaning. It is this kind of thing which causes intense confusion in the laboratory and drawing office. The properties of the variable resistors resemble closely those of the fixed resistor in scale. Shifts of 5 per cent. for composition tracks and 1 per cent. for wire tracks are normal, but the permitted change of 50 per cent. under load for composition tracks is rather shocking. It is not surprising that no overload test is incorporated. A second rating would have been a great help—one which would not have produced a change exceeding perhaps 10 per cent.

Wire-wound resistors for wireless apparatus are now produced in a wide range of values and with ratings of 3 to 100 watts.

Courtesy Erie Resistor, Ltd.

To conclude, a word on values and colour coding. The values of resistors have been standardisd on the preferred number scale, 10, 15, 22, 33, 47, 68, etc. This scale enables any value to be quoted as a standard value ±20 per cent. In production, therefore, a finished resistor, whatever the actual resistance value it happens to have, finds a bin to receive it. And there are no selection rejections. This scale of values has proved so useful in the last five years that it would seem to be desirable to extend it to all components. Most radio engineers now know the scale by heart and would welcome its introduction for all components on which symmetrical tolerances are required. The colour coding of resistors, too, is here to stay. Resistance value and the tolerance are both to be marked. The system is that which has been used for many years, and the writer has heard no complaints about it in industrial laboratories or from installation engineers in the field. It would be a quite unjustifiable change were it turned upside down; likely to lead to outbreaks of hysteria all over the country.

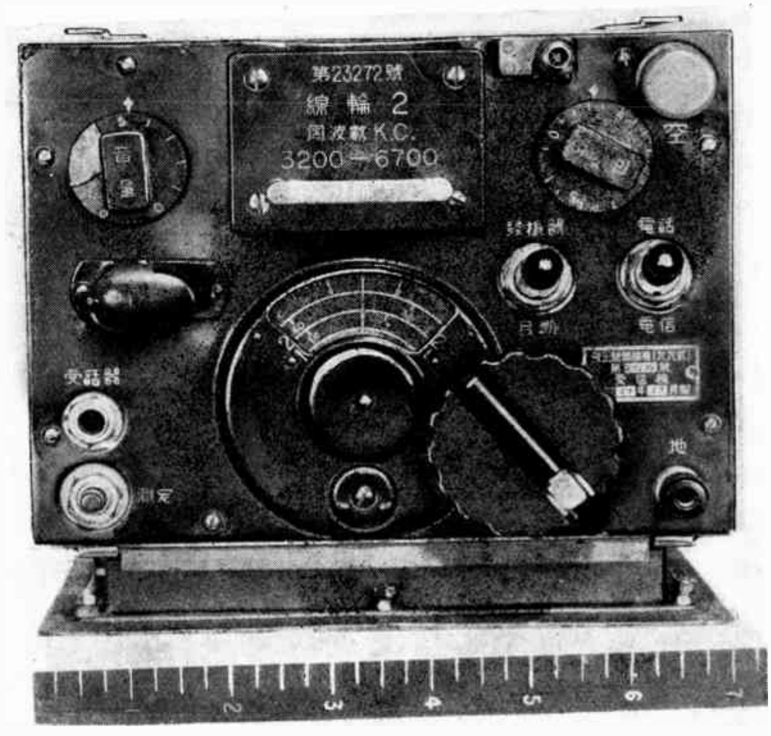
OUR COVER

THIS month's illustration of a group of Erie resistors gives some idea of the wide variety in which these vital but perhaps unspectacular wireless components are now being produced. The ratings of the specimens shown range from 2½ watts down to $\frac{1}{10}$ watt.

JAPANESE AIRBORNE RADIO

THE Model 99, Type 3 receiver, used in Japanese reconnaissance-bomber aircraft employs four similar valves of the triode-pentode type, identical with the American 6P7. The circuit is arranged as follows:—

RF amplifier ...	pentode section of valve	1
Mixer	triode ,, ,,	2
Oscillator	pentode ,, ,,	2
1st IF amplifier ...	,, ,, ,,	3
2nd IF ,, ...	,, ,, ,,	4
2nd detector and beat oscillator	triode ,, ,,	4
1st AF amplifier ...	,, ,, ,,	1
2nd AF amplifier ...	,, ,, ,,	3



The receiver has an intermediate frequency of 450 kc/s and a tuning range of 1.5 to 6.7 Mc/s in two bands with interchangeable coils. There is provision for reception on one crystal-controlled spot frequency. No AVC is incorporated. A folding handle is provided to speed up movement from one part of the dial to another, since the fixed reduction ratio of the slow motion tuning drive is 114:1.

The design makes no contribution to our knowledge of reception technique, but is an advance on Japanese-built receivers of two or three years ago.

INTERFERENCE FROM RADIO HEATERS

Suggestions for Control

By F. YOULE
(Rediffusion, Ltd.)

RADIO frequency heating is rapidly establishing itself in many industries. Equipment for thousands of kilowatts is already projected, in units ranging from 100 watts to 100 kW. and more; it requires little imagination to visualise single factories with an installed RF output approaching the combined carrier power of several main broadcast stations.

Until September, 1939, no control of radiation from industrial and medical equipment existed in Great Britain. Offenders were dealt with by persuasion and technical assistance. That situation still holds good for many forms of interference, but the Control of Apparatus orders of 1940 and 1942, under the Defence Regulations of 1939, did give the Post Office power to prohibit the manufacture, sale, purchase or use of any equipment which radiates at radio frequency to a degree considered dangerous to public safety and Service requirements.

This is a war measure; there is no guarantee of its survival when peace returns, and in fact there are good reasons for the withdrawal of some of its provisions; for example, the restriction on purchase of ordinary broadcast receiving valves above 10 watts anode dissipation. But on the question of radiation there is a strong case for not only continuing control, but extending it to include the highly annoying damped wave trains produced by all kinds of electrical machinery, sparking plugs and other essentials of our civilisation.

Some form of control for industrial radio heating is therefore indicated, at the earliest possible date. Later, the entire field of radio will be reviewed by the technical committee of the International Telecommunications Convention; existing frequency allocations will be revised and a new world plan prepared in which radio heating must inevitably be given a place. Until then no long-term decisions can be taken.

Fortunately most of the pioneers in the new sphere are themselves communication engineers with a lively sense of their responsibilities. They are, however, up against some stiff technical problems, and in spite of all reasonable care, cannot absolutely control the conditions under which their products may be used. It is evident that without some unifying code, attempts to meet these conditions will result in many individual standards, adding greatly to the task of subsequent rationalisation.

A comparatively simple case of effective anti-interference screening: the "work" chamber of a Rediffusion ¼ kW heater, mounted close to the generator and fully screened.

Let us consider some of the more obvious hurdles.

First, the materials to be heated range from an ounce or less of moulding powder and similar substances to several hundred pounds of large plywood board; from strips of P.V.C. less than 0.5 mm. thick to rubber mouldings several inches deep; from the tips of small lathe tools to steel billets weighing several pounds. These cannot all be dealt with on a limited frequency band. They call for a number of channels ranging from under 500,000 c/s to over 100 Mc/s, which will be difficult to find in our congested ether.

Secondly, whereas transmitters feed into circuits whose characteristics are known and stable, industrial RF generators supply loads which usually do anything but remain constant over a heating cycle. Changes of 1 to 5 in capacity, power factor and dielectric constant are relatively common; a stack of resin-impregnated paper heated under pressure to form, say, paxolin sheet, may exhibit a capacity change of 1 to 20 during the process. The properties of steel alter so greatly at critical temperatures that a fixed frequency oscillator will drop from maximum to one-tenth full loading in a couple of seconds. To meet such conditions one must either tie the frequency to the load constants or provide means of maintaining the latter within reasonably narrow limits.

Thirdly, RF heating will be used extensively with existing machines, often of very large size. These cannot be moved, replaced, or screened effectively except at prohibitive cost. A really big press, for instance, will occupy as much volume as a dwelling house, towering 300 feet above the floor, extending perhaps 10 feet below, with platens up to 16×8ft. flanked by mechanical loaders extending 20 feet on either side. Fortunately this type of plant is usually in a steel framed building, has a high capacity to earth, and by virtue of its shape and material—chiefly steel—is an inefficient radiator. But it will be linked to the biggest RF generators, and may therefore have to be permitted limited radiation on an approved channel.

Although evidence is being accumulated by means of field strength measurements for many installations, we are still far from the detailed knowledge essential to balanced decisions on what must be done. Nevertheless, action is needed, and the following code is put forward in the hope that its reasonableness will encourage general acceptance without coercion, until such a time as rules based on experience can be framed.

First, it is suggested that equipments built in such a manner that the total external field produced by the RF unit, its load and all interconnections, including mains leads, is below a specified level should be free from frequency control and additional screening requirements. Two provisions are added:—

1. That channels allocated to public services such as broadcasting and television be avoided, as in most industrial areas factories and large numbers of dwelling houses are so closely intermingled that the aggregate field strength from a number of RF units may easily cause appreciable interference.

