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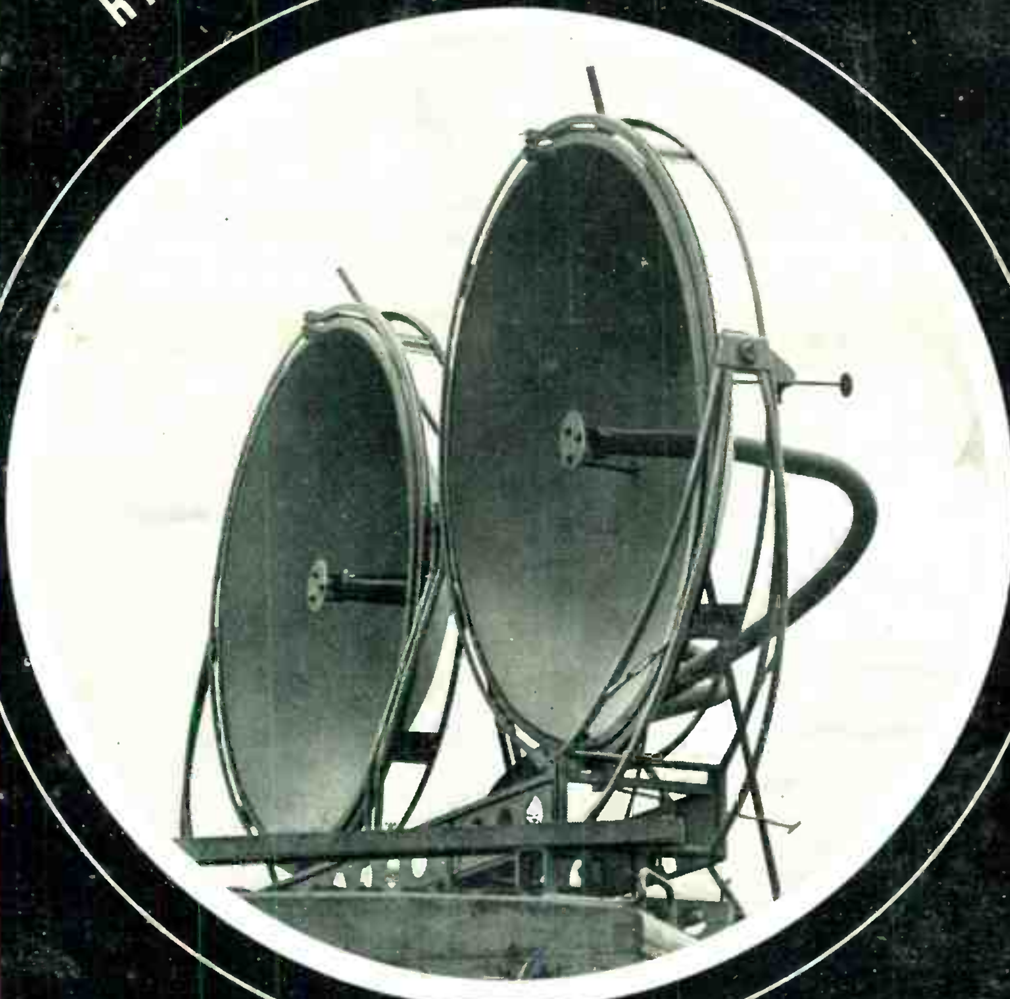

SEPT. 1946

1/6

Vol. LII. No. 9

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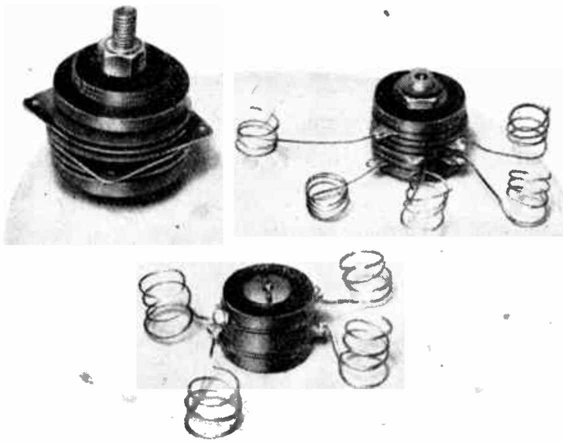

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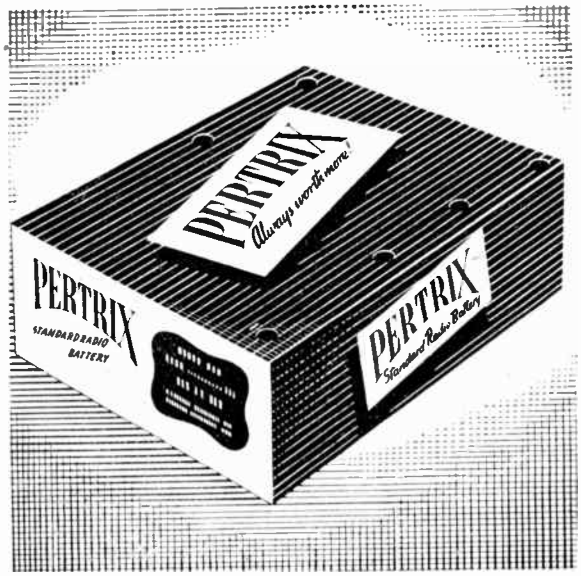

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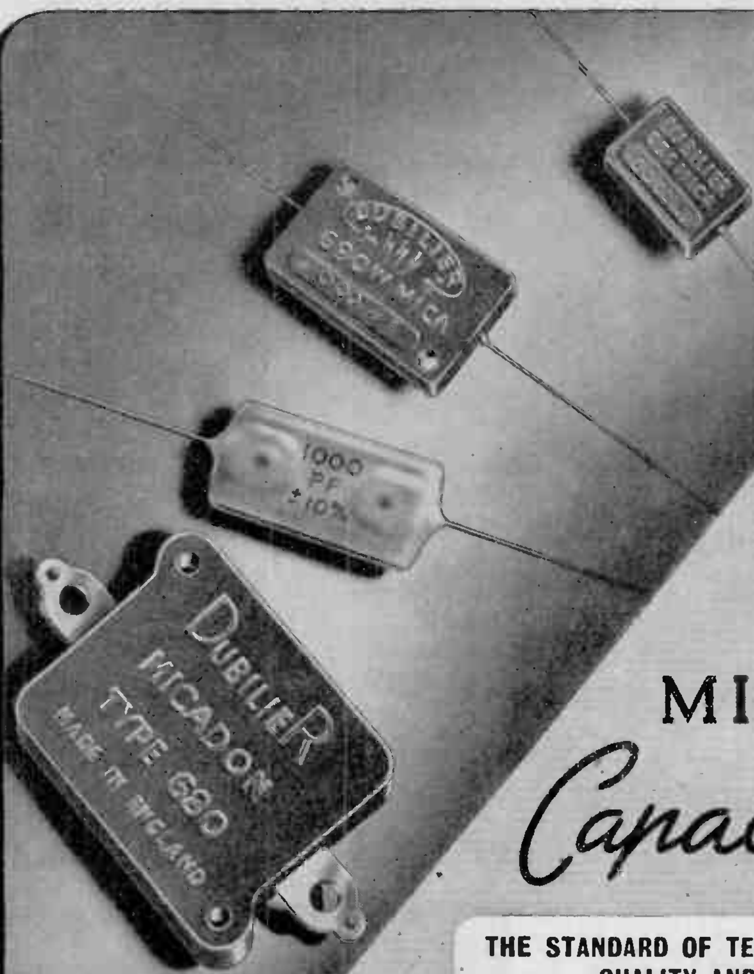

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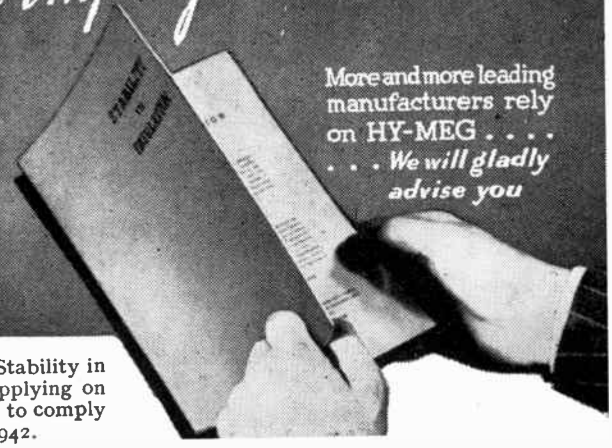

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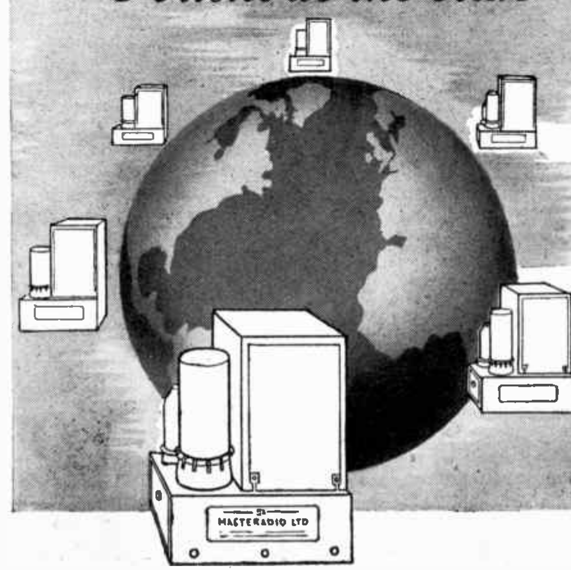

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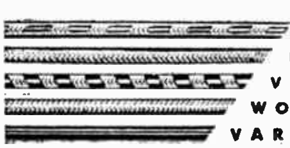

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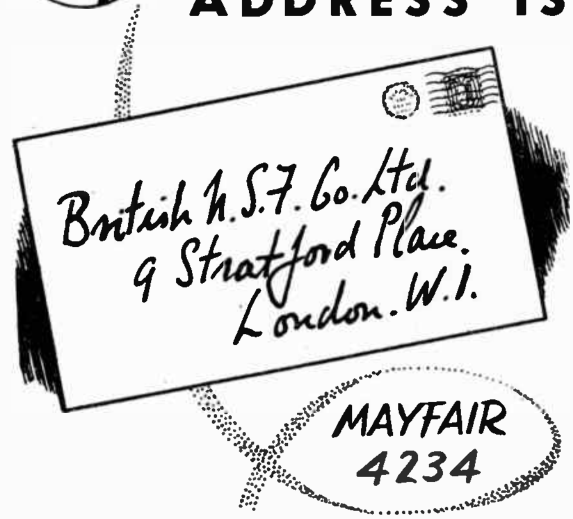

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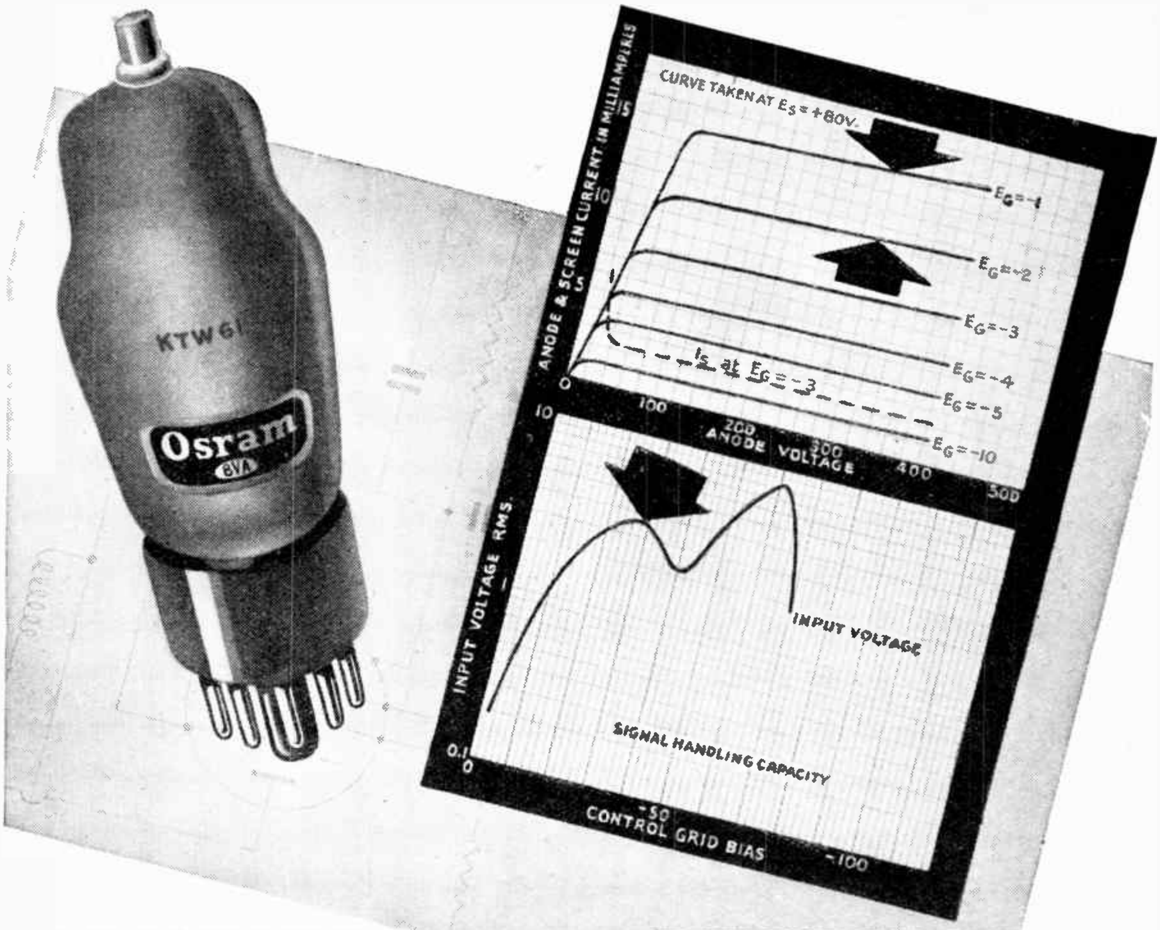
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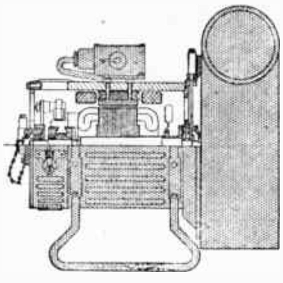

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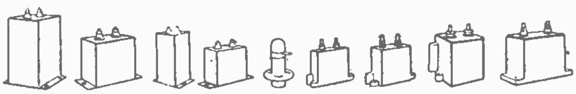

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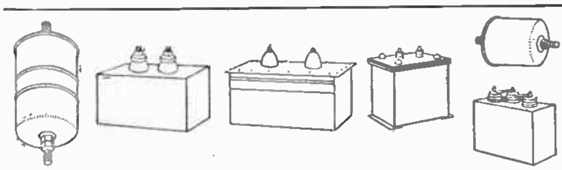