2. That the permitted radiation level should vary according to local conditions, and not be a single arbitrary figure at a fixed distance, for example, a factory situated away from residential areas, or placed in large grounds, may well cause no nuisance outside its walls with higher intrinsic radiation than one less favourably placed. Or a plant near a broadcast station might quite safely work on a frequency adjacent to that of the nearby station, but would create havoc at a frequency close to that of a popular distant station.

Second, if the radiation cannot be kept below the prescribed level, the installation must either be enclosed by adequate external screening or confined to a permitted frequency. The latter presupposes a closely controlled master oscillator and means for adjusting the load circuit to it.

Any attempt to forecast the ultimate frequency allocations for such cases is obviously highly dangerous to one's prophetic reputation. But a study of the International Radiocommunications Regulations (Cairo, 1938) combined with some knowledge of the industrial heating field already explored, suggests that a useful start could be made with eight selections in the following bands:—

100—140 kc/s	16—17.5 Mc/s
515—540 kc/s	28—30 Mc/s
1.7—2.0 Mc/s	60—66 Mc/s
6.8—7.1 Mc/s	112—123 Mc/s

It is possible that some of these may either now or later be occupied by new services of which we are not aware, but if adopted, they would fulfil the primary purpose of gathering together the many independent lines of current development into manageable groups, and creating a basis from which final agreement may more easily spring.

"WIRELESS WORLD" DIARY

OUR Publishers regret that owing to production difficulties the *Wireless World* Diary for 1945 will not be ready until the middle of December, when copies will be distributed through booksellers and stationers. The price will be 3s. 4½d., including purchase tax.

WARTIME SALVAGE

LAMINATED paper bonded with synthetic resin is being more widely used than ever by radio manufacturers. The shortage of materials is likely to persist after the war and it is, therefore, still necessary to save all waste paper.

WORLD OF WIRELESS

ALL-ELECTRONIC CINEMAS

IN his presidential address to the British Kinematograph Society, A. G. D. West submitted a ten-year plan of development for the cinema which might be summarised by the epithet "towards an all-electronic cinema."

The first two years of the plan are allotted to the solution of some of the technical problems facing the industry, particular attention being paid to acoustics and sound standardisation. The president added, "The talkie is 15 years old and it still has not learnt to talk clearly and intelligibly."

Two years are assigned to "settling the colour situation . . . and the stabilisation of screen brightness."

The president foresees the development at the end of six years of "a serviceable and commercial equipment and system for large-screen television in the cinema. It is here that we find our first departure towards equipment which is fully electronic—involving camera pick-up devices, cable or radio distribution, and cathode-ray projection."

A further two years should, according to Mr. West, see the completion of colour television in the cinema. Commercial stereoscopy on large screens is anticipated by the end of the ten-year period.

Reference is also made in the report to the use of electronic music.

It is noteworthy that the formation of a Television Division of the British Kinematograph Society is proposed.

STANDARDISED HEARING AIDS

THE Duke of Montrose, president of the National Institution for the Deaf, asked in the House of Lords what progress had been made by the Government in their negotiations with the hearing aid manufacturers to produce national standardised hearing aids.

Lord Templemore said that the Medical Research Council had set up a committee to investigate standard aids which could be sold at a reasonable price. They are supplied free of charge to ex-service men suffering from deafness due to war service.

FM IN CANADA

PREPARATIONS are being made in Canada for the introduction of FM broadcasting, which the Canadian Broadcasting Corporation believes "should be introduced generally when conditions permit." The first transmitter is to be erected at the summit of Mount Royal, Montreal, and a second in Toronto. When these stations are established all C.B.C. programmes in the two cities will be broadcast by them for experimental purposes and to provide demonstration transmissions to aid the sale of FM sets.

It is understood some 60 applications for commercial FM stations have already been made in the Dominion.

Dr. Frigon, the new general manager of the C.B.C., has announced that a Radio Technical Planning Board is being established in Canada to go into the question of FM.

E.M.I. APPOINTMENT

SIR ERNEST FISK, the Australian wireless pioneer, is vacating his position as chairman of Amalgamated Wireless (Australasia) to come to this country to become managing director of Electric and Musical Industries. He joined the Marconi Company in 1906 and went to Australia in 1910 where he assisted in the formation of A.W.A. in 1913. He was appointed managing director in 1917 and has been chairman since 1937—the year in which he was knighted.

Sir Ernest, who is a past chairman of the Institution of Radio Engineers (Australia) and an honorary member of the I.E.E. and of the Brit. I.R.E., has played a predominant part in antipodean wireless and has been a pioneer in the establishment of empire communications. He received the first direct transmission from this country to Australia in 1918.

Sir Ernest Fisk.

AMERICA LOOKS AHEAD

THE U.S. joint government-industry conference which, as reported in our last issue, is actively engaged in preparing recommendations for the guidance of the American delegates to the post-war international radio convention, has discussed several proposals that would radically affect the future organisation of wireless. Some of the most important suggestions made relate to an extension of the normal MW broadcasting band; these range from proposals for the mere addition of three additional channels to the low-frequency end of the band up to the transfer of the entire 200-400 kc/s band for use in high-power rural broadcasting.

Other proposals include: amateur allocations—56-60 Mc/s plus four channels below 150 Mc/s; radio heating and medical applications—10 narrow bands on various frequencies from 13 to 490 Mc/s.

WHAT THEY SAY

TRIBUTE TO RADAR.—The *Luftwaffe's* attacks in the Battle of Britain were met by a scientific plan made possible by radar. It was due to you [the radio industry] that the battle that changed the face of the world was won.—*Lord Sherwood, Joint Under-Secretary of State for Air, at the Radio Industries Club.*

A SQUARE DEAL.—The fact that many [American] amateurs feel it necessary to prepare to fight for their future is in itself little short of disgraceful. If the nation ever owed a debt to any group of "hobbyists," it owes it to the radio amateur. In peace it was the ham who was always on the job whenever disaster struck a community, generally affording the only means of communication when flood or wind wiped out normal facilities. With war the country had a ready-made band of specialists in radio, an incalculable contribution in a conflict where communications are of such prime importance.—*Jack Gould in the New York "Times."*

EDUCATIONAL BROADCASTING.—School-owned FM stations will come, more and more, to broadcast programmes for student listeners during out-of-school hours, designed to supplement the regularly scheduled work of the day school proper.—*Dr. J. W. Studebaker, U.S. Commissioner of Education.*

FRIENDSHIP BRIDGE.—International broadcasting is the greatest single instrument created by man for developing international good will—good will that comes back to us from the hearts of the common people and not merely from the lips of the statesmen of foreign countries. . . . If we close the door on international broadcasting, we close doors to men's minds in a hundred countries of the world.—*Paul W. Kesten, Executive Vice-President, Columbia Broadcasting System.*

NEWS IN MORSE

THE G.P.O. has advised us of one or two corrections to the schedule of morse transmissions of official news bulletins from the Post Office stations published in last month's issue.

The wavelength of station GIY was given as 51.50; this should have been 5830 metres (51.50 kc/s). This station is used for the 0045-0145 and 1800-1945 transmissions in addition to those given. Station GIJ is not now used for the transmission from 1915 to 1945.

RADIO HEATING

IN a paper on "High-Frequency Heating" read before the Royal Society of Arts on November 15th, Dr. L. Hartshorn, of the National Physical Laboratory, gave a résumé of the fundamental basis of heat generation by electrical methods. The paper dealt chiefly with the higher radio frequencies used in dielectric heating and touched on the possibilities of selective heating in laminated materials with layers of different dielectric characteristics.

"TELEVISE TO ADVERTISE"

DURING the four months ended in August the number of applications for commercial television stations in the United States was more than doubled.

There are still only nine stations operating, but applications for new commercial stations have reached the surprising total of 68. These stations will be erected in twenty-four different States.

According to the RKO Television Corporation, which conducts the television programme-building service with the slogan "Televise to Advertise," there is a market for nearly fifteen million television sets in the areas to be covered by these stations.

CANADIAN NEWS

WHEN giving evidence before the Canadian Parliamentary Radio Committee the general-manager of the Canadian Broadcasting Corporation stated that the Corporation is "awaiting the crystallisation of conditions in the U.S. before committing itself to a definite policy on the establishment of a television service in the Dominion." It was also pointed out that the C.B.C. would need a large Government grant if it undertook research work in the field of television.

In an 80-page report placed before the Committee on behalf of the sixty-four privately owned stations in the Dominion, the view is expressed that Canada's second broadcasting network should be placed in the hands of private enterprise and that a broadcasting control commission should be set up.

It is also recommended that the receiving licence fee is increased from \$2.50 to \$3 so that it would be unnecessary for the Corporation to "sell time" to increase its income.

PERSONALITIES

Lord Woolton has been elected president, and Sir Percy Ashley vice-president, of the British Standards Institution.

E. L. A. Mathias, general manager and chief engineer of the Marconi Wireless Telegraph Co. of Egypt, has been made an O.B.E. for services to the Forces and in connection with military operations in the Middle East.

J. W. Ridgeway, who was appointed assistant manager of the Radio Division of Ediswan in 1929 and manager in 1940, has been elected to the board of the Cosmos Manufacturing Co. He has been chairman of the British Radio Valve Manufacturers' Association for the past three years.