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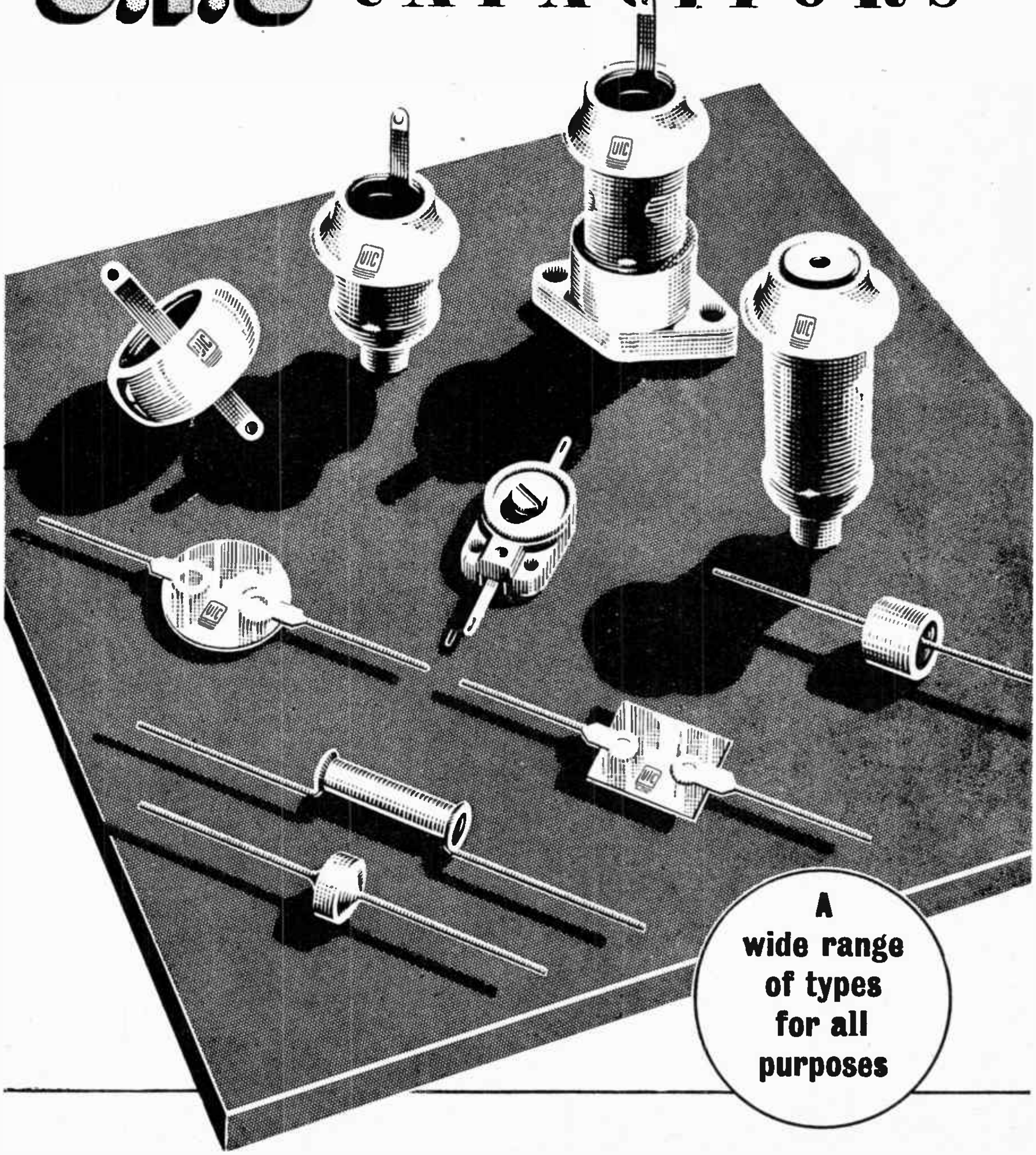

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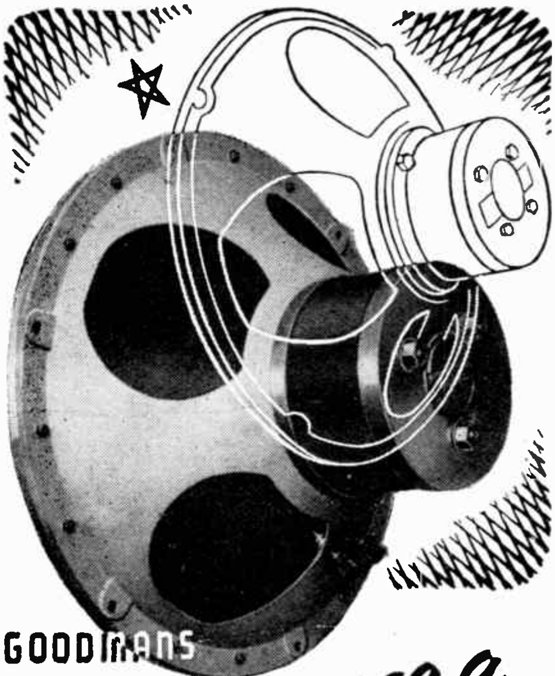

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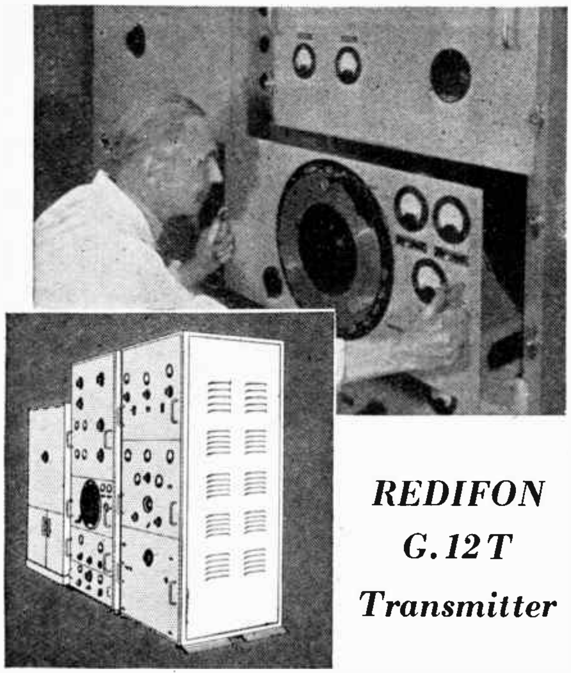

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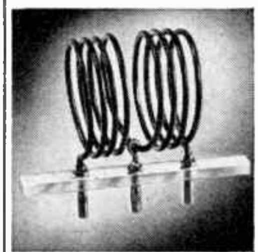

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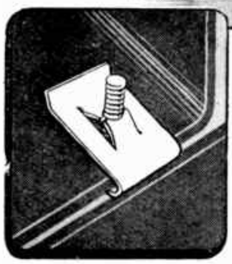

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Radio and Electronics

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Monthly Commentary

Illicit Transmission

IT had to come. Although we do not know, at the time of closing for press, how complete the ban on the sale of ex-Government transmitters will be, it is clear that gear with enormous potentialities for doing harm should not be sold indiscriminately to all comers, as it has been during the past few months. True, complete suppression of sale to the public will not put an end to the clandestine transmitter, but it will at least remove an almost irresistible temptation from the path of the irresponsible kind of person who is likely to cause the maximum of interference to legitimate services.

The position at present seems to be that, by agreement between the Government departments concerned, the sale of transmitters, at any rate of certain classes, is to be discontinued, except under conditions which reduce the risk of the sets falling into undesirable hands. No doubt methods will ultimately be devised whereby those qualified to make legitimate use of the sets will be able to obtain them. In the meantime, it seems likely that a certain amount of hardship will be suffered. It is a pity that the inevitable results of indiscriminate sale were not foreseen, and proper steps taken from the first to dispose of the sets to those who could make good use of them, or at least of their components. In particular, we can see no reason why the offer of the Radio Society of Great Britain to purchase sets on behalf of its members, made some considerable time ago, should have been flatly declined.

Guarantees

MUTUAL goodwill between producer and consumer is surely something to be striven for. If that can be accepted as axiomatic, it is to be regretted that, in framing the new standardized form of broadcast receiver guarantee, the British Radio Equipment Manufacturers' Association has lost an opportunity to remove a common cause of friction between seller and customer. We refer to the clause which states that the labour costs incurred in replacing a faulty component may, at the manufacturer's discretion, be charged to the customer.

Not unnaturally, the owner of a receiver feels aggrieved if he is charged an appreciable sum for the replacement of a component that is admittedly defective through faulty workmanship or materials. His ruffled feelings are not soothed by the fact that the replacement component itself has been given to him without cost. He argues, with some force, that the replacement was made necessary by an admitted error of judgment or negligence on the part of the manufacturer; why should he have to pay?

We have little doubt that the offending clause will in most cases be interpreted liberally, but that is hardly enough. The question of maintenance service is likely to assume particular importance during the early period of television development. The revised form of guarantee applies to television sets, and it is highly desirable that the growth of the new art should not be hampered by unsavoury squabblings over repair charges. The whole matter should be put upon a firm and equitable basis.

F.M. versus A.M.

THE issue between F.M. and A.M. is one that cannot be determined in the laboratory, but only by widespread field test. Consequently, the results of the B.B.C. frequency modulation trials, described by H. L. Kirke (head of the research department) in the current *B.B.C. Quarterly* will be read with particular interest. The general conclusion is very much in favour of F.M. as a means of distributing high-quality noise-free broadcasting.

ARMY No. 10 SET

Some Details of the U.H.F. Equipment

SIGNALLING Equipment No. 10 which forms part of the Army Wireless Set No. 10, was described under the title "Pulse Width Modulation" in the June issue of *Wireless World*.

It was explained how eight audio-frequency channels were made to modulate in width a series of rectangular pulses in the pulser or sending section of the equipment and how the separator recovered the audio channels from the received width-modulated pulses.

The width-modulated pulses produced by the pulser are used to modulate a magnetron U.H.F. sender working at a frequency of about 4,500 Mc/s. The receiver is of the superheterodyne type and the pulses in its output are passed to the separator section of the Signalling Equipment No. 10.

It is the purpose of the present article to conclude the account of the 10 set with a description of the U.H.F. sender, receiver and aerial system.

It is usual in U.H.F. equipment to conduct the energy from one unit to another by means of waveguides and coaxial cables. The principles of waveguide engineering and their uses in connection with coaxial cables have been dealt with in the issues of *Wireless World* for September and October, 1944. Resonant cavities are used in U.H.F. equipment for tuning purposes in much the same way as the more familiar tuned circuits are employed at lower frequencies.

These cavities are described below in relation to this particular equipment, but it is as well to give some general remarks at this point. The same principles apply to them as to waveguides and it is assumed that reference has been made to the earlier *Wireless World* articles. A resonant cavity is merely a waveguide of a certain length, usually a multiple or submultiple of a wavelength, closed at each end. Where such a cavity is, say, one wavelength long and energy of the appropriate frequency is fed into it, this energy will build up until quite large amplitudes are obtained. It will then be seen that if a cavity is equipped with a movable piston at one end it fulfils much the same purpose as the more familiar tuned circuit consisting of coils

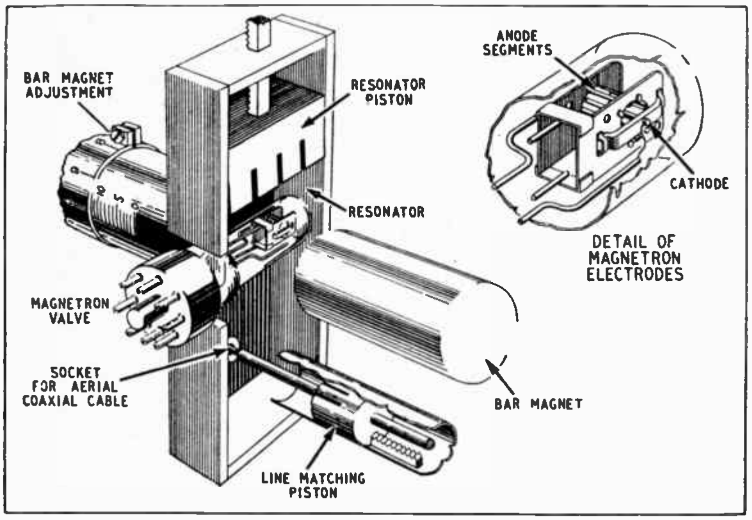
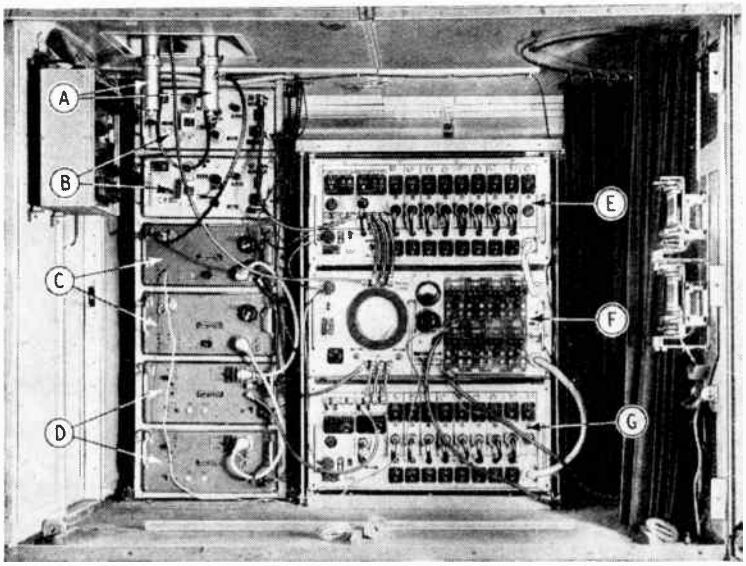


Fig. 1. This cut-away drawing shows the interior of the resonator used with the magnetron in the sender. The construction of the magnetron itself is indicated in the inset-sketch.



An interior view of the trailer of the No. 10 station. The various units are: A, waveguide matching sections; B, duplicate sender units; C, duplicate receivers; D, duplicate power supply units. The Signalling Equipment No. 10 consists of the pulser E, the monitor F, and the separator G.

and capacitors at lower frequencies. Arrangements for feeding in

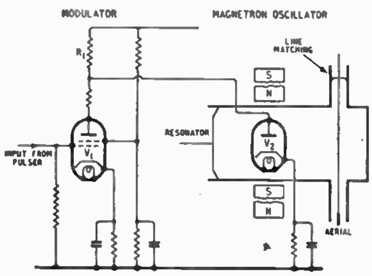
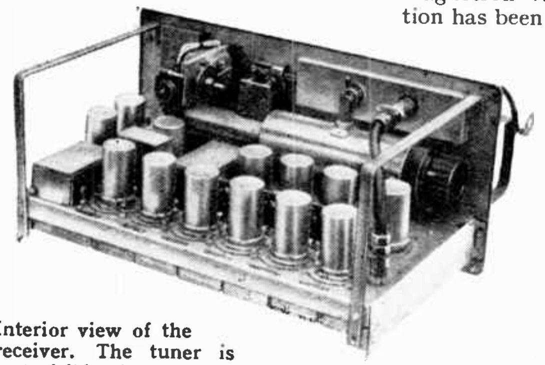


Fig. 2. Circuit diagram of the sender including the modulator valve which is fed with the pulses produced in the pulser unit.

and abstracting energy from a resonant cavity are similar to



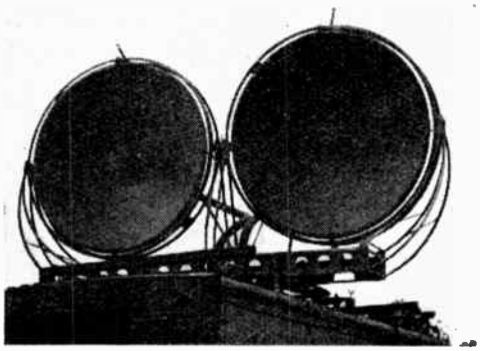
Interior view of the receiver. The tuner is just visible close to the panel

those used for the waveguides treated in the earlier articles. The tuning cavities are of rectangular cross-section and are designed for electromagnetic waves of H_{01} mode. It will be remembered that for H_{01} waves longitudinal loops of magnetic lines of force are formed and electric lines of force stretch from one side of the enclosure to the other. In a resonant cavity, the loops build up to form standing waves, the amplitude reached depending on the power dissipated in the material of which the cavity is made and the load to which it is coupled.

The waveguides used in this equipment are of circular cross-section and propagate H_1 waves. Longitudinal loops of magnetic lines of force are formed in this case also and the transfer of energy along the waveguide may be considered as due to the loops of magnetic lines of force moving down the waveguide.

A frequency of about 4,500 Mc/s is generated by a split-anode magnetron valve. The use of the magnetron valve in this connection has been described elsewhere, but it is of interest to note the construction of the electrodes which is shown in the inset of Fig. 1. The anode segments are arranged in cylindrical formation, the cathode lying along the axis. The magnetic field required to give the necessary spiral motion to the electrons is supplied by two cylindrical bar magnets and the magnetron mounting allows the valve to be rotated to a certain extent to bring the axis of the cylindrical anode parallel with the field. One of the magnets has a micrometer adjustment which enables the strength of the magnetic field to be varied, to suit the particular type of valve employed.

Energy is extracted from the magnetron by arranging that it lies in a rectangular cavity. This cavity is tuned to resonance at the frequency of the oscillator by an adjustable piston. The central conductor of a coaxial line crosses the cavity at a distance approximately one-quarter wavelength from the end and this picks up energy which is conveyed by the coaxial line to the aerial system. The impedance of the coaxial line is matched by an adjustable pis-



The aerial system is mounted on the roof of the trailer.

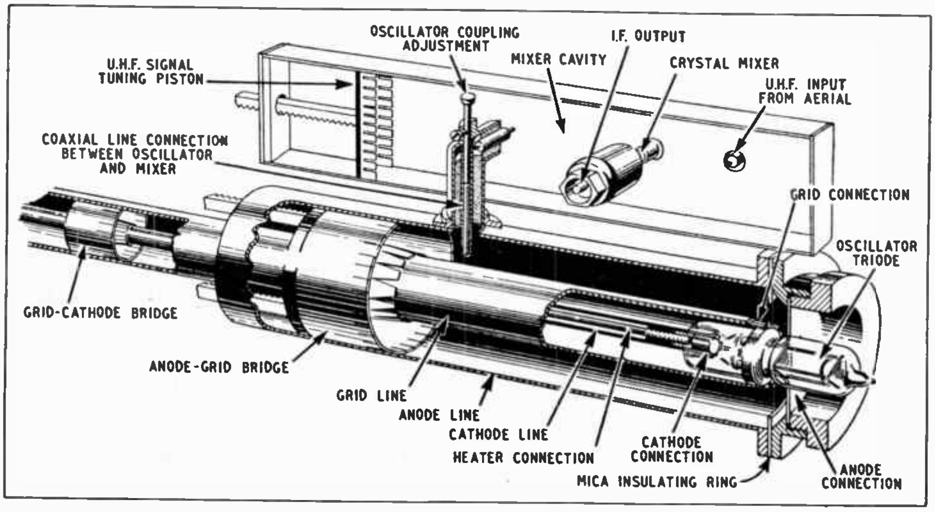


Fig. 3. Construction of oscillator and mixer used in the receiver is shown here. The oscillator is a triode and the third harmonic of its output is fed to the crystal mixer.

Army No. 10 Set—

ton in a cavity into which the centre conductor extends on the side of the resonator opposite the point where the coaxial line enters.

The manner in which the magnetron is modulated may be understood from the circuit of the sender shown in Fig. 2. V_2 represents the oscillator and V_1 the modulator. With no input from the Signalling Equipment No. 10, V_1 is so biased that it draws current. The magnetron H.T. supply is taken from a voltage-dropping resistance R_1 common to both valves and when V_1 is taking current, the anode potential of V_2 is too low for that valve to oscillate. The arrival of a negative pulse from the Signalling Equipment No. 10 at the grid of V_1, however, stops that valve from drawing anode current and the consequent rise in the anode voltage of V_2, about 300V, is sufficient to start the magnetron oscillating.

The output of the Signalling Equipment No. 10 consists of a series of negative-going pulses and thus the output from the sender consists of corresponding pulses of U.H.F. energy.

At the receiver (Fig. 3), the input from the aerial is fed into a mixer cavity or resonator, from a coaxial cable, the centre conductor projecting into the cavity about ¼ wavelength from one end. Energy from a local oscillator is similarly fed into the cavity at the other end. A crystal detector mounted across the cavity, i.e., parallel to the direction of the electric field, rectifies the oscillator and signal frequencies, thus producing a difference frequency (i.e., signal frequency minus oscillator frequency) of about 45 Mc/s which is amplified by an I.F. amplifier. It will be seen that there is nothing fundamentally different between this circuit and that of an ordinary superheterodyne receiver. The signal frequency is tuned by a resonating cavity instead of the more familiar coil and capacitor. It is also interesting to notice that the principle of heterodyning applies also at these frequencies although the arrangements required to carry it out are somewhat different.

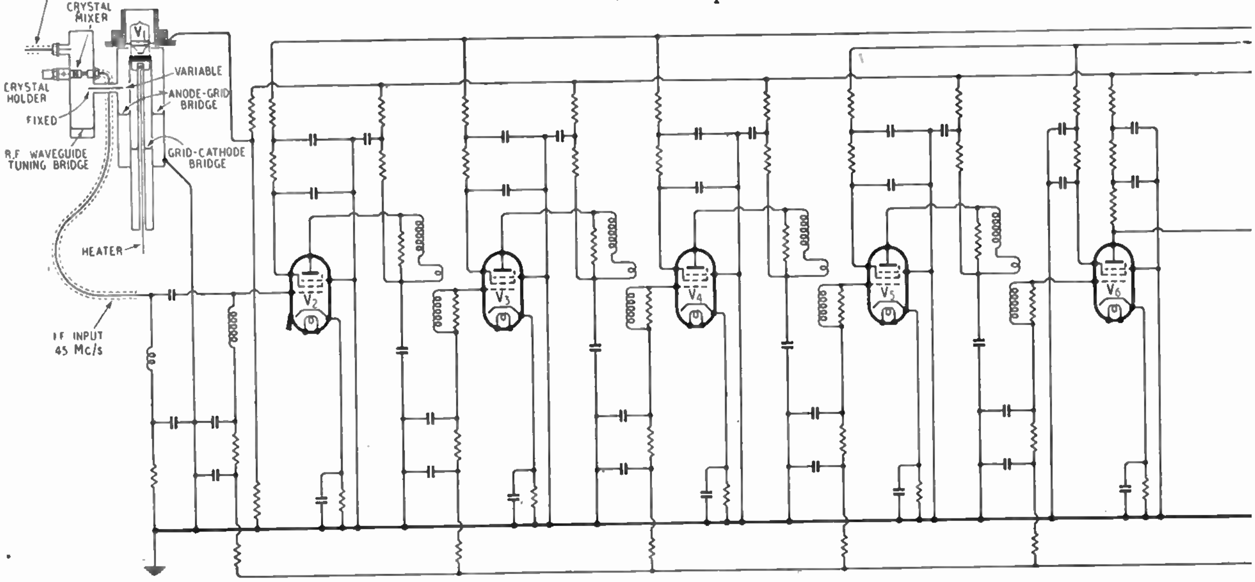
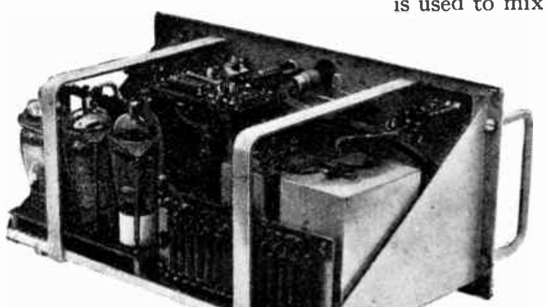


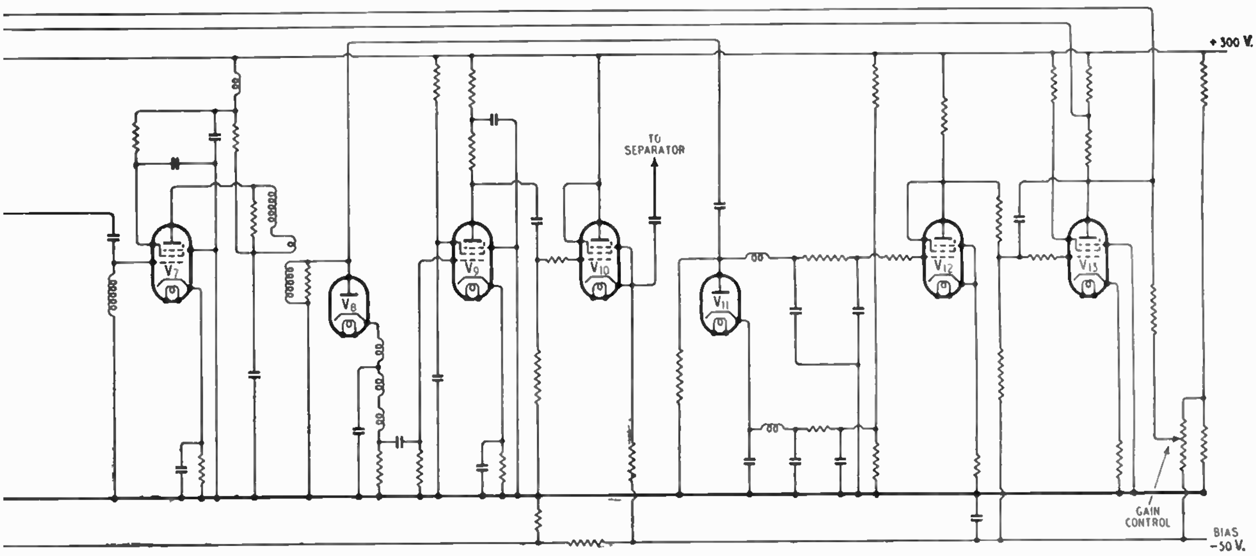
Fig. 4. Circuit of the receiver. The mixer is followed by a wide-band I.F. amplifier with diode detector and a V.F. stage. The output pulses are fed to the separator.

The local oscillator uses a miniature-type triode valve oscillating at about 1,485 Mc/s. The third harmonic of this frequency is used to mix with the signal frequency. The arrangement of the oscillator itself is very similar to that of the familiar triode oscillator tuned by a Lecher-wire system, the difference in this case being that the wires are replaced by concentric cylinders. Such an arrangement constitutes a system of concentric lines which are tuned by movable pistons, the pistons being the analogue of the movable bridges used with Lecher-wire tuning. For this reason they are referred to as bridges in Fig. 3. The necessary feedback between the anode-grid lines



The sender has its own built-in power supply unit.

and the grid-cathode lines to cause the circuit to oscillate is provided by internal capacitance in the valve. The coupling between the mixer cavity and the cavity between the anode and grid lines is by means of a concentric feeder,



the centre conductor extending into the mixer and oscillator cavi-

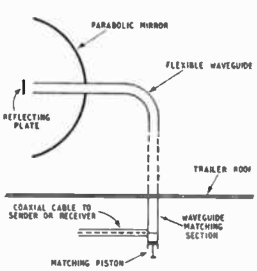


Fig. 5. This sketch shows the arrangement of the aerial system. A paraboloid is energized by a waveguide having a reflector plate opposite to its open end.

ties at each end. The oscillator coupling adjustment shown in Fig. 3, by varying the extent to which the centre conductor can protrude into the oscillator cavity, varies the amount of coupling between the oscillator and the mixer cavity.

The I.F. amplifier (V_2-V_7 in Fig. 4) is of conventional design and similar to the television amplifiers met with in commercial television receivers. A low-capacitance diode V_8 acts as detector and this is followed by an amplifier V_9 and a cathode-follower stage V_{10}, the latter giving a low impedance output required to match the input of the Signalling Equipment No. 10. This output consists of a series of positive-going pulses. Automatic gain control is provided by the diode V_{11}, which rectifies part of the output of the I.F. amplifier, followed by the D.C. amplifiers V_{12} and V_{13}. The control is applied direct to the screens of the first three I.F. valves from the anode of V_{13}.

OUR COVER

This month's cover illustration shows the parabolic reflectors for the Army's No. 10 set, mounted on the roof of the trailer. The half-wave dipoles, located off the centre of the paraboloid, are for monitoring purposes

The aerial system which is illustrated diagrammatically in Fig. 5, comprises two parabolic mirrors, one for the receiver and one for the sender. These aerials are mounted on the roof of a trailer, the remainder of the equipment being inside. The connection between each aerial and its sender or receiver is in two stages. A flexible waveguide connects the mirror to a waveguide matching section just below the trailer roof and a coaxial cable connects the matching section to the sender or receiver. The waveguide enters the centre of the mirror at the rear and carries a circular reflecting plate in front of its open end. This reflecting plate lies in the focal plane of the mirror. Inside the trailer the waveguide terminates in a matching section. This consists of a rigid tube connected at one end to the flexible guide and closed at the other by a movable matching piston. The centre line of a coaxial cable crosses the tube in front of the piston which can be adjusted to give the correct impedance match.

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WIRELESS TELEGRAPHISTS' HANDBOOK

THE eighth edition of the "Handbook of Technical Instruction for Wireless Telegraphists," by H. M. Dowsett and L. E. Q. Walker, which first appeared in 1913, was recently published from the offices of *Wireless World*. In addition to providing a complete theoretical course for the P.M.G. certificate for sea-going wireless operators, the Handbook, which costs 30s, gives practical details on the installation and maintenance of marine radio equipment. It contains 668 pp. and includes 618 illustrations and diagrams.

RADAR IN NATURE

Pulse Technique at Supersonic Frequencies

By THOMAS RODDAM

THE original plan of this article was that it should give a general description of an acoustic system analogous to radar, for the benefit of any *Wireless World* readers who might care to construct a model radar system. Only in such a way can the home constructor work in the radar field, for the power required for radar working is quite prohibitive even if many other practical difficulties did not exist. Unfortunately, the writer has had no opportunity of making such an acoustic model and was still nervous lest he should be asked for more details, when a most interesting paper[1] appeared on the acoustic equipment of bats which suggested a broader treatment.

Immediately, it must be explained that there is no suggestion that readers should become bat-fanciers: such a suggestion would probably cause a deputation of readers' wives, led by Mrs. Free Grid, to storm my attic in Pimlico. Equally, however, there is no suggestion that the younger readers should not take twilight walks along secluded lanes to study the habits of bats.

The interesting thing about bats to the radio engineer is their habit of flying about at full speed in dim lights. In fact, they can fly perfectly safely in total darkness. This apparent recklessness, however, does not lead them into constant collisions with the many obstructions which might harm them: even telegraph wires do not seem to constitute a hazard. To explain this behaviour it was suggested in 1920 by Professor Hartridge that bats were fitted with what would now be called a sonar system. Quite recently it has been shown that this is in fact the case, and that bats are equipped with a very efficient system for blind flying. This equipment is sometimes unserviceable, and a particular form of unserviceability occurs when the bat has a cold in the head, a disorder common in all animals kept in captivity, such as members of the Government Scientific Service. If a bat is deafened by plugging its ears it also loses the use of its blind flying system.

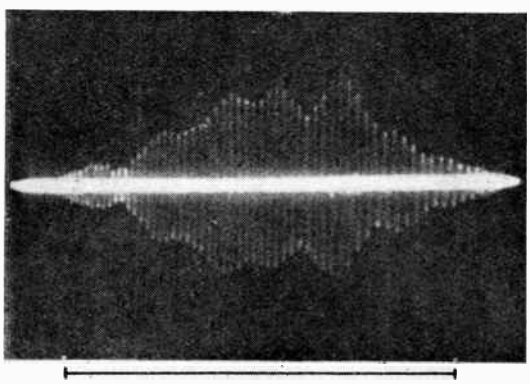
In flight a bat may, according to Hartridge (*loc. cit.*), produce any of four different kinds of sound:

(1) A buzz of about 12-60c/s;

(2) A tone of about 7,000c/s and lasting for about a quarter of a second. This is probably used as a communication channel to enable messages to be sent to other bats.

(3) A supersonic tone usually about 40-50c/s, but sometimes as low as 30kc/s or as high as 70kc/s. Pulses of this tone, each lasting about 1,1,000th second, are produced and normally twenty or thirty pulses per second are emitted. At rest the rate falls to 5-10 pulses per second, while when there is an obstacle immediately ahead the rate rises to sixty pulses per second.

(4) A click, which is probably a single pulse of the supersonic tone.



Oscillogram of supersonic cry of a bat taken by Dr. D. R. Griffin of Harvard University. The horizontal sweep motion is from left to right.

The mechanism which produces these various sounds is outside the scope of this article: it is discussed in the paper referred to above. A further discussion of the click appears in a later paper[2] and a letter[3]. Details of the various theories will not be given here, as the evidence does not seem to be sufficient to enable any really final conclusions to be drawn. There is also some conflict of opinion about just how the sound is radiated. Hartridge considers that it is emitted from the nose of the bat, while Griffin is convinced that the mouth is used. It would perhaps be unkind to suggest that there is some difference between Harvard bats and London bats in this matter. Many bats have snouts so shaped that fairly good beaming of the supersonic tone would be obtained, thus giving a useful power gain in the direction of dangerous obstacles. In addition, as the bat uses its ears for reception and direction finding, beaming of the signal reduces the level of the direct sound and thus prevents the echo being masked by a strong transmitted pulse. There is almost certainly some additional protection provided which desensitizes the hearing while the pulse is being emitted. The receiving system is also directive; a large flap extends from the side of the bat's head behind each ear, providing considerably increased sensitivity in a forward direction.

It is interesting to note that the sonar system used by bats is just

[1] *Nature* Vol. 156, p. 490 (1945). (This paper has a list of 14 references which can profitably be consulted.)

[2] *Nature* Vol. 158 p. 46.

[3] *Nature* Vol. 158 p. 135.

good enough for the job. In a description of the flight of bats towards a large lighted window[4], it is stated that on nearing the window the bats went into steep turns, stalled turns or half-rolls. An interesting avoiding technique adopted consisted of folding the starboard wing, which gave an unbalanced and reduced lift, swinging the bat on to its back and allowing the nose to drop. The wing was then opened again and the bat dropped in a vertical dive with its belly towards the window and pulled out about four feet lower down. This manœuvre was carried out within a foot of the window, avoiding action having begun about two feet from the obstruction. Assuming a speed of 25 feet/second and a reaction time of 1/10th second, the decision to turn must have been taken at a range of about four feet.

The pulse length is sufficiently short for a minimum range of about one foot, which corresponds to a total delay time of 2 milliseconds. Any muting during transmission will probably increase the minimum range, but clearly the performance is quite adequate for ordinary flying.

So much for this natural form of "supersonic radar" as it is observed by the zoologists. Let us now consider the "design data."