E. Y. Robinson has also been elected to the board of the Cosmos Manufacturing Co. He joined the Metropolitan-Vickers Co. in 1922, and transferred to the Cosmos Manufacturing Co. in 1927 as chief engineer of the valve department. He became chief engineer of the company in 1929.

B. St. John Sadler has been appointed managing director of Rediffusion, Ltd. He was formerly commercial manager of Marconi's Wireless Telegraph Co., Ltd.

IN BRIEF

War News.—When replying to a question in the House of Commons regarding the facilities for the transmission of news from correspondents with the British Army on the Continent, Sir James Grigg announced that three-quarters of the high-speed wireless transmissions from our Forces in N.W. Europe and all the high-speed teleprinter circuits are used exclusively by the Press.

Radio Officers are urgently required for civilian work of national importance in the North Atlantic Air Services. Applicants, who must have the P.M.G. First Class Certificate and experience of high-frequency DF work, should apply to "Civil Aviation," Radio Officers' Union, 37, Ingrebourne Gardens, Upminster, Essex.

Bravery at Sea.—The Editor of *The Signal,* the official magazine of the Radio Officers' Union, writes: "We are proud to state that since the beginning of the war, to date, 33 Radio Officers have been awarded Lloyds War Medal for Bravery at Sea.

Wireless Circuits Reopened.—Cable and Wireless announce that the London to Athens and London to Paris wireless circuits have been reopened for Press traffic only. The circuit to Athens,

World of Wireless—

which originally opened in 1937, has been closed since 1941.

Canada's Radio Industry produced $16,000,000 worth of apparatus a year just prior to the war. This year's estimated total will be $200,000,000. Measured by dollar value, the output of telecommunications equipment ranks sixth in the Dominion's war products. Canada is producing vast quantities of radar gear, the largest type of which incorporates 60,000 parts, including 270 valves.

Brit.I.R.E. Council.—At the recent annual general meeting of the British Institution of Radio Engineers the following were elected to the General Council: P. Adorjan (Rediffusion), J. W. Ridgeway (Ediswan), H. Brennan (Universal Relay, Gateshead), Lt. Col. F. Taylor (War Office), T. D. Humphreys (Cossor), and M. M. Levy (Standard Telephones and Cables). The following members remain on the Council for a further 12 months: G. A. V. Sowter (T.C.M.), Sqn. Ldr. S. R. Chapman, L. H. Bedford (Cossor), N. McLachlan (Philco), W. W. Smith (C.E.B.), and J. Dimmick (Norwood Technical Institute). G. A. V. Sowter has been elected Chairman for the year 1944-45.

Wireless School Transfer.—No. 1 Wireless School, Queen Mary Road, Montreal, Canada, has moved to Port Hope, near Hamilton, Ontario. Thousands of airmen and women who have graduated from it as wireless operators, wireless mechanics and radio telephone operators are now serving on all fronts.

Girton Radio Bursary.—Hilda R. Ridyard, of Audenshaw, has been awarded a State Bursary for a three-years' course in radio at Girton College, Cambridge.

Brit.I.R.E.—126 candidates entered for the graduateship examination of the British Institution of Radio Engineers which has just been held in various centres in this country and overseas and in prisoner-of-war camps. The President's Prize for the most outstanding candidate in the Graduateship Examination and the Mountbatten Medal for the most outstanding candidate serving in the Forces have been awarded for the previous examination to Sgt. T. R. Nisbet, serving in India. The S. R. Walker Prize for the second in order of merit has been awarded to P/O. H. N. Gant, R.N.

Licence Record.—According to the latest figures, some 250,000 more receiving licences are in force than at this time last year. There are now 9,609,503 in Great Britain and Northern Ireland.

MEETINGS

Institution of Electrical Engineers

Radio Section.—"The Measurement of Balanced and Unbalanced Impedances at Frequencies near 500 Mc/s and its Application to the Determination of the Propagation Constants of Cables" is the subject of a paper to be given by Dr. L. Essen at a meeting to be held on December 6th. On December 19th, Dr. D. C. Espley will open a discussion on "The Sound Channel in the Television Receiver."

Both meetings commence at 5.30 at the I.E.E., Savoy Place, Victoria Embankment, London, W.C.2.

Cambridge and District Group.—H. L. Kirke, Chairman of the Radio Section, will repeat his inaugural address at a meeting to be held on November 28th. "Applications of Psychology to the Engineering Industry" is the subject of a paper to be given by Miss A. W. Heim and K. J. W. Craik on December 12th. The meetings commence at 7 o'clock at the University Engineering Department, Trumpington Street, Cambridge.

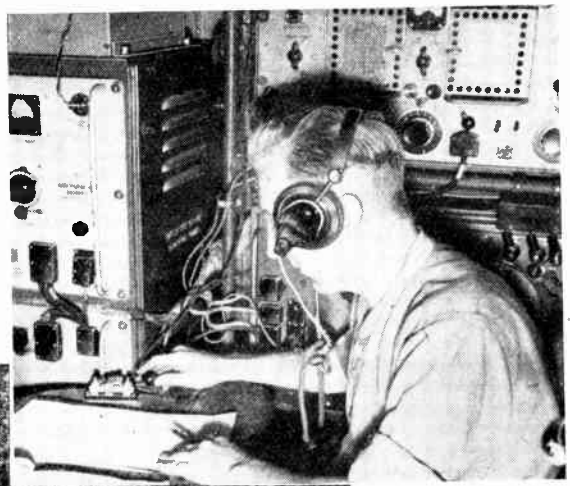
Midland Amateur Radio Society

The Society meets at the Birmingham Chamber of Commerce, New Street, Birmingham, at 6.30 on the third Tuesday of each month. Details can be obtained from the Hon. Sec., E. J. Wilson, 48, Westbourne Road, Olton, Birmingham, 27.

Institute of the Plastics Industry

Dr. A. C. Dunningham will lecture on "Heat Utilisation in the Moulding Shop" at a meeting to be held at 6.30 on November 28th at the Waldorf Hotel, Aldwych, London, W.C.2. Non-members should apply to the Secretary, H. F. Judd, 18, Danson Road, Bexleyheath, Kent, for tickets.

CORPS HEADQUARTERS SIGNALS OFFICE



During the more mobile phases of the war in Europe, wireless equipment capable of relatively long ranges has come into its own. This photograph shows a well-camouflaged 'Command' vehicle used for communication between Corps and Divisional Headquarters. Some idea of the relatively high power of the apparatus can be obtained from the inset.

Letters to the Editor

Post-war Reorganisation • Domestic Acoustics • Synthetic Sound

Aviation Radio Beacons

WARTIME development of aviation and radio bespeaks as great a change in our habits of thought as in our habits of life, but there is reason to fear that our thinking lags and that the cost to us may be serious.

There is, for example, grave need of economy in the use of the radio spectrum if the latter is to meet our essential needs. The interest in that economy, moreover, is global, as is the scope of aviation and radio. However, the aviator is not the only person who has essential need of radio, for any radio beacon may be the means of saving the life of a sailor, yachtsman, explorer or prospector, even though that beacon were installed without regard to his needs.

These thoughts are prompted by reports of proposed changes in the frequencies of commercial radio - navigational aids in America. That the contemplated frequencies are in the ultra-high or so-called "optical" band is beside the point, which is that beacon frequencies should now be allocated on a global basis, so that each, of itself, identifies latitude or a longitudinal great circle.

Regardless of political boundaries, beacons on a given latitude should have the same frequency, which might be modulated to indicate latitude. Special cases should be met by derivatives of this basic method.

To facilitate discrimination, latitudinal and longitudinal frequencies should be in separate and sufficiently separated bands, and adjacent parallels or great circles should have adjacent and sequential frequencies, each of such parallels or great circles having but one carrier frequency, starting at, say, Greenwich and proceeding westward.

Assuming that such a frequency-allocation system were adopted, radio beacons could be installed anywhere by any authorised person with a minimum of delay. The design of radio-navigational receivers would be simplified, and the beacons would serve for the benefit of anyone, anywhere, who had taken the precaution to equip himself with a suitable receiver and frequency-annotated map. Other results would be an immense economy in the use of the radio spectrum, and the instant provision of radio beacon frequencies for world coverage. Thereby any kind of navigator anywhere could be appraised of his location by reference to data and recourse to apparatus which would not be costly, complicated or cumbersome.

ARTHUR H. MORSE.
New York.

Reorganising Broadcasting

MAY I offer the following suggestions for post-war broadcast organisation

1. That a frequency separation of 10 kc/s be universally adopted.

2. That all stations send on an exact multiple of 10 kc/s for simplicity of reference.

3. That radio receivers be calibrated in multiples of 10 kc/s, e.g., 65, 66, 67, etc., for MW. These figures could then be referred to as "channels" and thus end the perpetual frequency *versus* wavelength war. The initiated would mentally add a nought and know it to be frequency in kc/s.

4. That all simultaneous and common wave broadcast be abolished, as experience shows this to be detrimental to quality. Most people would prefer fewer but more perfect programmes rather than a large variety of nothing worth listening to.

C. J. M. BOSWELL.
Norwich.

"Acoustics of Small Rooms"

I FOUND this article (your November issue) extremely informative, as it gives quantitative data on a subject in which I am interested.