The reader will remember that in an ordinary radar system a short train of radio waves is produced. This train of waves travels off into space with a velocity of 3×10^{10} cm/sec, is reflected by the target and the echo is picked up by the receiver. If the time between the transmitted pulse and the received echo is 10 microseconds, the target is clearly at a distance of 1,500 metres. Sound waves in air have a velocity of 34,250 cm/sec. at a room temperature of 20°C. (At other temperatures the velocity is $33{,}170+54t$ cm/sec.) The ratio of sound velocity in air to radio velocity in free space is therefore about $1.1:10^6$. As far as timing goes, therefore, a one-inch range with sound waves is roughly equivalent to 16 miles range with radio waves. For making a model radar system using supersonics the standard international map series with a scale of $1:10^6$ can be used to replace the actual area of a radar system.

[4] *Nature* Vol. 156 p. 693 (1945).

It is not very convenient to scale all the other dimensions of a radar system in the same way, and it is usual to base supersonic systems on the attenuation characteristic of supersonic waves in air. In Fig. 1 the range for a fall in intensity of 10db is plotted against frequency. It will be seen that with a frequency of 100kc/s the range is four metres. A perfect reflector at this range would, therefore, produce an echo 20db down. At the lower frequency of 50kc/s used by bats the corresponding range is greater, about 12 metres on this 20db criterion.

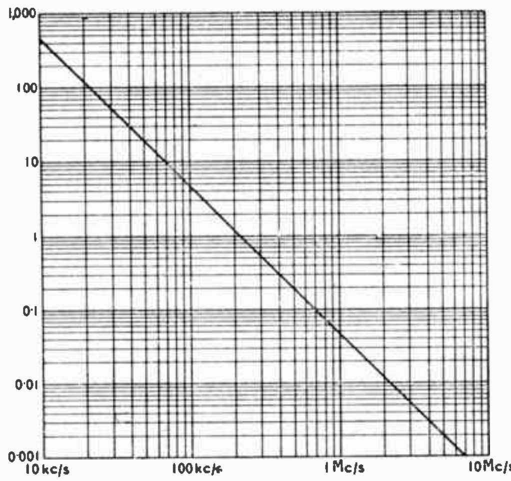


Fig. 1. Range of supersonic waves in air for a 10db fall in intensity. (*Courtesy: Nature*)

The actual transmitted field strength is about 10-50 dynes/cm², but there does not seem to be much information on the minimum size of object which can be detected. It seems that useful information could be obtained by jamming experiments, in which the room was filled with noise distributed throughout the 30-70kc/s band. With a noise field exceeding the pulse strength which the bat expects, the bat should find it impossible to detect objects in time to avoid them.

A frequency of 100kc/s corresponds to a wavelength of 3.3 millimetres: with an aperture of the "aerial" of 2 centimetres a beam about 10° wide will be obtained. A model-maker can easily obtain an aperture of this size in one dimension by using a flat quartz plate (X-cut) in longitudinal vibration.

The pulse length is fixed by the carrier frequency. At least ten wavelengths should constitute a pulse train, and in general about 30 should be used. This means that a pulse train of 3 to 10 centimetres, with duration 0.1 to 0.3 milliseconds is desirable. The resolution in range which is obtainable is thus of the order of 5 to 15 centimetres and the band-width required in the receiver is from 3 to 10kc/s. For ease in model making, it may be noted that this band-width is that of a conventional receiver: if a broadcast receiver with a long-wave band is used the carrier frequency can be increased to 150kc/s, and the only modification required will be the provision of a modified detector circuit for pulse working.

The pulse repetition rate is fixed by the maximum range: a pulse must not be transmitted until the echo of the previous pulse from the most distant target has been received. If the range is chosen as 3 metres, a repetition rate of 50 pulses per second can be used. It will be found very convenient to choose either 50 pulses per second, or some other rate simply related to the mains frequency, as this reduces the need for smoothing the supplies to the various circuits; 33 1/3 pulses per second or 66 2/3 pulses per second can be used, for example. As we saw above, bats at rest transmit about 5 to 10 pulses per second and in flight up to 60 pulses per second. Thus at rest the bat is using a long range warning system, presumably to detect approaching enemies up to 15-30 metres away. In flight the bat is interested in much shorter ranges with more frequent measurement in order to avoid obstacles. It is interesting to note how closely the blind flying system of the bat ap-

Radar in Nature—

proaches the system designed purely on the basis of the discussion above. Only the pulse length differs substantially, and this limitation does not affect flying, for the bat does not want to know anything about an obstacle which is too close to be avoided. The minimum range requirements are less stringent than with an A.I. system, in which the object is to come as nearly as possible into collision with the target.

A model radar system using supersonic waves in air was used for demonstration at the 1946 exhibition of the Physical Society. In this demonstration the signal frequency used appeared to be about 12kc/s, corresponding to a wavelength of about 3 cm. With the size of horn used the beam is rather wide. The resolving power in range appeared to be about 30 cm, which would mean pulses containing about ten cycles and lasting for about a millisecond. The peak power used in this demonstration is not known, but there is little difficulty in getting several hundred watts from a pair of push-pull KT8 valves. Powers of this order can most conveniently be used to drive magnetostriction radiators. It is thought that a much more successful demonstration would be produced by using higher frequencies as then the range limitation due to attenuation would prevent permanent echoes from the walls of the work-room, and the ranges could be laid out on a map to give a fair degree of verisimilitude.

It is equally possible to make a supersonic system working in water. Radar training devices have been produced on this basis, and "Asdic" is another well-known application. The velocity of propagation in water is 1,475 metres/second, so that the radar/Asdic scale ratio is 4 miles/1 inch. The range quoted for Asdic systems is 2,500 yards so that the pulse repetition rate for general search purposes can only be about one pulse every three seconds. The frequency used is not known, although references to "pinging" and attenuation considerations suggest that it is probably between 5kc/s and 10kc/s. This means that the wavelength in water will be about 14-28 centimetres, which would permit a range resolution of a few metres. For short range tracking repetition rates of more than one pulse in 3 seconds are probably used, as in this time the relative movements of two ships may be as much as 100 feet. Readers may be interested to know that even "Window" had an underwater equivalent. Just as metal foil strips provided artificial radar echoes, so "Pillenwerfer" produced artificial Asdic echoes. These devices were balls filled with chemicals which, like the familiar fruit salts, produced streams of bubbles. A stream of bubbles in water provides an impedance discontinuity which reflects the supersonic waves and thus provides an artificial echo.

These notes on the application of supersonic waves to range and distance measurement cannot, unfortunately, be completed by a description of a practical system which has been used for this purpose. They do, however, indicate to the keen experimenter a new field which he can explore without excessive apparatus costs. The signal frequency arrived at on purely theoretical grounds is convenient in that a long-wave receiver can be used with very little modification. The cathode-ray oscillograph will probably already be available. The writer does not know whether an ordinary "tweeter" will give an adequate output at such high frequencies, but if so the only apparatus to be constructed is an unsymmetrical multivibrator keying a self-oscillator. From this stage the addition of a rotating head to link the supersonic beam to a P.P.I. and construction of models of all the main radar systems offers a very interesting field for home study: a field, moreover, which does not involve the possession of a transmitting licence. Extensions to the study of polar diagrams using scale models can also be made using the same equipment. One word of warning must be added. Multivibrators can be very unpleasant neighbours if they are lashed up to produce very square pulses. A neat layout, with some screening, and capacitances added to round the pulses will prevent the circuit acting as a general-purpose jammer.

INDUSTRIAL ELECTRONICS

B.T.-H. Exhibition

RECENT developments in industrial electronics was the theme of an exhibition by the British Thomson-Houston Co. held last month at Rugby, and the application of thyratrons to industrial control was a major part of the display. As an example of the control now possible with such valves, a pentode-type thyratron can control currents up to 33 A, the thyratron itself being controlled by a photo-electric cell with no intermediate amplification.

Voltage regulation is one of the most interesting applications of the thyratron. A pair of such valves, with one hard valve, is usually employed and regulations up to 0.25 per cent are obtainable. The alternator output is rectified and the D.C. is amplified by a hard valve, the output of which controls the grid bias of a pair of thyratrons. These are fed with A.C. in push-pull on both anode and grids, but the grid voltage is 90° out of phase with the anode. The striking voltages are controlled by the D.C. bias and the thyratron output thus depends on the bias. It is used for the field supply and hence controls the alternator output. Similar principles are used in speed regulators, the control voltage being frequently derived from a tachometer.

Electronic timing circuits, ensuring that the amount of heat applied to the work is under exact control, are employed in the B.T.-H. radio heating equipment.

The Ignitron is a valve which effectively disposes of the idea still held by many that valve currents are small. Some Ignitrons pass peak currents of 10,000 A. They are steel-jacketed, and often water-cooled, with a mercury-pool type cathode and they are used for the control of A.C. power and for the conversion of A.C. to D.C. In this latter application six valves fed from a six-phase supply can provide an output of 900 A.

Magnetrons and klystrons form the major development at the other end of the scale—in centimetre-wave engineering. In conjunction with waveguide technique they have made modern radar possible and in the B.T.-H. marine radar equipment the aerial system is simply a slotted waveguide. Radiation takes place from slots across the wall of the guide and a beam angle of 1.5° is obtained. The display is in the form of a plan position indicator.

ELECTROMAGNETIC FRAME SCANNING

Time-base Amplifier

By W. T. COCKING, M.I.E.E.

THE characteristics of television line-scan amplifiers were recently dealt with* and it might be thought that the frame-scan amplifier would differ only in minor matters brought about by the lower operating frequency. While it is true that the differences all arise through this difference of frequency, they are very far from being minor ones. In fact, they are so great that line-amplifier theory is of very little help and it is better to start quite afresh than to attempt to modify it.

The ampere-turns needed in the deflecting coil are approximately the same as in the case of the line scan, for although the frame deflection required is only 80 per cent. of the line, the deflecting coils themselves are necessarily shorter for the frame than for the line. The two effects roughly cancel. It is, therefore, reasonable to take as a first approximation a current of 0.6A p-p in a coil of 200 turns with an inductance of 3 mH. The actual coil can have any number of turns, but the product of turns and current will remain constant at 120 A-turns and the inductance will be, approximately, proportional to the square of the turns. Thus, if we use 2,800 turns, the current will become 120/2,800 = 0.0428A = 42.8 mA, and the inductance will be about $3 \times (2{,}800/200)^2 =$ 588 mH = 0.588 H, or say, 0.6 H.

The resistance, too, will vary as the square of the number of turns because, as the winding space is roughly constant, it is necessary to use finer wire when the turns are increased. Thus, if the 200-turn coil has a resistance of 6.4 Ω, the coil of 2,800 turns will have a resistance of about 1,250 Ω.

The current through the coil is required to rise linearly with time for the 19 msec. devoted to the frame scan in the present transmissions and fly-back in 1 msec. If the current is 0.6A in a 3 mH coil, the back e.m.f. on the scan is $L\,di/dt = 3 \times 10^{-3} \times 0.6/0.019 = 0.095$ volt; the drop across the resistance is 0 to $0.6 \times 6.4 = 3.84$ volts. With a 0.6 H coil and 43 mA, the figures become 1.35 volt and 0 to 53.8 volts, respectively. In both cases the inductive back e.m.f. is negligible in comparison with the drop across the resistance.

If the fly-back were linear the inductive back e.m.f. would be 19 times as great as on the scan. It will not be linear, however, and so will be greater still. Referring to Fig. 1, the conditions on the fly-back are as if the deflector coil, itself of inductance L_L and resistance R_L, were shunted by a resistance R_1 and the maximum current i_0 were allowed to die away.

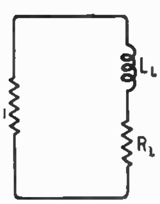


Fig. 1.

The current at any instant is then $i = i_0 \varepsilon^{-t/T}$ where $T = L_L/(R_L + R_1)$. The total voltage across the deflector coil terminals is $R_1 = i_0 R_1 \varepsilon^{-t/T}$. This is a maximum when $t = 0$, that is, at the start of the fly-back, and is simply $i_0 R_1$.

The fly-back is 99 per cent. complete when $i = 0.01 i_0$ and then $t/T = 4.5$. Therefore, $R_1 = 4{,}500 L_L - R_L$ in henrys and ohms. This is the *minimum* value of R_1 permissible if the fly-back is to be 99 per cent complete in the nominal fly-back period.

For the 3 mH coil, we have $R_1 = 4{,}500 \times 0.003 - 6.4 = 7.1\,\Omega$ and for the 0.6 H coil $R_1 = 4{,}500 \times 0.6 - 1{,}250 = 1{,}450\,\Omega$. These are minimum values of resistance for the required fly-back time, and with them the maximum back e.m.f. for the smaller coil is 4.26 volts and for the larger 62.3 volts.

It will thus be clear that the maximum voltage across even a high-inductance deflector coil is not sufficient to cause serious insulation difficulties. In the case of the line scan, the back e.m.f. reaches 1,000—2,000 volts, and a high-inductance coil is ruled out by the impossibility of providing adequate insulation. No such difficulty arises in the frame scan and a choice between the two must be made on other grounds.

The use of low-inductance deflector coils is desirable for two reasons; they reduce interaction between the line and frame deflection circuits and they are easier to wind. However, a transformer is necessary and its construction demands a large quantity of fine gauge wire which is not easy to obtain at the moment.

The usual transformer circuit

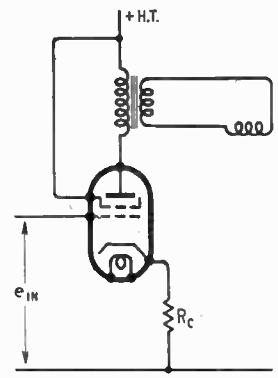


Fig. 2.

is shown in Fig. 2 and has the equivalent of Fig. 3 (a). This can be further reduced to Fig. 3 (b) in which R_1 represents the total shunt damping of valve and transformer-core losses, r_p is the transformer-primary winding resistance and L_p the primary-inductance. R is the sum of the deflector coil resistance R_L and the secondary winding resistance r_s multiplied by the square of the transformer ratio (n), and $L = n^2 L_L + 2L_p(1 - k)$ where $k = M/\sqrt{L_p L_s}$ = coupling co-efficient. The circuit capacitances,

*Electromagnetic Deflection, by W. T. Cocking, *Wireless World*, July, 1946.

so important in the line-scan case, can here be ignored. It is to be noted that k is taken as unity except where its difference from a nearly equal quantity is involved; the approximation $2(1 - k)$ instead of $(1 - k^2)/k^2$ is then used.

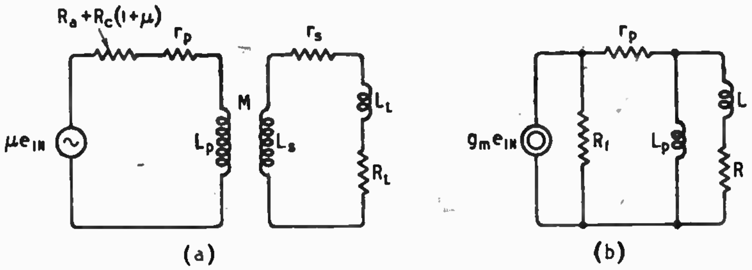


Fig. 3.

Taking a 3-mH deflector coil, if the transformer ratio is arbitrarily made 14 : 1, the primary current required becomes 43mA and, ignoring the leakage inductance for the moment, L becomes 0.6H. These are the same values as for the high inductance coil without a transformer. Ignoring r_s temporarily, R = 1,250 Ω. Our aim is now to form a preliminary estimate of the primary inductance needed.

It is not difficult to show that during the scan the deflector-coil current is proportional to $1 - \varepsilon^{-tR/(L + L_p)}$ if the valve is linear. If 2 per cent distortion at the end of the scan is permissible, then at this time $tR/(L + L_p) = 0.02$. As t is 19 msec., we have $L + L_p = 0.95R$ in henrys and ohms. With R = 1,250 Ω, $L + L_p = 1,185$H.

This is a very large inductance and cannot be obtained in any reasonable size with negligible winding resistances; r_p is unlikely to be less than 1kΩ and $r_s n^2$ about the same. The value of R will thus be around 2.25kΩ instead of 1.25kΩ and L_p will have to be further increased to 2,130H.

Taking into account the fact that the valve will need 30–40mA mean anode current, which flows through the transformer primary, the primary winding is likely to need some 20,000–40,000 turns with an iron core similar to that of a small mains transformer.

The leakage inductance then becomes very important. Even if many interleaved primary and secondary sections are used it is unlikely that k can be made greater than 0.998. Taking this figure and with L_p = 2,000H, the leakage inductance is 2 × 2,000 (1 − 0.998) = 8H. The true value of L is thus 8.6H and the leakage inductance pulls more weight than the deflector coil.

Using the formula given earlier, the minimum shunt resistance for an adequate fly-back time is 4,500 × 8.6 − 2,250 = 36,500 Ω. Of this r_p will account for at least 1,000 Ω, so that R_1 of Fig. 3 (b) would be not less than 35,500 Ω. As the current is 43mA, the peak voltage across the transformer primary is 35,500 × 0.043 = 1,530 volts.