Letters to the Editor—

The problem of too short a reverberation period at low frequencies can be very much alleviated by introducing an artificial "echo," either by use of an echo chamber or by use of an electro-mechanical delay system consisting of, say, a magnetic disc recorder and a series of reproducing heads.

The problem was attacked experimentally before the war by Poste Parisien, and gave very interesting results in an experimental hour they held at that station.

It is a "post-war plan" of mine to install some such system myself, and now that full publicity has been given to the subject it would not surprise me if high-fidelity receivers of the future all possess a knob marked "Reverberation" and calibrated in seconds!

But what the "non-coloration" school of reproduction fans would say I shudder to think!

R. G. YOUNG.

Wimbledon, S.W.19.

Synthetic Music

ALTHOUGH C. C. Buckle has effectively disposed of the arithmetical "proof" in H. A. Hartley's letter, there remain some points which require stressing:—

(a) Mindful of what has already been done by Pfenniger (who, by the way, is mentioned in the *Oxford Companion to Music*), I wrote my article[1] with eyes fixed on the future. Hartley ignores this achievement and concerns himself with what he maintains is possible *now*.

(b) I wrote from the point of view of composers who suffer much "excruciating horror" when they hear their works misinterpreted.

It may be worth reminding readers that Dr. Alexander Wood has recently referred to the synthetic creation of a variable-area sound track, remarking that "the technique has great possibilities, since it is open to the creative musician to cut records corresponding to sounds which have never yet been heard on land or sea."[2] If the technique does involve a great deal of spade work and meticulous analysis, why should not the composer be one of a team—in other words, a creator of music *à la* Disney—and rule as the creative main spring and final arbiter of all that was produced in his laboratory? The advantage is that the composer would have personal contact with his workers: no sound-track would emanate from his studio without his approval and *imprimatur*, and the results would be very much closer to his original conception than 99 per cent. of normal performances, even when conducted by the composer during his lifetime. For let me assure Mr. Hartley that printed music is far from being an exact indication of the notes the composer wanted to be played. Disregarding interpretative and instrumental questions of historical authenticity (a major difficulty with old music), a score is only "a first rough indication of the (sound) curve" desired by the composer. The curve *is* the composition, and the score only part of a very imperfect means to its attainment.[3]

Being a lover of music in its present form, I, too, view with misgivings the prospect of a synthetic revolution, yet realise my qualms are due to sentiment and tradition. It must be agreed that the continual translating of the same printed notes into sound—at least on the symphonic scale—is a most cumbersome and expensive process, often hard to justify æsthetically or economically.

Regarding the question of a different kind of music, which Mr. Hartley is certain won't be music, I would hazard the opinion that synthetic technique, by freeing the art from the circumscribed powers of the human hand, will father the introduction of "a continuous scale in which every interval can be made perfect . . . for, in the last resort, our limited scales have their origin in the limitations of our hands.[4] Overwhelming advantages like this may make the synthetic revolution carry all before it.

PATRIC STEVENSON.

[1] "Towards Synthetic Music"; *Wireless World*, September 1944.
[2] "The Physics of Music," pp. 214-15.
[3] *Vide* Jeans, J., "Music and Science," p.13.
[4] Jeans, J., *Op. Cit.* p. 190.

The Editor does not necessarily endorse the opinions of his correspondents

High-quality Recordings

THE opening remarks of Peter W. Granet's letter, in your November issue, on the quality of American recordings, are indicative of the wide interest shown in the technical quality of commercial recordings.

This is understandable as the 100 per cent. Purchase Tax (on the wholesale price) of commercial records makes us all more careful when purchasing new discs these days. But it is not always fully appreciated that British recording companies have been and are producing some recordings of remarkable technical quality, under extremely difficult working conditions, and shortage of skilled labour, as well as limited raw materials. In fact, without referring to questions of frequency response, dynamic range, "balance," and spatial effect, the quality of the surfaces of many of our solid-stock pressings is the envy of certain American record manufacturers to-day.

Of course, unfortunately, a uniformly high standard is not reached by all English recordings, and a number of inferior records, even including "swingers," are still issued to-day; hence the need for selection. Adverting to the question of surfaces, although English records are, on the whole, quieter than American records, I am not alone in noticing an increase in noise-level on even the best English recordings issued in the last twelve months or so. I have not been able to discover the precise reason, but it may be the use of substitute raw materials and/or a longer working run from individual pressing stampers. Several excellent surfaces, however, in recently issued discs lead one to believe that improvements are being made.

Finally, I append a few recent recordings of outstanding technical merit, and may I mention, for the benefit of interested readers, that the British Sound Recording Association is hoping to publish a pamphlet listing all the high-grade records mentioned in these columns since 1938, with many others, as the number of inquiries received for such information seems to warrant its compilation?

H.M.V. DB.6172, Mozart's "Symphony No. 32 in G," by B.B.C. Symphony Orchestra, under Boult; H.M.V. DB.6171, Strauss' "Blue Danube," by N.B.C. Symphony Orchestra, under Toscanini—a good American recording; Decca K.1091-4, Bliss' "String Quartet," by Griller String Quartet; and Decca K.1095-7, Ferguson's "Octet," by augmented Griller String Quartet—these Decca discs are fine examples of chamber music recording; and I heartily concur with Mr. Hartley's good opinion (October, 1944, *Wireless World*) of the British Council sponsored H.M.V. series, among which the Liverpool Philharmonic Orchestra's performances, under Sargent, have a magnificent quality of realism. (The Liverpool Philharmonic Hall seems to possess ideal acoustic properties for sound recording.

DONALD W. ALDOUS.
Torquay, Devon.

RF Volume Expansion

MANY interesting articles on volume-expansion have appeared in the *Wireless World* during the last year or so, all working on the principle of altering the gain of an audio-frequency amplifier stage.

I should like to suggest an alternative method; namely, altering the gain of a radio-frequency amplifier.

Assuming a superhet receiver is available, the scheme may be outlined as follows. First, take any of the circuits suggested for providing a positive control voltage with increase of volume, embodying any desired arrangements to give unequal "pick-up" and "decline" delays—for example, Fig. 7 of Williamson's original article of September, 1943. Omit the controlled valves (V2, V3 of of that diagram) and associated components, and use the output of the gramophone pick-up to modulate a small dynatron oscillator[1] operating at the intermediate frequency of the superhet. The modulation depth should of course be kept low, say, 25 per cent. or less, to avoid distortion, but this would be satisfactory, as ample power would be available.

Then couple the output of the modulated oscillator to the input of the IF amplifier of the receiver, and transfer the controlled grid-returns of this amplifier from the normal AVC line to the contrast expander control voltage.

The number of valves required, assuming the receiver already exists, would be no greater than in the original design; in point of fact, two less, if it is not found necessary to use amplification between pick-up and control grid of dynatron oscillator.

With a "straight" receiver, using tuned RF and having AVC it would be possible to use an oscillator working on some frequency to which the receiver will tune, injecting the modulated RF into the earth lead with suitable precautions to avoid radiation.

It would appear that the principle could also be used for volume-expansion in radio programmes; in a receiver employing delayed AVC a volume expander control voltage could be used as the delay voltage which the rectified radio-frequency signal must overcome before the AVC begins to operate.

I suspect that some experimenting would be needed to avoid self-oscillation, for the volume expansion control voltage would have to be taken from the already "expanded" audio frequency; but a suitable attenuator between the loudspeaker voice coil terminals and the rectifier of the expander should overcome this possible cause of trouble.

I am at present unable to try the suggestion, but if any of your correspondents make experiments on these lines I hope he will publish the results in your columns.

C. R. COSENS.
Cambridge University Engineering Laboratory.

[1] See Scroggie: "Radio Laboratory Handbook" Section 35, and *Wireless Engineer*, October 1933.

CHANGE OF ADDRESS

The Sales and General Offices of De la Rue Insulation, Ltd., are now at Imperial House, 84, Regent Street, London, W.1. (Telephone: Regent 2901.) A full range of the company's products is available for inspection at this address.

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

RECENT INVENTIONS

A Selection of the More Interesting Radio Developments

VELOCITY-MODULATION TUBES

IN ordinary practice the discharge stream is first subjected to a radio-frequency field which speeds up any in-phase electrons relatively to the others. It is then passed through a fieldless "drift" gap, where the faster electrons overtake the slower, so that the main stream is broken up into bunches which recur at equal axial intervals and deliver energy to a suitable resonant circuit.

By contrast, in the present arrangement, the electrodes of the discharge tube are so arranged that the effect of the applied RF field is to deflect the in-phase electrons outwards from the axis of the tube, thus forming a fast-moving tubular stream, the hollow centre of which is filled by the slower-moving electrons. The target electrode is a disc with a forwardly projecting centre piece or rod, so dimensioned that the slower electrons strike against the front end of the rod at the instant when the faster electrons reach the disc at its base. This serves to impulse a hollow resonant chamber forming the output circuit.

The full available energy is thus extracted from both sets of electrons, whilst the effect of mutual repulsion is reduced, as compared with ordinary "bunching," because the maximum density is less.

Marconi's Wireless Telegraph Co., Ltd. (assignees of W. A. Zalesak). Convention date (U.S.A.) October 30th, 1941. No. 561911.