The voltage on the transformer, and valve, is thus of the same order as in the case of line-scanning and very high insulation is needed. This is particularly difficult in view of the large number of interleaved primary and secondary sections needed to secure tight coupling.

As an example of the fantastic voltages which can be reached, in theory at least, suppose that the coupling is 0.99—a value which is quite likely to be obtained if the primary and secondary are not interleaved. Then the leakage inductance is 40H, so L = 40.6H; R_1 = 4,500 × 40.6 — 2, 250 = 180,000 Ω, and the peak voltage is 180,000 × 0.043 = 7,750 volts.

Such a voltage is not likely to be reached in practice, because iron losses in the core and the valve A.C. resistance would prevent R_1 from being made high enough. The practical effect of inadequate coupling would thus be to slow down the fly-back.

The question now arises as to what can be done to ease matters, for the requirements laid down lead to an impracticable design. The fly-back time can be increased slightly, and this will result in slight curvature of the scan at the top of the picture. In a small degree this is not important, but it must be kept small and then the situation is eased only slightly.

The second thing is to permit increased curvature towards the end of the scan, which will cramp the picture towards the bottom. Quite a bit can be done to correct for this by the natural curvature of the valve characteristic, so that much more distortion can be allowed than would otherwise be permissible.

Before proceeding further with a consideration of transformer coupling, however, it is as well to investigate the alternative of a high-inductance deflector coil with a resistance-capacitance feed. Choke-capacitance feed is ruled out because the choke would have to be of as large an inductance as a transformer. The circuit is shown in Fig. 4, and its equivalent in Fig. 5, in which R represents R_1 in parallel with the output resistance of the value[$= R_a + R_c(1 + \mu)$].

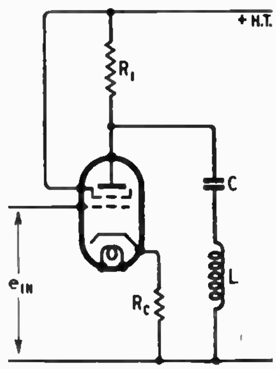


Fig. 4.

On the fly-back C has a negligible effect, and the circuit is essentially the same as that of Fig. 1 with R written for R_1. We found earlier for this that with
L_L = 0.6H, R_L = 1.25kΩ
and a current of 43mA, the value of R should not be less than 1.45kΩ for a fly-back time of 1 msec. This can easily be achieved with a pentode valve.

On the scan the deflection current is proportional to $1 - \Sigma^{-t/T}$ where $T = C(R + R_L)$. For 2 per cent distortion at 19 msec. $t/T = 0.02$; therefore, $C(R + R_L) = 50t = 0.95$ in farads and ohms. If $R = 2k\Omega$ and $R_L = 1.25k\Omega$, $C = 0.95/3{,}250 = 0.000292F = 292\mu F$. This is inconveniently large, for in a 500-volt rating the component would be both

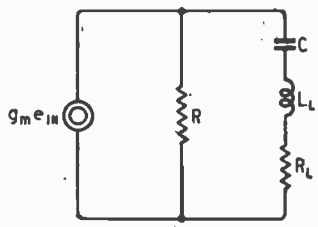


Fig. 5.

expensive and bulky. The working voltage on the valve will, of course, be well below 500V, but this rating is desirable to allow for the voltage rise when switching on.

By permitting more distortion the capacitance can be reduced just as in the case of transformer coupling. Thus, if 6 per cent distortion is allowed it can be brought down to $100\mu F$. It can be further reduced by increasing R, for it is the product $C(R + R_L)$ which is important, not the individual values.

As R consists of the coupling resistance R_1 in shunt with the output resistance of the valve, and as the only limitation to the maximum value of R_1 is set by the loss of anode voltage in it, it is clearly desirable to make the valve resistance as high as possible. The use of a pentode valve is thus indicated in preference to a triode, which would be permissible on the score of fly-back time. With a pentode and any reasonable value of R_1, the output resistance of the valve is high enough to be ignored, and to all intents and purposes $R = R_1$.

The limit to R_1 is set by the minimum permissible anode voltage of the valve, and with a positive-going saw-tooth input this occurs at the end of the scan when the anode current is a maximum. Ignoring the inductive back e.m.f., and assuming that the change of voltage across C is negligibly small during the scan, the change of anode voltage ΔE_a on the scan is $\Delta i R_L$, where Δi is the peak-to-peak coil current. In this instance it is $0.043 \times 1{,}250 = 53.8$, or say 54 volts.

The saw-tooth anode current is

$$\Delta i_a = \Delta E_a \Big/ \frac{R_1 R_L}{R_1 + R_L} = \Delta i\,(1 + R_L/R_1)$$

so that in effect R_1 robs the coil of current and the valve must provide a greater output. It is again advantageous to make R_1 as large as possible compared with R_L.

If we call the mean anode voltage E_a and the current i_a, the minimum anode potential is $E_a - \Delta E_a/2$ and with a pentode this should not be less than about 100 volts in most cases. With some valves it can be a little lower, but this is a reasonably safe figure. Therefore, the mean anode voltage must not be less than $E_a = 100 + \Delta E_a/2 = 127$ volts in our example.

Now this voltage is also $E_{HT} - i_a R_1$, so that it is necessary to determine i_a. There is a minimum permissible anode current $i_{min} = i_a - \Delta i_a/2$ which is necessary for reasonable linearity. This varies with different valves, but one is not far out in taking it around 15mA.

These factors are expressed in Eqns. (1) to (5) in the Appendix, and lead to Eqns. (6) and (7) for the values of R_1 and i_a. If we have $E_{HT} = 350V$, $E_{a\,min} = 100V$, $i_{a\,min} = 15mA$, $\Delta i = 43mA$, $R_L = 1.25k\Omega$, we find $R_1 = 5.35k\Omega$ and $i_a = 41.5mA$. Then $R_L + R_1 = 6.6k\Omega$ and $C = 144\mu F$.

In the foregoing it has been assumed that the valve characteristic is linear. In practice, it will not be unless an uneconomically large valve is used. If the input saw-tooth wave is positive-going on the scan the curvature at the start of the scan is in the right direction to compensate for the curvature introduced by C. Valve curvature towards the end of the scan, however, can be in the opposite direction, and so may accentuate the non-linearity of the scan. This can be avoided by the use of an adequate H.T. voltage, but even then the curvature at this point may not be sufficient to correct the circuit distortion.

From all this it is clear that it is necessary to make use of valve curvature in order to obtain an economical time-base. An attempt to design for linearity in each part by itself, while the ideal, is much too expensive for normal purposes. Adequate valve linearity demands a heavy anode current and a large amount of negative feedback. Adequate linearity in the coupling to the deflector coil demands either an impracticable transformer or an uneconomically large capacitance.

By letting the defects of one piece of apparatus offset those of another, a much more economical design is obtainable. Of course it is too much to expect exact compensation, but the distortion can be greatly reduced without difficulty, and a reasonable amount of negative feedback can be employed to clear up the residue.

It is of the first importance to note that for such compensation it is essential for the output valve to be fed with a positive-going saw-tooth wave. This is necessary in any case on the line scan for other reasons, but there is no obvious objection to the use of a negative-going input on the frame scan. However, with a negative-going input the valve distortion is in the same direction as the circuit distortion and the two accentuate each other. Only with a positive-going input are the valve and circuit distortions in opposition.

The estimation of the effect of valve and circuit together will be considered in detail in a further article.

APPENDIX

Units (mA, V, $k\Omega$)

Let

i_a = mean anode current.

Δi_a = peak-to-peak saw-tooth anode current.

Δi = peak-to-peak saw-tooth coil current.

$i_{a\,min}$ = minimum permissible instantaneous anode current.

E_a = mean anode voltage.

ΔE_a = peak-to-peak saw-tooth anode voltage.

$E_{a\,min}$ = minimum permissible instantaneous anode voltage.

E_{HT} = voltage of H.T. supply.

Then

$$\Delta i_a = \Delta i(1 + R_L/R_1) \quad (1)$$

$$\Delta E_a = \Delta i R_L \quad (2)$$

$$E_a = E_{a\,min} + \Delta E_a/2 \quad (3)$$

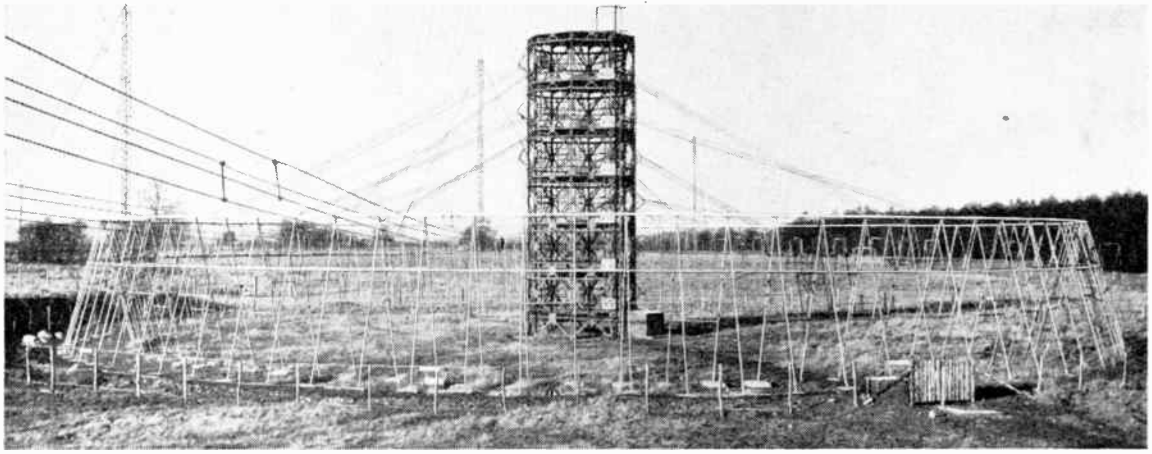
$$E_{HT} = E_a + i_a R_1 \quad (4)$$

$$i_a = i_{a\,min} + \Delta i_a/2 \quad (5)$$

and

$$R_1 = \frac{E_{HT} - E_{a\,min} - \Delta i R_L}{i_{a\,min} + \Delta i/2} \quad (6)$$

$$i_a = i_{a\,min} + (1 + R_L/R_1)\Delta i/2 \quad (7)$$



SHORT-WAVE FORECASTING

Using Ionosphere Charts for Choosing Frequencies

(Concluded from page 250, August issue)

By T. W. BENNINGTON

(Engineering Division, B.B.C.)

CHARTS prepared in the way described last month may be used to find the predicted *average* M.U.F.—and from this the Optimum Working Frequency, or O.W.F.—for a transmission path of any distance, in any part of the world, for every hour of day for the month for which they are valid.

If the transmission path is exactly 2,500 miles long, then the M.U.F. will be read off *directly* from the chart at the point at the centre of the path. If the path is less than 2,500 miles long then, as has been explained, the M.U.F. will be less than that indicated on the chart. It is only necessary in this case to read off the M.U.F. at the centre of the path and multiply it by a factor which is the ratio of the M.U.F. for 2,500 miles to that for the given distance. A set of such "Distance Factors" for various distances is given in the second column of Table I.

TABLE I

Distance Factors by which F layer 2,500-mile contours or E layer 1,000-mile contours must be multiplied to obtain M.U.F. for shorter distances.

Distance: miles	Factor		
	For F, F_2 layer	For E layer	For F_1 layer
0	0.35	0.22	—
250	0.36	0.39	—
500	0.42	0.64	—
750	0.52	0.85	—
1,000	0.64	1.00	—
1,250	0.74	1.10	—
1,500	0.83	1.14	—
1,750	0.90	—	1.15
2,000	0.95	—	1.14
2,250	0.98	—	—
2,500	1.00	—	—

When the transmission path is *more* than 2,500 miles long the transmission will be by multiple hops, but the M.U.F. can still be read off *directly* from the chart. Experience has shown that beyond 2,500 miles the M.U.F. does not at first decrease, as might have been expected owing to the sudden decrease in the length of each hop, and transmission cannot be considered as a simple extension of one-hop transmission to multiple hops. In multi-hop transmission there is considerable scattering at each reflection at ionosphere and earth, resulting in energy travelling by a multiplicity of paths, and, because of this and other effects, it is not possible to consider the conditions at certain separate ionospheric points as if transmission were by a "single ray" of radio energy. It has been found in practice, however, that if ionospheric conditions are considered at two points 1,250 miles (the distance of "half a hop") from each end of the path, good results are obtained. If the frequency used is such as will be reflected at both of these "control points," then the wave will, in general, be propagated by the ionosphere over the whole path.

Putting ionosphere theory into practice. Our title picture above shows the aerial switching tower and feeder terminating ring at the B.B.C.'s short-wave station at Skelton, near Carlisle, by means of which transmissions are fed to the previously selected aerial arrays. The output from six transmitters is handled by this tower and it is possible to connect each one to six arrays. With its twelve 100-kW transmitters Skelton is the world's largest short-wave broadcasting centre.

Finding the Working Frequency.—The full procedure for the determination of the M.U.F.s and other relevant quantities for any transmission path is thus as follows: Using a Mercator map of the same size and co-ordinates as those used for the contour charts the location of the transmitting and receiving points is first marked off, and the great circle path between them is drawn in. If the path is 2,500 miles or less in length, the centre of the path is then marked off, whilst, if it is of greater distance than this, the two control points 1,250 miles from each end of the path are similarly indicated. By reference to the map of Fig. 3 (last month's issue) it is next ascertained in which zone the separate control points lie. If, as in the case of paths 2,500 miles or less in length, there is only one control point, or if where there are two they both lie in the same zone, it is only necessary to make use of one contour chart, but if the control points lie in different zones, then the contour charts appropriate to both zones must be consulted.

We will deal with multi-hop circuits first. Using the appropriate chart, this is placed over the Mercator map so that the equators on each coincide, and the transparency is slid over the map until its 00 hours meridian coincides with the meridian on the map corresponding to the standard time in which it is desired to work. For instance, if it is desired to work in terms of G.M.T. we start operations with the 00 hours meridian coincident with the 0° longitude meridian on the map. Fig. 4 will help to make this clear. The 2,500-mile M.U.F. at each control point is then read off, and by sliding the transparent contour charts along so that each hour in turn coincides with the Greenwich meridian, this is done for every hour of the day, the M.U.F.s indicated being entered upon a Work Sheet like that shown in Table II, which is for a multi hop path with control points in two zones.

Having done this it is only necessary to strike out the *higher* of the two M.U.F.s appearing on the work sheet to be left with a value which is the M.U.F. for the whole path.

It must be remembered that the contour charts are compiled from critical frequency measurements which are the *average* of those obtained on every day of the month, so that what the contours show is the average predicted 2,500-mile M.U.F. for the month. On some days the M.U.F. is likely to be considerably above this value and on others considerably below it. It is likely to be somewhat below it, in fact, on about half the days of the month, and in operating a service like that of the B.B.C. where the aim is to provide regular service on every day, we cannot afford to work on a frequency which is likely to fail for a considerable portion of the total time. We must work somewhat below the average M.U.F., though it is always advisable to work as near it as possible, because of the fact that as we reduce the frequency ionospheric absorption increases, and with a given power radiated the field intensity at the receiving end will tend to decrease.

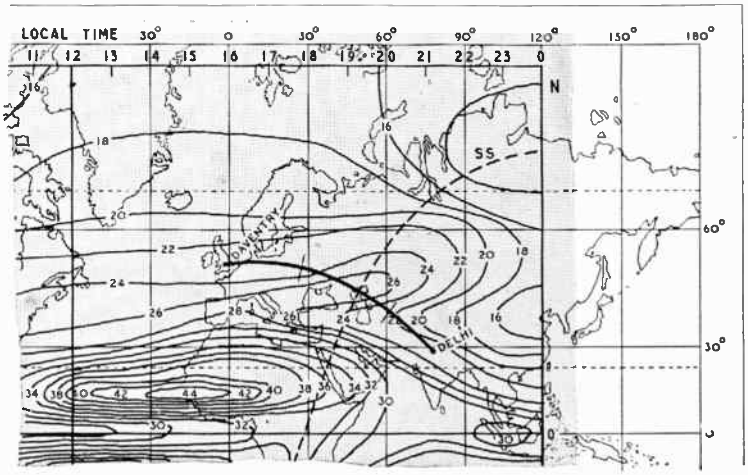


Fig. 4. Showing the method by which the M.U.F. is read off for every hour of day. The transparency is shown over the Great Circle path to Delhi at 16 hours G.M.T.