FM SIGNALLING SYSTEM

AN "operative" carrier wave is first produced by frequency-modulating one RF sine wave by a supersonic wave, say of saw-tooth form. The resulting wave is therefore one in which the frequency varies continuously and periodically throughout any desired range. This range is next modulated by the signal, and is then transmitted in periodic "pulses" of constant repetition frequency.

In the absence of any signal message, the radio-frequency content of any one pulse of the operative carrier will be the same as that of any other pulse (since the recurrence frequency is constant). However, the presence of a signal will cause successive pulses to be advanced or retarded in phase. The extent to which the phase of successive pulses will change is determined by the amplitude of the signal, whilst the frequency of the phase-change is a function of the frequency of the signal.

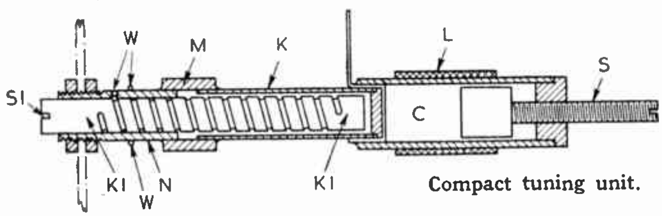
Since the carrier pulses recur at definite intervals, they can be received by a frequency-discriminating circuit in which provision is made for automatic sensitivity control, so as to ensure the maximum signal-to-noise ratio.

Marconi's Wireless Telegraph Co., Ltd. (communicated by T. L. Gottier). Application date December 21st, 1943. No. 561331.

TUNING DEVICES

AN iron-cored inductance is mounted in line with a screw-type trimming condenser to form a compact tuning unit, say for a "midget" type of set, the arrangement being such that the tuning and trimming adjustments can be made from opposite sides of the chassis.

The core C of the tuning coil L is moved to and fro by inserting a screwdriver in the slotted end of a threaded spindle S. The outer tubular electrode K of the trimming condenser is spaced slightly apart from a screw-threaded inner electrode K1, the far end of which fits closely into a second tube N held by an insulating collar M in alignment with the tube K. Part of a spring wire W, which is coiled around the outside of the tube N, passes through a peripheral slot to engage the screw thread on the rod K1; this allows the latter to be moved in and out of the electrode K by using a screwdriver on a slot S1.



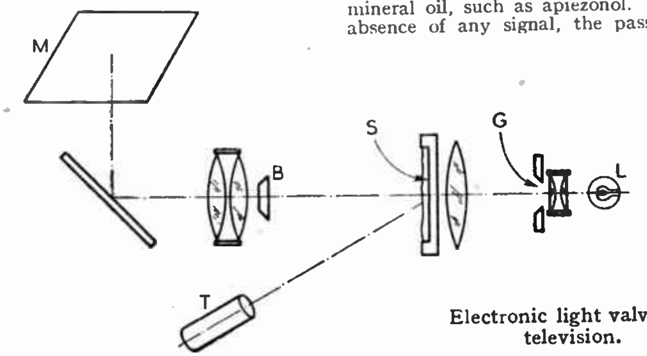
Compact tuning unit.

C. A. W. Harmer; J. W. Dalgleish; and Pye, Ltd. Application date February 19th, 1943. No. 561787.

TELEVISION

PROPOSALS have already been made to replace the usual fluorescent screen by one which is mounted outside the cathode-ray tube and illuminated by an electric lamp through a suitable "shutter" under the control of the incoming signals. The present invention discloses the use of a "deformable" liquid, which automatically allows more or less light to pass the screen in response to the impact of a signal-modulated stream of electrons.

As shown, light from a lamp L is projected through an optical system, comprising the shutter device S, on to a viewing screen M. The shutter consists of a trough containing a heavy mineral oil, such as apiezonol. In the absence of any signal, the passage of light from the lamp L through the gap G to the viewing screen is completely blocked by a bar B. The impact of the negatively charged scanning stream momentarily deforms the normal alignment of the molecules of the liquid S, and so deflects the light rays over and around the bar B to the extent required to reproduce the received picture. The electrostatic deformation produced by the electron stream is purely local, and persists only for a short but definite interval of time, after which the liquid molecules revert to their normal condition ready to respond to the next impact of the scanning stream.



Electronic light valve for television.

Ges. zur Forderung der Forschung, etc. Technischen Hochschule. Convention date (Switzerland) August 28th, 1940. No. 561926. *Addition to* 543485.

TRANSMISSION LINE NOISE

IF a coaxial transmission line happens to pass near an AC power circuit, "hum" voltages are induced between its two ends and ground, which may be several times stronger than, say, the television signals it carries. These pick-up potentials will affect both the inner and outer conductors of the transmission line.

To eliminate them, the outer conductor or sheath is directly earthed at the sending end, whilst at the receiving end it is coupled, through a resistance, to the grid of a phase-reversing valve. The output from the latter is fed, preferably through a cathode-loaded "buffer" valve, which does not alter the phasing, to an impedance connected to the delivery end of the inner conductor of the line. The grid of the receiving valve is tapped to this impedance at a point where the hum voltage from the outer conductor is balanced by that induced in the inner conductor, so that the signals carried by the latter alone pass through the amplifier. One advantage of the arrangement is that the hum voltage is cancelled out before the combined signal-and-hum voltages on the inner conductor can reach the line amplifier, so that no cross-modulation occurs.

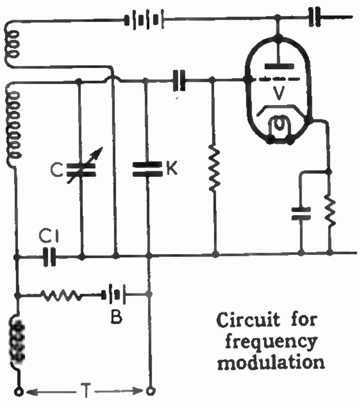
Philco Radio and Television Corporation (assignees of F. J. Bingley). Convention date (U.S.A.) February 3rd, 1942. No. 562569.

FREQUENCY MODULATION

THE action of the circuit shown depends upon the variable capacity response to a low-frequency current of a condenser in which a "blocking layer" (such as is used in dry contact rectifiers) forms the dielectric between two fixed plates set not more than one-tenth of a millimetre apart.

The grid circuit of a back-coupled valve V includes a condenser K of the kind mentioned above, arranged in shunt with the usual tuning condenser C. Low-frequency signals are applied to the blocking-layer condenser from terminals T, together with a fixed biasing voltage from a battery B. An auxiliary condenser C1 of low impedance to the carrier-frequency oscillations prevents the signal currents from being short-circuited.

As the effective capacity of the condenser K varies in rhythm with the amplitude of the applied signal voltage,

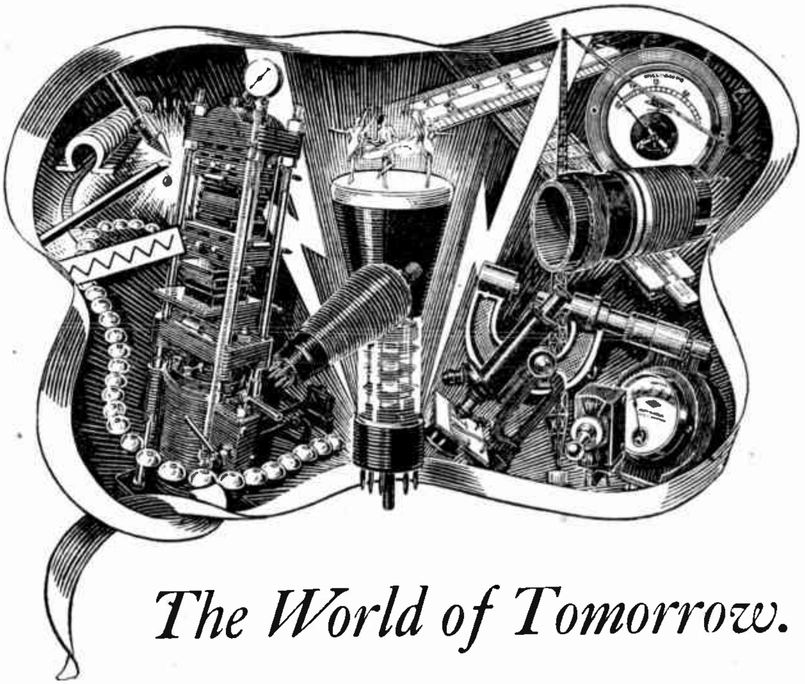


Circuit for frequency modulation

the corresponding instantaneous changes in the tuning of the grid circuit will give rise to a frequency-modulated carrier wave in the output circuit of the valve.

"Patelhold," Patentverwertungs and Elektroholding A.G. Convention date (Switzerland) October 28th, 1941. No. 561323.

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



UNBIASED

By FREE GRID

Nostalgic Neurosis

MANY of you have probably heard the story about the girl (perfectly proper, my dear Mrs. Grundy) who was rather given to association with the American soldiery at present in this country and had, therefore, inevitably picked up a good deal of their forthright and robust phraseology. Eventually her mother ventured to remonstrate with her about certain aspects of her newly acquired vocabulary and said: "Mary, my dear, I want to speak to you about the words you use; one of them is 'lousy' and the other 'swell.'" "Oh, yes, mother," replied the bright young thing in an interested manner, "and which of my words is lousy and which is swell?"

I have used this small story as an opening gambit as I, like the girl's mother, am going to venture on to very dangerous ground and remonstrate with the B.B.C.'s women announcers about the very objectionable words they use, although I would hasten to add that I do not for one moment suggest that they obtained them from American soldiers.

It may be argued that *Wireless World* is a technical journal and I have no business to butt-in on what is purely a programme matter. But I am in good company, since the Editor himself thundered *ex cathedra* quite a long time ago against the B.B.C.'s Italo-Portuguese rendering of the pronunciation of the French colonial town of Brazzaville. Apart from this, I feel

Nostalgic memories

justified, as although we of *Wireless World* are primarily concerned with the means whereby the B.B.C. communicates with its listeners, surely we are entitled to have some small say about the use to which our labours are put.

The two words about which I wish to complain are perfectly normal and proper when used sparingly and in their proper context. But every evening the B.B.C.'s women announcers persist in prefacing about 99 per cent. of the sentimental slush which their duties compel them to put on the turntable by telling us that the tune we are about to hear is either a "nostalgic" or a "haunting" melody. I have no doubt that these young ladies went to what are usually known as good schools, but it is very evident that the study of English literature was not prominent in the curriculum; otherwise, their vocabularies would have been more extensive.

If I may venture to make a suggestion, I would recommend a course of good reading with Shakespeare as an *hors d'œuvre*, but with stronger meat such as Carlyle and Emerson to follow. Personally speaking, the word "haunting" always reminds me of ghosts and other unpleasant things, while "nostalgic" conjures up gloomy memories of my early days at school.

For once Mrs. Free Grid agrees with me, which is rather surprising, as my remarks are directed against members of her own sex. However, she qualifies her agreement by saying that the B.B.C.'s young ladies are probably acting under the orders of the male caucus which rules at Portland Place. Be that as it may, I feel that only the tongue of the redoubtable Mrs. Mop could do full justice to my sentiments about the constant reiteration of these two overworked adjectives.

Peak for Pain

MY colleague "Diallist's" physiological failing of being unable to detect AC from DC by touching the insulated portion of an electric light switch, which he mentions in the November issue of this journal, can easily be remedied if he removes the cover and bridges the two contacts with his thumb and forefinger, the switch being in the "off" position. If the mains are AC he will receive a considerably greater shock than if they were DC of the same voltage. "Peak for Pain" will serve as a better memory-jogger where this little dodge is concerned than all "Diallist's" mnemonics in verse.

Notwithstanding this, it is apparently RMS which actually kills, according to a little book I have been reading by an ex-warden of the famous Sing-Sing Prison, where

Undoubtedly AC.

the electric chair was pioneered as far back as 1890.

A Prophet Vindicated

THERE have, I am sorry to say, been a number of base attempts by readers to manœuvre me into an entirely false position about a prophecy I am supposed to have made in the October issue of this journal to the effect that the war would end on October 27th, 1944. Actually I neither said nor suggested anything of the kind, as any of my detractors who had bothered to read my words carefully would have realised. I said nothing about 1944 or, indeed, about any particular year.

One reader whose name is a household word in the world of wireless goes even farther and tries to link up my utterances with those of a Chinese sailor who, so he alleged, made a similar prophecy in a London evening paper (*The Evening Standard*) on March 29th last. Needless to say, the Chinese sailor and myself are two entirely separate entities (do I look like a Chinese sailor?) and in any case the Chinese sailor, too, is being maligned as I have gone to the trouble of looking up his remarks in the particular issue of the evening paper mentioned, and he also was careful to avoid mentioning any specific year. No doubt, he is, like myself, an ex-politician.

This sort of attitude on the part of my readers reminds me of those queer souls who write indignantly to the Press whenever the utterance of some prophet about the end of the world has failed to materialise. They always seem quite indignant to find themselves still alive and well, with the old world still sailing serenely along on its way through the heavens.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NEW RECEIVERS AND AMPLIFIERS

COMMUNICATION receivers. — Remember "Dale" after the war.—Dale Electronics, Ltd., 152-6, Gt. Portland St., W.1. Mus. 1023.

FIRSTLY, season's greetings to friends in the Forces in all theatres and all whom we have had the pleasure of serving. A happy Christmas to you.

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AMBASSADOR PA 143 radio amplifier, 15w output, radio or records with real volume, £27/15/6; suitable grey steel cabinet speakers, £3/12. ROTHERMEL Brush piezo-crystal pick-ups, latest Senior model, £3/18/9.

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MULLARD cathode ray tube unit, type B100, complete with 3in cathode ray tube, 12gns.

MULLARD ECR30 3in cathode ray tubes, complete with holder, 4gns. GTIC Argon filled relay, 25/-.

MEICO moving coil microphone, with Meico stand, £7/15/6; Meico mike trans, 12/6.

VIBRATORS, Mallory 6v 4-pin, 22/6; Bulgin 6v 6-pin self-rectifying 20/-, bases 1/-.

CAR radio plug and distributor suppressors, 2/6 each; dynamo condensers, 3/- each; telescopic aerials (few only), 21/-; ex television chassis containing approx. 100 new modern radio parts, 29/6.

BOOKS.—"Modern Radio Test Gear Construction," 1/6; "Amplifier Manual," 2/-; "Radio Valve Manual," 3/6; "Radio Inside Out," 4/6; "Radio Circuits," 2/-.

H. P. RADIO SERVICES, Ltd., 55, County Rd., Walton, Liverpool, 4. Tel. Aintree 1445. Estab. 1935. [3280

QUALITY amplifiers, 200-250v ac, 5w, 8½gns; 12w, £14; output impedance to requirements, both types; s.a.e. for leaflet and copy "Design for Quality."—John Brierley, 1, St. Paul's Ave., Lytham St. Annes. [3195

AMPLIFIERS.—Complete equipment for P.A. industrial, dance and stage installations and portable apparatus from 15 to 150w; early deliveries; illustrations and spec. on request.—Broadcast and Acoustic Equipment Co., Ltd., Broadcast House, Tombland. Norwich 26970. [2963

HENRY'S offer t.r.f. 4-valve ac/dc kit set, med. wave, complete with all components and drilled chassis 10×4×2½, easy to build, circuit supplied, 5ft speaker, no other extras; cabinets for same, 22/6; 7 days delivery.—Henry's, 5, Harrow Rd., Edgware Rd., W.2. Pad. 2194. [3217

A NEW type of high fidelity amplifier, output 40 watts, response 20-15,000 c.p.s., gain, 98 d.c.b. with 5% deg., 12 months' maintenance guarantee, 43gns.; also a range of quality amplifiers, 15-30 watts, ac or universal, with microphones and speakers; immediate delivery.—Electron (London), Ltd., 31, Curzon St., W.1. Gro. 1993. [3255

£24/10 only.—New 7-valve "Wireless World" Quality amplifier with tone control stage, 8watts push-pull triode output, price includes super Quality triple cone, 12in permanent magnet speaker with large matched output transformer and all valves; as above but with 15watt tetrode output, £25/10; ideal for realistic reproduction for public address, limited number available.—Bakers Selhurst Radio, 75, Sussex Rd., S. Croydon. Tel. Croydon 4226 for demonstration. [2772

RECEIVERS, AMPLIFIERS—SECOND-HAND

50-W. Vortexion multi ratio output G.12; highest offer.—Tel. Wimbledon 5703.

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QUALITY 12-watt special W.W. amplifier, elaborate power pack, perfect, as new; £28.—Box 3282. [3269

A.C. 12w amplifier, 2 12in speakers, crystal mike, £30.—Collins, Wells Rd., Chilcompton, near Bath. [3181

H.M.V. all-wave battery set, £11; Philips all-wave ac mains, £9; both perfect.—33, Baden Rd., Brighton. [3242

HALLICRAFTER Skyrider 23, with speaker, perfect condition; best offer over £50.—Rogers, Summerhill, Market Drayton. [3248

HALLICRAFTER S27 receiver for sale, in good condition; frequency range 27.8 to 143 mc. What offers?—Box "D. W.," Parrs, 121, Kingsway, London, W.C.2. [3191

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R.C.A. Phototone amplifier, using Westinghouse rectifiers and two UX250s, type No. R1197, for 110 volt ac mains, price £16; also several valves, 4033A and 4074A, at list —Darley 39, Coolhurst Rd., N.8. Mou. 9234.

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AMBASSADOR 7-valve radio amplifier, £18; W.W.Q.A. super receiver and Q.A., with duode de luxe, £30; Autochanger, 20 records, both sides, cost £100, offers; 1940 Decca table radiogram; Baker 7-valve amplifier, 12in speaker, new, £19/10. Wanted, twin triple portable and 12v. car radio.—Bert Carswell, 118, Union St., Glasgow. [3243

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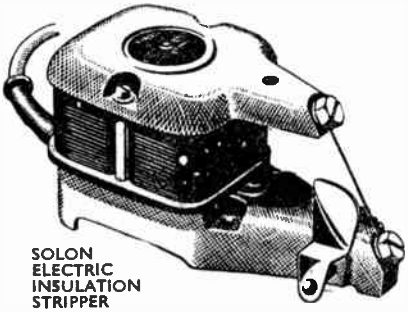

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AVOMINOR Universal, new; £8.—Richardson, 17, Galgate, Barnard Castle, Durham.