TABLE II: PREDICTED WORKING FREQUENCY WORK SHEET

TO INDIA DELHI — d = 4,220 MILES. MAY 1946

FREQUENCIES IN MEGACYCES

G.M.T.		00	02	04	06	08	10	12	14	16	18	20	22
FIRST CONTROL POINT I CHART	F, F_2 2,500 M.U.F.	14·4	14·0	17·4	20·5	22·3	23·0	23·2	23·6	~~23·8~~	~~25·8~~	~~22·0~~	15·8
FIRST CONTROL POINT E CHART	F, F_2 2,500 M.U.F.	~~15·8~~	~~20·0~~	~~22·2~~	~~25·5~~	~~27·0~~	~~27·7~~	~~29·0~~	~~26·2~~	23·3	19·6	20·2	~~17·4~~
K = ... F, F_2 M.U.F. FOR PATH		14·4	14·0	17·4	20·5	22·3	23·0	23·2	23·6	23·3	19·6	20·2	15·8
F, F_2 O.W.F.	−15%	12·3	11·9	14·8	17·5	19·0	19·6	19·8	20·0	19·8	16·7	17·2	13·5
E 1,000 M.U.F.													
K = ... E, F_1 M.U.F. FOR PATH													
M.U.F. FOR PATH		14·4	14·0	17·4	20·5	22·3	23·0	23·2	23·6	23·3	19·6	20·2	15·8
O.W.F. FOR PATH		12·3	11·9	14·8	17·5	19·0	19·6	19·8	20·0	19·8	16·7	17·2	13·5

K = DISTANCE FACTOR

The extent of the departure of day-to-day critical frequencies from the average for the month, both up and down, is known, and it has been found that, except during ionosphere disturbances, they do not often vary by more than about 15 per cent. So if we work on a frequency 15 per cent below the M.U.F. for the path we ought to be able to maintain regular service on all days except those on which ionosphere storms are in progress. The next step on the work sheet is therefore to find a figure 15 per cent below the M.U.F. for the path, and this is called the Optimum Working Frequency. Those whose interest lies in the exploitation of a particular frequency band rather than in the operation of a regular service would find that they can often work on frequencies well above the Optimum Working

Frequency or even well above the M.U.F. They would, in fact, often obtain best results by working on such frequencies, but that is a different matter from the operation of a regular broadcasting service, where no immediate reports from the receiving end are available.

Circuit Curves.—It is now advantageous to plot the data from the Work Sheet in the form of curves, as is done in Fig. 5. We are now in a position to choose our actual working frequencies for every time of day and these will depend upon the allocations made for the particular services in which we are interested ; i.e., the highest frequency band, not above the O.W.F. at the various times of day, which we may have available. Fig. 5 shows (in horizontal full lines) the actual working frequencies inserted into the curves in terms of the broadcast bands, while the vertical lines connecting them indicate the times when a frequency shift is necessary. Of course, it does not follow that one would necessarily change frequency at all the times indicated, particularly in a broadcast service, in which continuity of transmission on a single frequency for as long as possible is a desirable feature. Nevertheless, such curves show at a glance the frequencies which should be used at any time of day, and, in general, the transmission schedules will be compiled in conformity with them. Thus, having available, some three months in advance, curves like this for every circuit over which it is desired to transmit, one is able to plan the transmitting schedules with some facility.

Single Hop Circuits.—Now let us return to the case of the single-hop circuit ; i.e., one of 2,500 miles or less in length, such as we meet in the B.B.C. European services. As has been said, the 2,500-mile M.U.F. is read off at the centre point of the path. This is then multiplied by the Distance Factor from the second column of Table I appropriate to the length of the circuit and the result is the M.U.F. for the path. The O.W.F. is obtained in the same way as for multi-hop paths, and this completes the operation for most circuits and times of day.

There is however, a further complication in certain cases. Because the F_1 and E layers are lower than the F_2 they are capable, at certain times of day when their ionisation is highest and yet lower than that of the F_2, of *controlling* the transmission at certain distances. What this means is that at these times the M.U.F. for certain distances is determined by the critical frequency of the lower layer and not by that of the F_2, and any frequency which penetrates the E (or F_1) at the particular angles necessary to cover these distances will also penetrate the F_2. Thus the E layer can, during the summer day, act as the controlling layer for distances out to about 1,400 miles, whilst the F_1 layer can do the same thing up to about 2,000 miles.

It will be noticed that on the chart of Fig. 2 there are plotted (in dotted lines) contours of E layer M.U.F. for a distance of 1,000 miles. These are calculated from the measured values of E layer critical frequency obtained from the observatories, these being multiplied by the E M.U.F. factor for 1,000 miles, and contours drawn in a manner similar to that already described for the F M.U.F. contours. It may be noted about the E layer that, unlike the F, it is always more or less symmetrical (in its ionisation) about local noon, and that the highest values of ionisation always exist over the sub-solar point. Thus the contours move north and south as the seasons progress in accordance with the relative movement of earth and sun. It may also be of interest that the E layer is always at the same height and so the M.U.F. factors for any distance remain constant for all times of day and seasons, and that it is only, in any case, of any significance in short-wave communication during daylight.

In order to take account of these effects it is necessary during the daylight hours and for distances up to 2,000 miles, to read off the E layer 1,000-mile M.U.F. as well as the 2,500-mile F_2 M.U.F. When the former is multiplied by the E layer distance factor appropriate to the distance (Table I) the result is the E layer M.U.F. for that distance. This is entered on the Work Sheet, and whenever it *exceeds* the F layer M.U.F. for the path it is the controlling M.U.F. Fig. 6 shows a curve for a distance of approximately 1,100 miles during June, and the

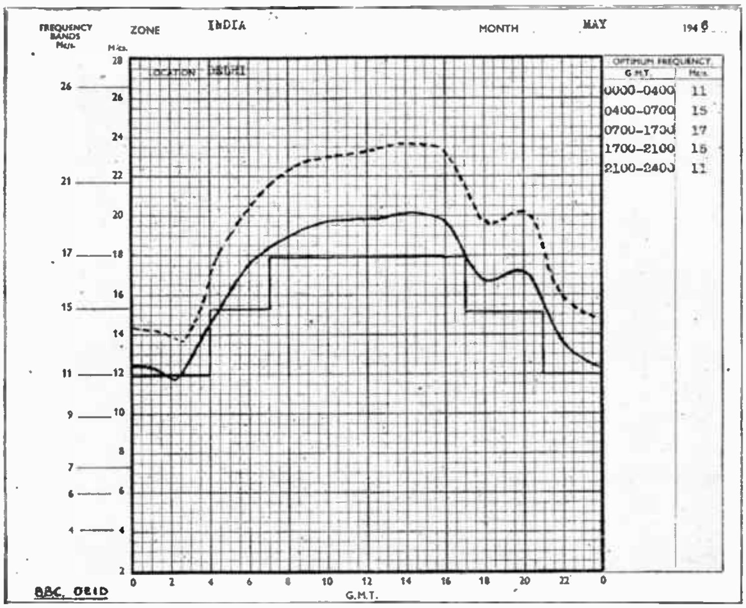


Fig. 5. Curves of frequencies for a specific route. Dotted line shows M.U.F. for path, while the full lines refer to O.W.F. ; broadcasting bands are shown.

hump in the centre of the day shows the effect of the E. It is seen that because of this effect higher frequencies may be used E layer; i.e., if the M.U.F. so found for the F_1 is higher than that for the F_2 then the former is the controlling M.U.F., and as

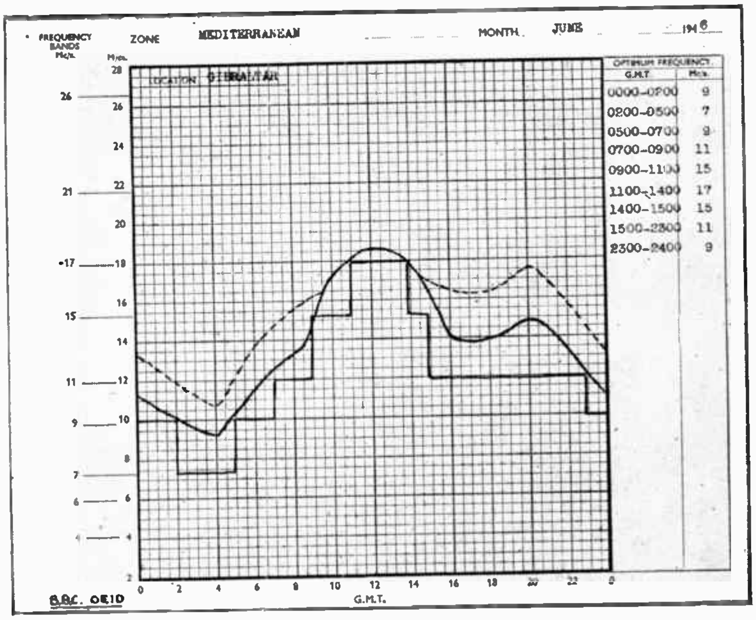


Fig. 6. Frequency curves for a relatively short route.

for this distance at that time of day than would otherwise have been possible. Incidentally it has been found that the E layer ionisation varies so little from day to day that it is not necessary to take any account of the departure of the M.U.F. from the average for the month; i.e., one may with reasonable safety work right up to the M.U.F. for the path on all days of the month.

For distances between 1,400 and 2,000 miles it is the F_1 layer which sometimes controls the M.U.F. and since the F_1 ionisation, although somewhat higher than that of the E, follows that of the E layer in the nature of its variations, it has been found convenient to avoid plotting the F_1 M.U.F. contours on the charts, but rather to obtain the M.U.F. from the contours of E M.U.F. For the distances 1,400–2,000 miles (the only cases where it applies) it is therefore only necessary to multiply the E layer 1,000-mile M.U.F. by the F_1 distance factor (Table I) in order to obtain the F_1 M.U.F. for the path. This is applied in the same way as was described for the such is plotted into the curve.

This, then, is the modern technique in which, by the use of world-wide M.U.F. contour charts, the scientific data is put to use in practical engineering. There are two other features which may be mentioned — though not discussed in detail. The first is that, particularly during the months of May, June, July and August, the M.U.F. for single-hop transmission may sometimes be higher than those found because of the presence of sporadic E. This, however, is not predictable. It appears and disappears at random and during most months of the year is not present often enough to be of significance. During the months just mentioned, however, it is much more prevalent; so much so that it does become a tangible factor in transmission over 1-hop circuits.

The second point is that, although it is a good principle always to work as near to the O.W.F. as possible, it is useful also to know the *lowest* frequency on which it is possible to obtain communication. Particularly is this so on long multi-hop circuits where this low limiting frequency may exceed the O.W.F. for several hours a day; i.e., the circuit may become unworkable. The low limit frequency, however, unlike the high limit, does not depend on the ionosphere alone, but varies also with the power radiated, the noise level at the receiver, the type of service and other factors. The technique has, however, been so developed that this low limiting frequency may also be calculated with the aid of contour charts, and inserted into the circuit curves, but the principles underlying this operation are too complex to deal with here.

AMATEURS' EXAMINATION

In view of the number of applications for amateur transmitting licences it has been decided by the City and Guilds of London Institute to hold an additional Radio Amateurs' Examination this year on November 15th from 7-10 p.m.

It will be held at a number of centres throughout the country, and intending candidates are asked to apply to their local technical colleges. The Institute's examination fee is 10s, in addition to which a small accommodation charge may be made by the examination centres. The closing date for applications is October 8th.

It is intended that in future the examination will be held annually in May.

Prospective candidates will be interested in the following questions set at the first examination, when 145 of the 182 entrants passed.

1. A 100-ohm resistor and a 300-ohm resistor are joined in parallel and connected to a battery of e.m.f. 7.5 volts and negligible internal resistance—
   (a) What is the total current taken from the battery?
   (b) What power is dissipated in the 100-ohm resistor?
2. What do you understand by the term "resonance"? If an inductance of 100 μH is connected in parallel with a capacitance of 100 $\mu\mu$F, what is the resonant frequency of the circuit?
3. Draw a diagram of a self-oscillating valve circuit and explain simply its method of functioning.
4. Why are quartz crystals frequently used in radio transmitters? Describe, with diagram, a typical crystal-controlled oscillator.
5. Explain why "standing waves" are undesirable in a feeder system connecting a transmitter to an aerial. How would you detect their presence and minimize them?
6. Describe an "artificial aerial." How can an "artificial aerial" be used to measure the power output of a transmitter?
7. In what ways may a low-power transmitter interfere with radio and television reception? What precautions should be taken to minimize such interference?
8. What are the conditions laid down by the Postmaster-General for the frequency measurement and control of amateur transmissions?

World of Wireless

SERVICING EXAMINATION

ARRANGEMENTS have now been made for the first of the joint servicing examinations to be held since the merger of the examinations previously held by the Radio Trade's Examination Board and the City and Guilds of London Institute. It will be on May 17th.

It will be known as the Radio Servicing Certificate Examination, the practical tests for which will be conducted under the auspices of the Radio Trade's Examination Board whilst the written examination will be conducted by the City and Guilds.

Applications to sit for the examination should be made to the Secretary, R.T.E.B., 9, Bedford Square, London, W.C.1.

PORTABLE LICENCES

THE Postmaster-General has announced that he will now issue permits for licensed amateurs to operate portable transmitters for an additional fee of 10s.

This permit will allow a transmitter to be operated within a radius of 10 miles of the permanent address of the licensed amateur or, alternatively, within a similar radius of a given point if different from the operator's address.

As in the past, amateurs will suffix their call sign with "/P." The maximum permissible power is 25 watts on all present bands, with the exception of 1.8-2.0 Mc/s on which 10 watts is the limit. Applications should be made to the Engineer-in-Chief, Radio Branch, W5/5, G.P.O., London, E.C.1.

FACSIMILE

THERE has been a tremendous growth in the interest in facsimile transmission and reception in the U.S.A., especially among newspaper proprietors. Apparatus has been installed in some 100 public buildings in New York and a small four-column facsimile newspaper, called *Air Express*, is being produced twice a day.

The apparatus, which has been installed by Finch Telecommunications, Inc., is similar to that illustrated on this page. At a recent demonstration a four-page paper, each page measuring 8½ × 11in. took eight minutes to produce—that is, at a speed of approximately 44 sq in a minute. This means that it takes one minute to reproduce 550 words of 8pt type—the size in which this paragraph is set.

The transmissions were radiated by the recently completed F.M.-facsimile station, WGHF, New York, operating on 99.7 Mc/s.

Another New York demonstration, arranged by Radio Inventions, Inc., a research organization sponsored by some 20 newspapers and broadcasting stations, showed a facsimile attachment which can be connected to an ordinary F.M. receiver. During the demonstration printed pages measuring 9½ × 12in were reproduced, complete with illustrations, at a rate of 16 an hour.

The F.M. station used for this transmission was WBAM, New York, working on 96.5 Mc/s.

The Finch facsimile receiving unit which reproduces pages a little larger than those of *Wireless World* at the rate of thirty an hour.

SLOW MORSE PRACTICE

READERS who, from time to time, have asked for details of slow morse transmissions for practice reception, will be glad to hear that the Radio Society of Great Britain has now organized a regular service of transmissions.

The stations participating in the service and the frequencies (kc/s) on which they operate are: G2CPF (Yorks), 1,892; G2BJY (Staffs), 1,930; G3JK (Notts), 1,865; G3LP (Glos), 1,865; G5UM (Herts), 1,900; G6GD (Ches), 1,885; GW3GL (N. Wales), 1,965.

The operating schedule (B.S.T.), which has been arranged by D. Rock, G8PR, "Sandhurst," Vicarage Road, Amblecote, Stourbridge, Worcs, to whom further offers of help from licensed amateurs should be sent, is:—

Sundays, 0900, G3LP, G3JK.
1030, G5UM.
1130, GW3GL.
Mondays, 2130, G2CPF, G2BJY, G6GD.
Wednesdays, 2130, G2CPF, G3LP, G6GD, GW3GL.
Saturdays, 2130, G2BJY, G6GD.

MEASURING INTERFERENCE

WE referred in our June issue to the fact that the G.P.O. was adapting a number of Army interception receivers, Type R206, for the measurement of radio interference and that these would be made available to manufacturers of electrical equipment through the British Standards Institution.

The B.S.I. has notified us that a limited number of these modified receivers will be available early next year and will cost about £350 each. Manufacturers who are in a position to undertake the modification will be able to purchase sets at £250.

Applications for sets should be addressed to the Director, B.S.I., 28, Victoria Street, London, S.W.1, quoting reference OC/1/3.

FULLY AUTOMATIC RADIOPHONES

ACCORDING to a correspondent, the Bell Telephone Laboratories, U.S.A., have recently patented a V.H.F. radio-telephone communication system in which the operation of dialling calls the distant station and, at the same time, causes the transmitting aerial to orient itself in the desired direction. The system is particularly adapted to inter-communication between a small group of islands or in other circumstances where metallic links would be uneconomic.