AVOMETER model 7, £19/10; Avo All-wave oscillator, with mains filter, £13/10, as new.—Box 3270. [3220

E.M.I. 1943 all-wave battery oscillator, as new, chart, less batteries; 11gns.—Nicholson, 2, Matlock Rd., Ambergate. [3200

OSCILLOSCOPE, modified Wireless World, complete with time base and amplifier. What offers? North London.—Box 3277.

PHILCO battery signal generator, less batteries, range 100 k/cs to 20 m/cs, also over 150 service sheets, £10.—Box 3268. [3212

WESTON valve voltmeter, type 669, £18; E.M.I. service audio oscillator, type Q.2505, £17; both little used and as new.—246, Stanley Rd., Bootle, Liverpool, 20. [3241

TESTOSCOPE, indispensable to radio service engineers; makes 20 lists; interesting booklet on request; from all wholesalers or direct; send for leaflet "R.1."—Runbaken, Manchester. 1. [2702

MULLARD oscillograph (G.M.3152) for disposal, purchased 12 mths ago, 30 hours' use; £50.—F. S. Taieb, 57, High St., Hoddesdon, Herts. Tel. (evngs. only) Hoddesdon 3102.

OSCILLOSCOPES, signal generators, multi range test meters, etc., test gear of every description, British or American, repaired, serviced, recalibrated.—A. Huckelsbee, "Hazlejohn," Crofton Lane, Orpington, Kent. [3031

AVOMETER Universal, 36 range, £13; Ferranti 2½in scale meters, m.c., 1,000 o.p.v., 0-7.5-15-30m.a., £3; 0-250u. a.c. rect inst., £3/10; 0-5-50-250v d.c., £3; Weston 2¼in m.c. type F.O.1, panel fixing, 0-5m.a. ditto, 0-50m.a., £2/10 each; Hartley Turner Hi-Fidelity Piezo P.U., 3gns.; cash or c.o.d.—Griffith, Parkway, Horley, Surrey. [3232

TRIPLETT oscillator, model 1231, £9; Stanelco toggle press, as new, 1½-ton pressure, £25; Van Dorn ¼in capacity electric drill, with adjustable spring return stand, £14; Stanelco "Fuzit" wire jointer, as new, £5; 550 pressphan bobbins, tagged with extended cheeks for M.E. 59 laminations, ¾in stack, suitable O.P. transformers, small chokes, etc., 6/- doz.; 80 pressphan bobbins, 1⅜in stack, for Rola 5 laminations, 6/- doz; new 7OL7GT, 15/-; well made 125 watt auto transformers, tagged with engraved figuring 110/200/220/240, 25/- ea.; Bakelite tubes, 4½in long×½in dia., 4/- doz; riveting tags, 6/- 100; buyers must collect heavy mechanical item. 15 miles N.W. London.—Box 3269. [3219

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SPECIAL offer to clear.—150 approx. extension speaker cabinets, polished walnut, suitable for 6in to 8in speaker unit; price 13/- each.—Write Box 3264. [3205

SPECIAL offer to clear.—Loudspeaker cabinets, polished oak, 12/6 and 15/6, polished walnut, 17/6 each, delivered in any quantity; any type of radio cabinet made to order; send us your enquiries.—Waldenberg Bros., Ltd., New York Rd., Leeds, 2. [3030

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OUR adaptors will help in replacing unobtainable valves; send 7d. for interesting booklet on valve replacements; trade eng. invited.—V.E.S., Radio House, Ruislip.

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VALVES, surplus to our requirements: 473 Mullard, 277 Brimar, 202 Marconi, 473 Mazda, 32 Cossor, 19 Philips; all guaranteed new; send us a note of your requirements; these or their equivalents we will despatch immediately c.o.d.; all valves offered for sale at manufacturers' retail price lists.—Larg's, 18-24, Whitehall St., Dundee. [3091

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COIL M/C P.U., £5; Monodial A.C. Super, £5.—31, Senior Ave., Blackpool. [3228

ROTHERMEL mike 105, with stand, as new, £4; H.M.V. electric record player, as new, £10.—Box 3283. [3270

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PARMEKO recorder, comprising cutting head, tracking gear and motor, precision built; £52, or part exch.; H.R.O.—Box 3274.

COILS for filters, tone controls, etc., transformers and chokes wound to your specification.—R. Clark, 30, Langland Crescent, South Stanmore, Middx. [2888

A.C. record-player, complete in walnut cabinet, ac amplifier, 6w, push pull (P. x 4's), new; Remington shaver ac Dumville, Vigilant 2175.—Box 3280. [3266

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ACORNS.—A few of the following types in stock: 954 50/-, 955 45/-, 956 50/-; 1006, 9001, 9002, 27/6 each.

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J. BULL and SONS, 246, High St., N.W.10.

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P.M. speakers, 6½in. 19/-; 0.3 voltage droppers, 4/-; T.R.F. coils, 6/6 pair; push-back wire, 2/- 50ft.; vol. controls, 3/-, with sw, 4/10, list 1d.—16, St. Helen's Av., Lincoln. Mail order only. [3249

FIRST Pretuned Quality receiver, £7; AF5, 20/-; OPM1, 20/-; choke, 20/-; 2 mains trans., 350-0-350, 4v 2.5a, 4v. 5a, 25/- each; PX4 (perfect), 8/6; Novotone compensator, 12/6; Hartley Turner crystal pick-up, 90/-; lot £15.—Box 3257. [3182

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Type	Range	Price	Type	Range	Price
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04A	12-26 m.	2/6	06A	12-26 m.	2/6
04B	22-47 m.	2/6	06B	22-47 m.	2/6
04C	41-94 m.	2/6	06C	41-94 m.	2/6
04D	76-170 m.	2/6	06D	76-170 m.	2/6
04E	150-350 m.	3/-			
04F	255-550 m.	3/-			
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2 Push-Pull Switches to suit above, 9d. each.

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Rola 6½in. P.M. Speaker, 3 ohms voice coil, 25/-.
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Above speakers are less output transformer.
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CHARLES BRITAIN RADIO (K. H. Ede) for radio components.

SERVICE kits.—See page 28, Nov. issue.

MAINS trans., ex R.G.D., with fixing feet, silver finish, 350-0-350v, 100ma, 4v 4a, 4v 1a, brand new and boxed, 30/-; Midget t.r.f. coils, m.w., 5/6 pr; 40pf-50pf trimmers, 4/6 doz; 0.0003 reaction conds, 2/3 ea; push button units, 12-way, with escutch. but no knobs, 5/6 ea; Yaxley type switches, 2 pole-2 way, 2/3 ea; 2 pole-3 way and 3 pole-4 way, 3/6; 2 pole-4 way 3 bank, with screen, 6/- ea; Philco switch wafers, 6/- doz.

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THIS month's special offer.—10-way push-button units, all-wave, with padders and trimmers, ex R.G.D. (damaged), 15/- ea; for other components see page 28, Nov. issue; terms, cash or c.o.d. over £1.—Charles Britain Radio (temp. address), "Eureka," Surrey Gdns., Effingham, Surrey. [3239

ARMSTRONG EXP48 coil pack, 4 bands, 2 465kc i.f. transformers, drilled chassis, calibrated glass scales, 4-bd., station names; 67/6. Bate, 44, Bohun Grove, E. Barnet, Herts.

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THE Simplex Four, theoretical circuit diagram of 4-valve, m. wave ac-dc t.r.f. Midget, with all component values, 1/6; complete kit of parts, valves, etc., for this most successful midget receiver, £9; Midget aerial and h.f., m. wave, t.r.f. high gain coils, 9/- pr.; m. and l. wave, ditto coils, 11/- pr.; short wave, aerial and oscillator coils, i.f. at 465 kcs, 5/6 pair; Midget 2-gang variable 0.0005 mfd condensers, 15/-; ditto 3-gang, 14/-; Midget chassis, sprayed grey, de luxe, 10½×6×2in, drilled 4 valves, 9/6; standard ditto chassis, 10×4½×2in, 5/6; Midget dials, m. wave, 4×3½ in, 2/-; s.m.l. wave, 7×4in, 1/6; Midget chokes, 7/6; heavy duty, 80 mA 12/6, 120 mA 15/-; Midget speaker trans. (pen), 7/6; 10-watt, 20/1 ditto, 10/6; Celestion 8in p.m. speaker, with trans, 30/-; Midget rotary switches, on/off, 3/-; d.p.s.t. 3/6, d.p.d.t. 4/-; line cord, 3-way, 60 ohms ft, 0.3 amp, 6/6 yd; 2-way ditto, 5/- yd; mains droppers, 0.2 amp, 1,000 ohms, 4/6; 0.3 amp, 800 ohms, 5/6; wirewound 10-watt resistances, 100, 60, 30 and 24 ohms, 1/6 each; wirewound pots. for bridges, etc, 2,000 ohms, 6/6; nuts and screws, 4BA, brass, 7/- gross; 6BA ditto, 6/- gross; trimmers, 30 pfds, 9d.; triple trimmers, pfds each, 1/6; double, ceramic, 80 and 40 pfds each, 2/-; comprehensive list, 2½d.; s.a.e. enquiries; postage all orders.—O. Greenlick, 34, Bancroft Rd., Cambridge Heath Rd., E.1. Ste. 1334. [3281

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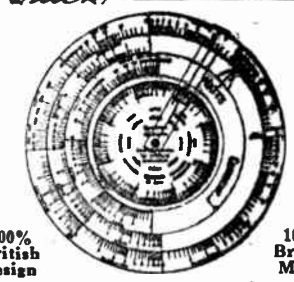

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What will be the resistance where watts W is at voltage E?