DECCA CHAIN

THE first chain of Decca Navigator Stations, cited in the South of England, was officially declared operational by the Admiralty and Ministry of Transport on July 18th, following a test period of transmission. The Master Station is at Buntingford, Herts, the "Red" slave station at Stokeholy Cross, near Norwich, and the "Green" slave station at East Hoathley, near Lewes, Sussex. A third slave (Purple) will be at Wormleighton, Warwickshire.

HIGH-POWERED P.A.

PHILIPS have introduced a high-power A.F. amplifier with a maximum output of 1,000 watts; the characteristic is flat within better than 1db from 50 to 10,000 c/s; total harmonic content at 1,000 c/s is 1 per cent. The "Philowatt," as it is called, is designed for very large P.A. installations or relay networks serving up to 6,000 subscribers. Automatic monitoring allows unattended operation of the amplifier. When no audio signal has been present in the output stage for 3 minutes, a test impulse is automatically applied to the input. If this impulse fails to reach the output, an alarm signal is sounded, or, alternatively, a stand-by amplifier may be switched on.

TELECOMMUNICATIONS RESEARCH

THE formation of a new company to promote telecommunications research in this country is announced by British Insulated Callender's Cables and the Automatic Telephone and Electric Co. (A.T.M.), the sponsoring companies.

Laboratories are being established at Taplow Court, near Maidenhead, which will be under the direction of Air Vice-Marshal O. G. Lywood, C.B., C.B.E., managing director. He recently retired from the R.A.F. after 33 years' service in the Signals Branch.

The chairman of the new company is P. V. Hunter, C.B.E., director and engineer-in-chief of B.I.-Callenders. Dr. T. Walmsley, C.B.E., formerly of the G.P.O., is a director and chief engineer. The other members of the Board are: Dr. J. L. Miller, chief engineer (equipment and telecommunications), B.I.-Callenders; A. F. Bennett, director and manager, A.T.M., and A. J. Leyland, director and chief engineer, A.T.M.

PERSONALITIES

Sir John Lennard-Jones, K.B.E., D.Sc., F.R.S., who has been Director General of Scientific Research (Defence) in the Ministry of Supply, is returning to his post at Cambridge University, but will continue as Chief Scientific Adviser to the Ministry.

Sir Clifford Paterson, O.B.E., F.R.S., D.Sc., director of the G.E.C. Research Laboratories, has been elected a vice-president of the Royal Society of Arts.

DR. T. WALMSLEY, C.B.E., Ph.D., B.Sc., director and chief engineer of the new telecommunications research organization announced above. He was staff-engineer in charge of the G.P.O. Wireless Broadcasting Branch until 1940, when he was seconded to the M.A.P.

Air Vice-Marshall R. S. Aitken, C.B., C.B.E., has been appointed to the Board of Radio and Television Trust, Ltd., as a full-time director. He was appointed chief signals officer, R.A.F. Fighter Command, in 1940, and the following year became Air Officer Commanding 60th Signals Radar Group.

S. L. Capell, vice-president and general manager of the Philco Corporation of Canada, has been elected president of the Radio Manufacturers' Association of Canada.

Prof. G. W. O. Howe, D.Sc., Technical Editor of our sister journal *Wireless Engineer,* is retiring from the James Watt Chair of Electrical Engineering at Glasgow University at the end of the present session. Old students and friends of Prof. Howe are invited to contribute to a presentation to be made to him, contributions for which should be sent to Dr. A. J. Small, Electrical Engineering Department, The University, Glasgow, W.2.

R. G. Clark, who until recently was head of the Research and Development Department of Philips Lamps, which he joined in 1928, has been appointed manager of the Engineering Departments of Ferguson Radio Corp., Ltd., Enfield, Middx. Mr. Clark was a member of the B.R.E.M.A. sub-committee responsible for the industry's Plan for European Broadcasting.

J. M. Flemming, who has been appointed chief development engineer of the Micanite and Insulators Co., was secretary of the U.K. Radio Materials Mission to the U.S. in 1944.

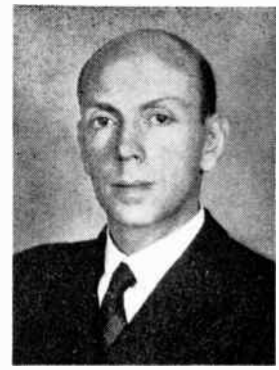
H. MacDougall has been appointed secretary of the Electronic Manufacturers' Association, the offices of which will temporarily remain at Vernon House, Sicilian Avenue, Bloomsbury Square, London, W.C.1. In the Association's rules the term electronic apparatus is defined as including "all apparatus depending for its functioning in whole or in part on the emission of a stream of electrons, including apparatus incorporating thermionic valves."

A. Parsons, until recently of the Overseas and Engineering Information Department, B.B.C., has rejoined the Radio Department of the Municipal College, Portsmouth.

J. W. Ridgeway, manager of the Radio Division of Edison Swan Electric Co., has been re-elected for his fifth term of office as chairman of the British Radio Valve Manufacturers' Association (B.V.A.). He has also been appointed vice-chairman of the Radio Industry Council. The new B.V.A. vice-chairman is **G. A. Marriott,** who preceded Mr. Ridgeway as chairman. He is a director of the Marconi-Osram Valve Company and manager of the Osram Valve Sales Department.

G. R. Scott Farnie, GW5FI, has been appointed to handle the section of E.M.I. which is to cater for the particular needs of the radio amateur.

C. W. Goyder, C.B.E., has relinquished his appointment as chief engineer of All-India Radio and is returning to this country. He went to India in 1936 as the first chief engineer (broadcasting) to be appointed by the Government to develop a broadcasting system in British India. This now comprises 22 medium- and short-wave transmitters at nine broadcasting centres, with an engineering staff of some 300. Mr. Goyder, who was created a C.B.E. in the New Year Honours, will be remembered by many readers as the amateur who, in 1924, with his station G2SZ at Mill Hill School, was the first British amateur to obtain two-way communication between England and New Zealand.



C. W. GOYDER, C.B.E., until recently chief engineer, All-India Radio.

IN BRIEF

Television Interference.—Amateurs operating in the 14.1 to 14.3 Mc/s band have been warned by the R.S.G.B. that interference may be caused to television receivers if due care is not taken to suppress the third harmonic.

No Radio Imports Yet.—As in the case of the token imports permitted from the U.S.A. and Canada, radio apparatus (except H.T. batteries) is not in the list of goods now allowed into this country from Belgium.

Overseas Receiver Wanted.—The superintendent of a leper colony in Africa asks for suggestions as to where a short-wave (10-50 m) broadcast receiver to operate entirely from a 6-volt accumulator can be obtained.

Dry batteries of not more than 6 volts are now exempt from Purchase Tax.

Coming of Age.—We offer our congratulations to the *R.S.G.B. Bulletin* which, with the publication of the July issue, attained its majority.

B.R.E.M.A. Secretary.—The British Radio Equipment Manufacturers' Association announces the appointment of S. E. Allchurch, O.B.E., as secretary.

Singapore.—Reception reports of transmissions from the Singapore broadcasting stations are welcomed by the Department of Broadcasting, Cathay Buildings, Singapore, Federated Malay States. Transmissions on 4.78 Mc/s are radiated from 1130-1630 B.S.T. and on 7.22 Mc/s from 0530-0730. A third transmitter works on 9.54 Mc/s.

Radio SEAC, the 100-kW station of the South-East Asia Command, which is now broadcasting in the 19-, 25- and 49-metre bands, welcomes reception reports, which should be sent to Radio

World of Wireless—

Unit, S.E.A.C., 191, Turret Road, Colombo, Ceylon. The latest schedule gives transmission times (G.M.T.) as 0000-0245, 25.49 m; 0315-1145, 19.84 m; 1215-1700, 49.42 m.

Amateurs' Examination Course.—A course covering the syllabus of the City and Guilds Radio Amateurs' Examination has been arranged by the Brentford Evening Institute for the 1946-47 session. The fees for the course, which commences on September 23rd, are: students over 16 years of age 5s, under 16, 2s 6d. A prospectus is obtainable from the Chiswick Polytechnic, Bath Road, Bedford Park, London, W.4.

F.M. Goes Ahead in U.S.—According to our Washington, D.C., contemporary, *Broadcasting*, the number of constructional permits for F.M. stations granted by the F.C.C. totalled 102 at the middle of July. It is also stated that the number of applicants to whom formal permission has been granted to operate F.M. stations, although they have not yet received permission to erect stations, totals 349. In addition, some 380 applications are pending.

Television Slow-down.—As a result of a request made by the American Television Broadcasters' Association the Federal Communications Commission has deferred for six months—until January 1st, 1947—the introduction of the rule requiring television stations to broadcast a minimum of 2 hrs on any one day and not less than 28 hrs of programme service a week. A further indication of the television slow-down is provided by the withdrawal of some 80 applications for the erection of television transmitters.

I.E.E. Council.—The following members of the I.E.E. Radio Section have been elected to serve on the I.E.E. Council for the ensuing year:—V. Z. de Ferranti, M.C., president; Prof. E. B. Moullin, M.A., Sc.D., vice-president; and Dr. F. C. Williams, O.B.E., an ordinary member.

I.E.E. Radio Section.—The vacancies which will occur on the Radio Section Committee on September 30th have now been filled. Prof. Willis Jackson, D.Sc., D.Phil., recently appointed head of the Electrical Engineering Department of the Imperial College of Science, has been elected chairman; R. T. B. Wynn, assistant controller, B.B.C. Engineering Division, vice-chairman; and Dr. R. F. T. Jarvis, G.P.O. Research Station, B. N. Maclarty, O.B.E., B.B.C., Dr. E. C. S. Megaw, M.B.E., Admiralty Signal Establishment, Dr. R. L. Smith-Rose, N.P.L., and G. M. Wright, Marconi's, as ordinary members.

Glasgow Exhibition.—Enquiries regarding the exhibition of engineering components relating to electrical, scientific and marine instruments, to be held in the Kelvin Hall, Glasgow, from November 15th to 27th, should be addressed to D. M. Slorach, the honorary director, at 19, Ladysmith Avenue, Sheffield, 7.

Southampton's Enterprise.—An attendance of nearly 400 was recorded at the recent course of lectures and demonstrations on telecommunications and electronic navigation at the School of Radiotelegraphy, University College, Southampton.

Licence Figures for the three months ended June 30th show an increase of 279,000. The total is 10,671,000.

INDUSTRIAL NEWS

Television School.—Since the opening of the Television School by Pye, Ltd., last February, some 200 students have been trained. Those wishing to take the ten-day course should apply for particulars to the Service Manager, Pye, Ltd., Cambridge.

Equipment for high-quality reproduction of radio and gramophone is to be the main interest of the H. A. Hartley Co., 132, Hammersmith Road, London, W.6. A new loudspeaker with 9-inch diaphragm and Ticonal magnet is already available at £8 5s, and other items in preparation include radio tuner units, amplifiers and a pick-up.

Rola Speaker repairs will in future be undertaken by a newly formed company—Speaker Services, 50, Malden Road, Cheam, Surrey (tel.: FAIrlands 9531). The managing director, W. T. Maynard, has been works director of British Rola for 15 years.

Philco Patents.—Some 600 patents relating to radio, television and electric gramophones have been licensed by the Philco Corporation to the Radio Corporation of America. The corresponding patent rights in Great Britain are licensed to Airmec, Ltd., manufacturers of Philco sets, a subsidiary of Radio and Television Trust.

Morgans at War is the title of an excellently produced book telling the story of the Morgan Crucible Company's achievements at their Battersea, London, S.W.11, factory. Isotype charts show that, among other increases in production, the company's wartime output of resistors was seven times that of its pre-war figure.

Frank Murphy of London, Ltd., incorporated in May, 1944, as a private company for the production of woodware, was converted to a public company on June 6th, and the balance of the authorized capital, approximately £6,000, is now the subject of a public issue. A further public issue of shares will shortly be made to establish a factory to produce receivers which it is planned to retail at between £10 and £12, including purchase tax.

VINCENT Z. de FERRANTI, M.C. chairman and managing director of Ferranti Ltd., the new president of the Institution of Electrical Engineers. His father, the late Dr. S. Z. de Ferranti, was president in 1910 and 1911.

R.S. Amplifiers have moved to a new factory in Reynolds Road, Acton Lane, London, W.4. Tel.: CHIswick 1011.

CLUBS

Chatham.—Meetings of the Medway Amateur Transmitters' Society are held every Monday at 7.30 at the Co-operative Employees' Welfare Club, 207, Luton Road, Chatham. The Club's transmitter will soon be operating, using the call G2FJA. Sec., S. J. Coombe, "Stanvic," Longhill Road, Chatham.

Coventry.—Members of the Coventry Amateur Radio Society are to visit the B.B.C. station at Daventry on September 14th. A revival of the pre-war transmitting and receiving contest in competition with the Midland Amateur Radio Society is planned for October. The new secretary is J. W. Swinnerton, G2YS, 118, Moor Street, Coventry.

Holloway.—The Grafton Radio Society meets three times a week, on Monday, Thursday and Friday, at 7.30 at the Grafton L.C.C. School, Eburne Road, Holloway, London, N.7. Details of the current syllabus are obtainable from the Secretary, W. H. C. Jennings, 82, Craven Park Road, London, N.15.

Oswestry.—As a result of a meeting held on July 31st the Oswestry and District Radio Society has been formed. Details are obtainable from A. D. Narraway, "Lamorna," Pant, Nr. Oswestry, Salop.

Reading.—At a recent meeting of the Reading and District Radio Club, G6CU, formerly of Cocos Island, spoke of his activities on the island. The club, which has been in existence for just over two years, has a membership of 75 and meets at the Palmer Hall, West Street, Reading, at 6.30 on the last Saturday in the month and again fourteen days later. Hon. Secretary, P. J. Nash, 9, Holybrook Road, Reading.

Romford.—Meetings of the Romford and District Amateur Radio Society will in future be held in the Mawney Road Schools, Romford, each Monday at 8. Secretary, R. C. E. Beardow, G3FT, 3, Geneva Gardens, Whalebone Lane North, Chadwell Heath, Essex.

South Shields.—Meetings of the South Shields Amateur Radio Club are held every Friday at 7.0 in St. Paul's School Room, Westoe. Secretary, W. Dennell, 12, South Frederick Street, South Shields.

Wolverhampton.—Meetings of the Wolverhampton Amateur Radio Society will in future be held at 7.30 on the first Monday in each month in the canteen of Messrs. Baynell, Merridale Street, Wolverhampton. W. O. Sturmey, G8KL, of 3, Broome Road, Wolverhampton, is the secretary.

CONVENTIONS AND VIEWPOINTS

Where Readers and Writers Have to Take Care

By "CATHODE RAY"

I WONDER how many thousands of *Wireless World* readers had to do their bit towards winning the war by trying to stay awake while listening by the hour to this sort of thing—". . . negative square wave cuts off V_{99}, charging C_{270} positive and making current flow through R_{1001} and R_{1002} in parallel, biasing V_{1000} positive. . . etc., etc." Does that bring it back at all? No? Then at least you must often have tried to follow some printed explanation of circuit action. In doing so did you ever feel in your inner heart that when a condenser was said to be charged it was really being discharged? Or that "positive" should have been "negative," or "parallel" should have been "series"? If you have never been confused in ways like this you must either be very clever or (forgive me) very inattentive; and just to make sure, will you please answer the following simple questions:

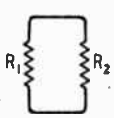


FIG. 1

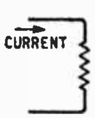


FIG. 3

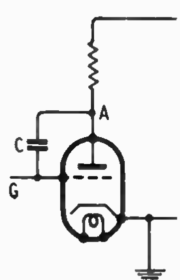


FIG. 2

In Fig. 1, are R_1 and R_2 in series or in parallel? When G in Fig. 2 is made positive, does it charge C or discharge it? If it charges C does it do so positively or negatively? An arrow alongside the resistor in Fig. 3, to show the direction of the voltage drop, should point downwards—true or false? In the "valve equivalent circuit" (Fig. 4) does the signal current i_a flow in the same direction as the signal voltage μv_g or in the opposite direction?

If you have given the right answers to all these I bow to your omniscience. The last question was hotly debated for several months by Prof. G. W. O. Howe, D.Sc., M.I.E.E., K. R. Sturley, Ph.D., B.Sc., A.M.I.E.E., D. A. Bell, M.A., B.Sc., and D. H. Parnum, B.Sc., A.R.C.S., Ph.D., among others, in at least three different technical journals; while the easiest-looking of the lot (Fig. 3) was the subject of controversy in the inconceivably learned pages of *Wireless Engineer*. So perhaps I am not insulting readers by hinting at the possibility of their being confused, even in such elementary matters.

In fact, failure to crack off ready answers to these questions is no ground for shame or despondency. Quite the reverse. Whether or not it is true that there are two sides to every question, there are certainly two sides to these. There are so many sides to the Fig. 4 problem that it might almost be described as a polygon.