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INPUT strips, 2in×¾in, 2-way, 2/6 dozzen; with terminal screws, 3/3 dozen; anchor or mounting strips, 2/3 dozen, 5-way.

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TWIN rubber flexible cable, new, for mains leads, etc. (one cover), 1/3 yd, 3yds 2/9; push-back connecting wire, stranded, 2 colours, cotton-covered, 12yds 2/3. [3237

SERVICE kits. See November issue. C.o.d., but cash with order preferred.—London Sound Labs., Ltd., 40, South Molton Lane, Bond St., London, W.1. Look out for combined valve tester and circuit analyser. [3253

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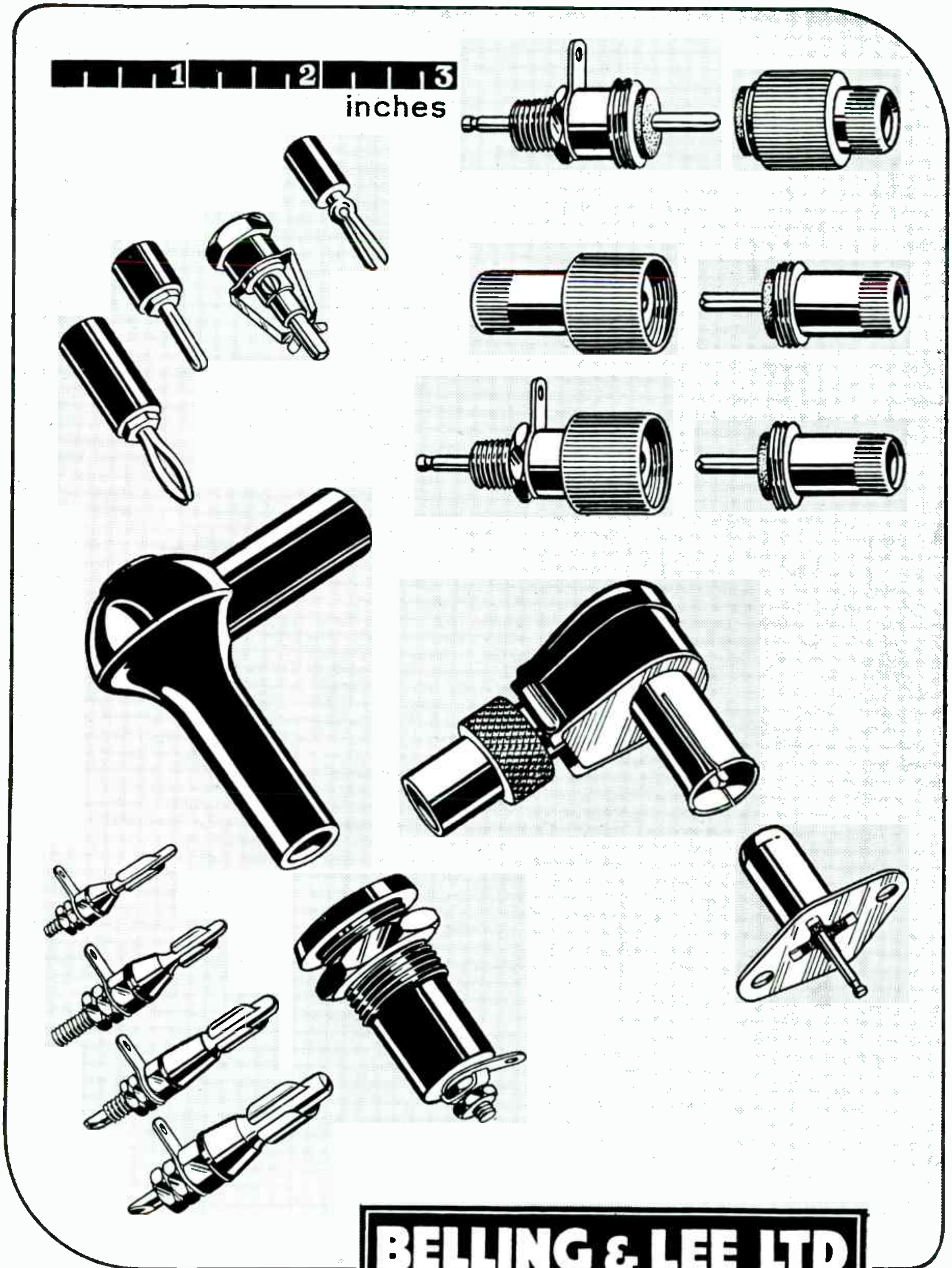

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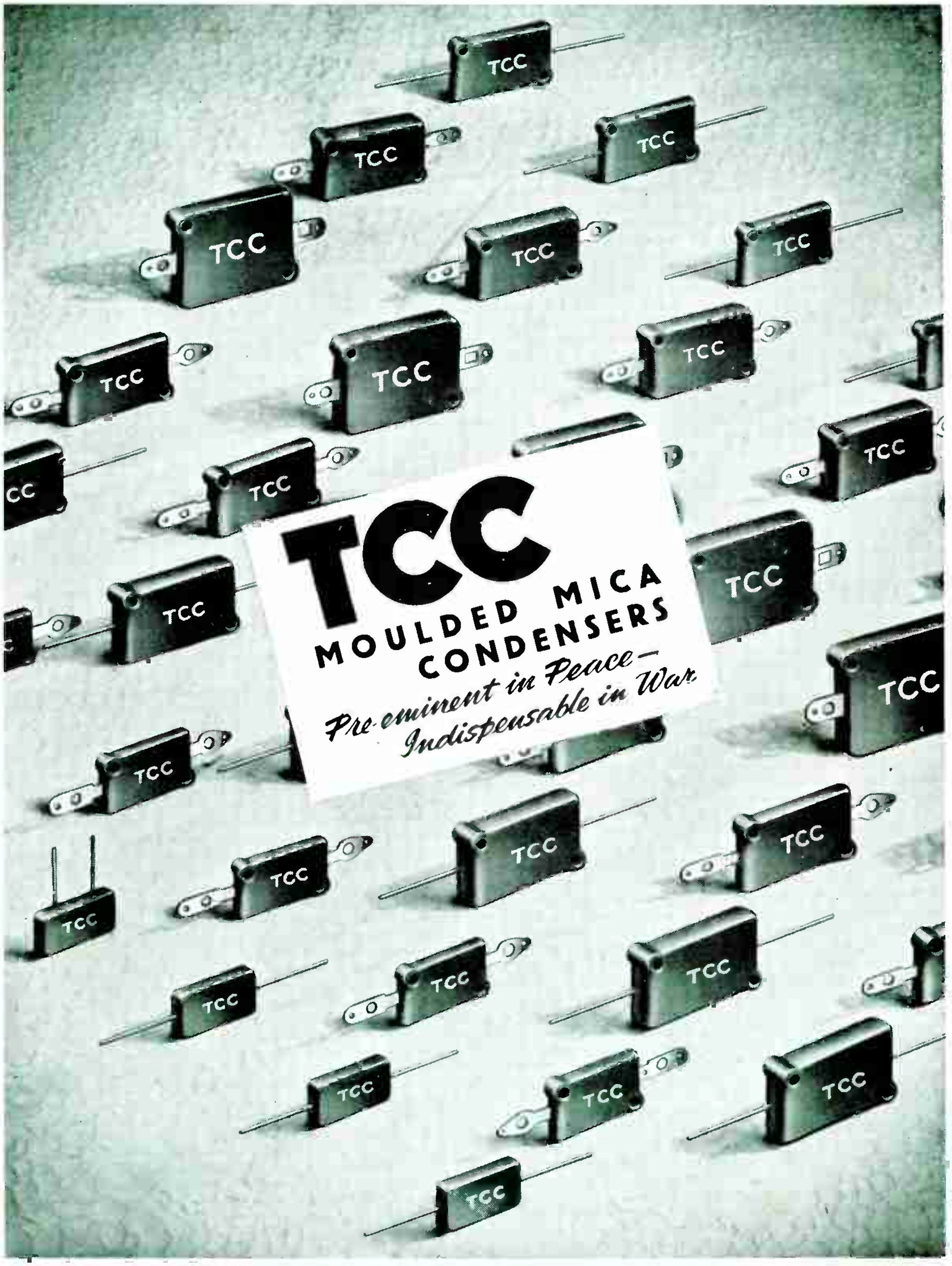

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