For there are quite a number of crossroads in electrical science where Nature does not give an indisputable lead, so the direction has to be settled by convention or general agreement. And where there is no general agreement, how is one to know which is right and which is wrong?

The direction of electric current is a good example. When the need first arose for specifying it, nobody had much of a clue to what an electric current was or how to tell which way it was flowing. So it was agreed to make a guess and say that in the external circuit of a cell the current flowed from copper to zinc. When electrons were discovered, this looked like a bad guess, because it was found that they flowed in the opposite direction to the supposed current. So long as only wire circuits were involved, it didn't matter a great deal. Electrons were only a theory, anyway. But when vacuum valves came into use, electrons could no longer be treated as a collective phenomenon in which direction was a mere matter of convention. They became real and individual. So a lot of people have reversed the original guess and now say current flows from "negative" to "positive" (two more conventional terms). The maximum confusion thereby exists. The revisionists contend that obviously everyone ought to change over, instead of clinging to what is now known to be wrong. To which the conservatives answer that an electric current *can* flow in the conventional direction, and does so in soft valves and electrolytes.

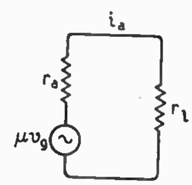


FIG. 4

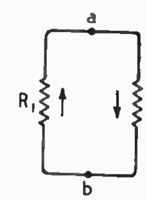


FIG. 5

So until an international authority succeeds in persuading everyone to do one thing or the other (and international authorities don't seem to be having much luck at this kind of thing just now) confusion can only be avoided if people take the trouble to say which convention they personally are using.

Fig. 3, for all its apparent simplicity, is a little more subtle. It was discussed on page 442 of the September 1945 *Wireless Engineer*, and has nothing to do with the current flow convention, being a question of e.m.f. and potential difference (p.d.). To me the answer seems to be bound up with the Fig. 1 question. Two circuit elements connected as shown there are in series *and* in parallel. Which is the more appropriate way to regard them depends mainly on what is not shown—the e.m.f. or e.m.fs. If the source of e.m.f. is external, connected between the points *a* and *b* in Fig. 5, then with respect to this source R_1 and R_2 are in parallel. Any currents flowing must be downwards in both or upwards in both, and

Conventions and Viewpoints—
arrows indicating their directions will also mark the direction of the e.m.f. driving them.

But suppose the sole source of e.m.f. is in R_1 (R_1 might be the resistance of a battery supplying the e.m.f.). Its direction, and that of the resulting current, is indicated by the upward arrow alongside. R_2 is in series, and although the arrow beside it is pointing downwards it correctly indicates the direction of current, which is the same as in R_1, i.e., clockwise. But what about the voltage drop across R_2—the p.d.? Where should its arrow point?

The e.m.f. in R_1 causes a p.d. between the points *a* and *b*, which according to the pre-electronic convention would be marked + and — respectively. It is impossible with any convention to have two different p.d.s between the same two points, so according to one school of thought it seems natural to make the p.d. arrow alongside R_2 point upwards. To them it indicates the voltage drop across the resistance, which opposes the e.m.f.; just as when you push a heavy box across the floor by pressing against it your hand feels an equal pressure in the opposite direction. Others hold that voltage arrows ought to show the direction of the electric field every time. Again, either of two opposite customs can be intelligently adopted, but until everybody agrees to adopt the same there is the risk of confusion, not to say acrimony.

The uncertainty about charging and discharging in circuits such as Fig. 2 is one of those that arises when it is a matter of opinion whether to count voltages and currents that have to do with the feeding of valves, or to ignore them and reckon only the "signal" voltages and currents. When the voltage across the condenser never reverses, I think it is clearest to call it charging when that voltage increases, and discharging when it decreases. According to this, G going negative in Fig. 2 charges C, and *vice versa*. As for the polarity of charge, it all depends which side of the condenser is temporarily understood to be at zero potential. While G is going negative, A is going positive.

Sticking rigidly to this rule when the condenser voltage is periodically reversed by the signal may lead to very cumbersome explanations. Then it may be better to ignore incidental "base-line" potentials. For instance, in Fig. 6 suppose the effect of a recurring signal at the input to the valve is to make A alternately positive and negative with respect to B. A detailed description of this by the first method would involve one in a discharge and a charge in opposite polarity at each stroke of the signal. It is easier to forget the fixed positive potential of B and call each positive movement of A a charge, and *vice versa*.

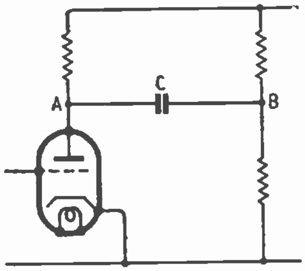


FIG. 6

The same question crops up in specifying potential changes. A in Fig. 2 is always positive, if it is understood that earth is zero. But one would generally say that making G positive drives A negative. The initial potential of A is understood for the time being to be zero. At least, it is understood by the more experienced, but I am sure it must be terribly muddling to the novice who has only learned the printed rules and not the unspoken traditions. Even the experienced would sometimes like to be told whether "negative" means really negative (with respect to earth) or just less positive. I find it helpful to call a signal "negative-going" rather than "negative" if one wants to indicate its direction rather than its relationship to earth.

There is another aspect of this relative potential business that I am sure learners must often find confusing, just because it may never occur to their instructors to point it out. They are told, for example, that a positive voltage is applied to *a* in Fig. 7. C is charged by it; so as *a* is its positive terminal, *b* must be its negative terminal. But when R is considered, *b* is not negative; it is positive. Then are both terminals of C positive? Easy enough, you say. But if you are teaching somebody else, do make quite sure he is following the leaps and jumps of your potential "zero."

No, I am *not* going to answer Fig. 4. If you want some of the answers, you can turn up the following and sort it out for yourselves:

Wireless World: May 1945, p. 140; July 1945, p. 209; Aug. 1945, p. 252.

Wireless Engineer: June 1945, p. 261; Aug. 1945, p. 390; Nov. 1945, p. 532.

Electronic Engineering: Feb. 1946, p. 56.

All I will add is to drag in the series-parallel question by mentioning that Fig. 4, showing valve internal resistance and load resistance in series, is only the better-known of two alternative valve equivalent circuits. The other shows r_a and r_l in parallel with one another and with the e.m.f. Both equivalents work.

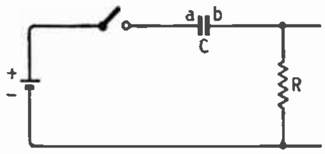


FIG. 7

Moral: Whether you are the explainer or the explainee, make quite sure that in matters of viewpoint or convention you are both on the same ground at the same time. Polarity, direction, positive and negative, charge and discharge, even series and parallel, are relative things; and if you don't take care about them the ambiguity bug will get you.

MARINE NAVIGATION PRIZE

THE Royal Society of Arts is again offering a prize of £50 under the Thomas Gray Memorial Trust for "an invention, publication, diagram, etc., which . . . is considered to be an advancement in the science or practice of navigation proposed or invented between January 1st, 1941, and December 31st, 1946." Further details are obtainable from the Secretary, Royal Society of Arts, John Adam Street, London, W.C.2. Last year's prize was awarded to W. J. O'Brien for the Decca Navigator.

Design Data (7)

VIDEO AMPLIFIER H.F. RESPONSE

1.—Shunt-Corrector

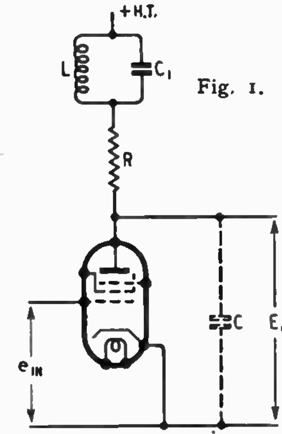


Fig. 1.

SIMPLE resistance coupling is of little use when the high-frequency response of an amplifier extends into the megacycle region because of the shunting effect of the valve and circuit capacitances. In order to obtain a useful amplification from each stage, therefore, inductance is associated with the circuit in such a way that it tends to compensate the unwanted effects of the capacitance.

Of the many possible circuits the shunt-corrector, of which the circuit is shown in Fig. 1, is one of the most widely used. It has the great merit of combining good performance with simplicity. The procedure for determining the optimum circuit values is given below and followed by some examples.

Assumptions

That the anode A.C. resistance of the valve is very large compared with R, and that the resistance of L is very small compared with its reactance at high frequencies, and small compared with R at low frequencies.

Conditions

The formulae are derived for the condition of the flattest frequency response, curves A, and for critical damping, curves B.

Procedure

Given the drop in response (db) required at a maximum frequency f, and the total circuit capacitance C, to find the other circuit values :—

(a) *for the flattest frequency response*

1. Determine fCR from curve A, Fig. 2.
2. $R = (fCR)/fC$
3. $A = g_m R$
4. $L = 0.414CR^2$
5. $C_1 = 0.352\ C$

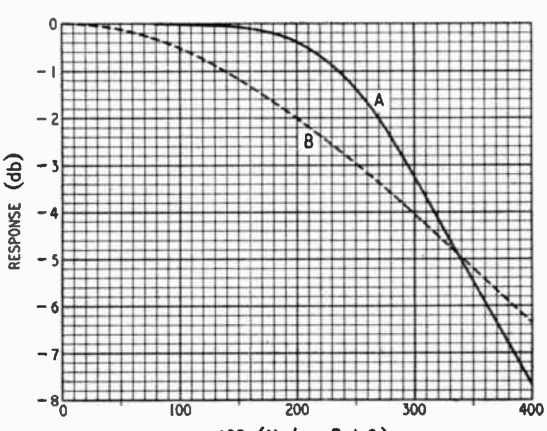


Fig. 2.

(b) *for critical damping*

1. Determine fCR from curve B, Fig. 2.
2. $R = (fCR)/fC$
3. $A = g_m R$
4. $L = 0.296\ CR^2$
5. $C_1 = 0.125\ C$

Alternatively, given the response required at a given time t after the onset of a pulse :—

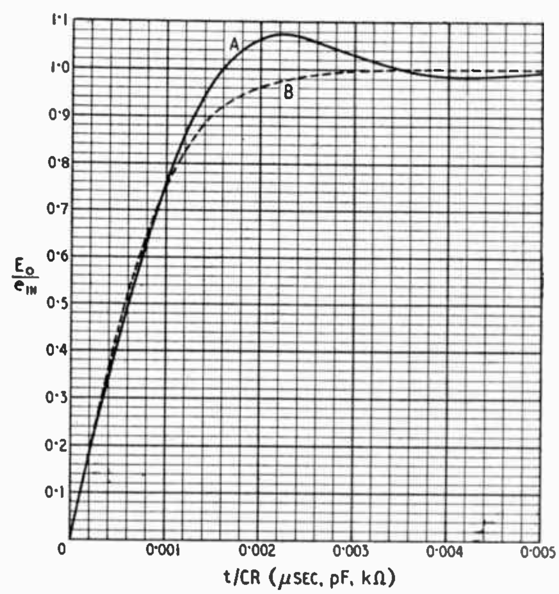


Fig. 3.

(c) *for the flattest frequency response*

1. Determine t/CR from curve A, Fig. 3.
2. $R = (t/C)/(t/CR)$

then proceed as in (a) 3, 4 and 5.

(d) *for critical damping*

1. Determine t/CR from curve B, Fig. 3.
2. $R = (t/C)/(t/CR)$

then proceed as in (b) 3, 4 and 5.

Design Data—

Symbols

E_o = output voltage
e_{in} = input voltage
A = E_o/e_{in} = amplification
g_m = mutual conductance of valve
R = coupling resistance
L = correction inductance
C = total stray capacitance
C_1 = capacitance across L
f = maximum frequency required
t = time

Units

mA/V; kΩ; μH; pF; Mc/s, μsec.

Examples

Referring to Fig. 1, C represents the sum of the stray circuit capacitances and is the starting point of design. Its value must be measured or estimated and, in practice, it is rarely less than 25 pF, and may be 40—50 pF. The capacitance C_1 bears a definite optimum relation to C; in its smaller values the self-capacitance of L can provide it without an additional component.

The circuit relations are given for the alternative conditions of the flattest frequency response and for critical damping. The former leads to rather higher amplification but for pulse excitation there is some overshoot. The latter is free from overshoot.

As an example of the procedure, suppose that a response oi — 1db at 3 Mc/s is required when the total capacitance is 40 pF and that the condition of flattest response is satisfactory. From curve A of Fig. 2 fCR = 232, and hence R = 232/(40 × 3) = 1.93 kΩ. If the valve has g_m = 6 mA/V, A = 11.6. Then L = 0.414 × 40 × 3.74 = 62 μH; and C_1 = 0.352 × 40 = 14 pF.

It will be noticed that R, and hence A, is inversely proportional to C, so that in the interests of maximum amplification it is important to keep the circuit capacitance as small as possible.

The transient response is indicated by Fig. 3, curve A showing E_o/e_{in} as a function of t/CR. This curve indicates the way in which the output voltage varies with time for an input step voltage, that is, a voltage which changes instantaneously from one value to the other.

It will be observed that the output oscillates slightly about its final value before settling down. This can be avoided by a different choice of circuit values, but only at the expense of amplification. For television purposes when only a single V.F. stage is usual this small degree of overshoot is usually permissible.

For oscilloscope amplifiers and for multi-stage television amplifiers it is often necessary to avoid overshoot. With critical damping different relations exist between the components and a different set of design equations is given. Curves B in Figs. 2 and 3 then apply.

As an example, taking the same values as before, but working from curve B of Fig. 2, we find fCR = 140, so R = 140/(3 × 40) = 1.165 kΩ. Then A = 7; L = 0.296 × 40 × 1.36 = 16.1 μH; and C_1 = 5 pF. There is thus a considerable loss of amplification as compared with the condition of flattest frequency response.

To illustrate the pulse performance of this last condition we have CR = 40 × 1.165 = 46.5. We want to know how many microseconds after the application of a pulse the output reaches 90 per cent of its final value. Curve B of Fig. 3 gives this information; t/CR for E_o/e_{in} = 0.9 is 0.00145, so that t = 0.00145 × 46.5 = 0.0675 μsec.

For the example with the flattest frequency response we use curve A and find t/CR = 0.0013, while CR is 40 × 1.93 = 77.3, so that t = 0.0013 × 77.3 = 0.101 μsec.

As another example, suppose that overshoot cannot be tolerated and that it is required that the pulse response be 90 per cent complete in 0.1 μsec. Let the stray capacitance be 30 pF and the valve have a mutual conductance of 6 mA/V, what circuit values are needed?

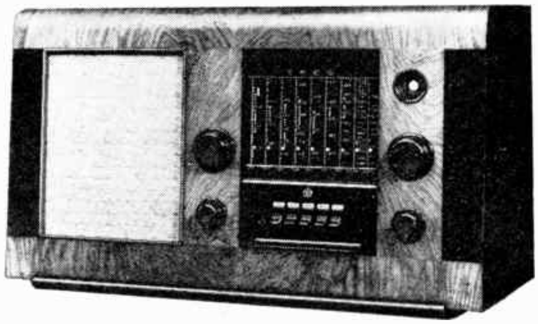
From Fig. 3, curve B, t/CR = 0.00145, hence $R = \frac{0.1}{30 \times 0.00145}$ = 2.3 kΩ; A = 6 × 2.3 = 13.8; L = 0.296 × 30 × 5.3 = 47 μH; C_1 = 0.125 × 30 = 3.75 pF.

If the condition of flattest response had been permissible, we should have used curve A and obtained t/CR = 0.0013, giving $R = \frac{0.1}{30 \times 0.0013}$ = 2.56 kΩ; A = 6 × 2.56 = 15.4; L = 0.414 × 30 × 6.6 = 82 μH; C_1 = 0.352 × 30 = 10.55 pF.

NEW BROADCAST RECEIVERS

BANDSPREAD tuning for television sound and the 13, 16, 19, 25, 31, 41 and 49 metre bands is provided in the Ekco Model A28 by a system of permeability tuning which is claimed to obviate microphony on the short waves. Station selector switches for three medium-wave and two long-wave programmes are additional to normal slow-motion drive tuning. The four-valve plus rectifier superhet circuit employs a pentode output valve with negative feedback and there is a "magic eye" tuning indicator. The price is £29 8s (purchase tax £6 6s 5d). In the Ekco Model A23 a similar circuit is employed with five station selection buttons, and television sound as well as short, medium and long wave ranges. The price of this receiver is £21 (purchase tax £4 10s 4d). The makers are E. K. Cole, Ltd., Southend-on-Sea.

The Model A4653, produced by Allander Industries, Milngavie, Glasgow, is a superhet (four valves plus rectifier) and is available in two forms: (1) for the home market; (2) for export. The home model uses British valves and has wavebands of 17-50, 185-565 and 820-2,300 metres, while the export model uses international octal, covers 185-565,



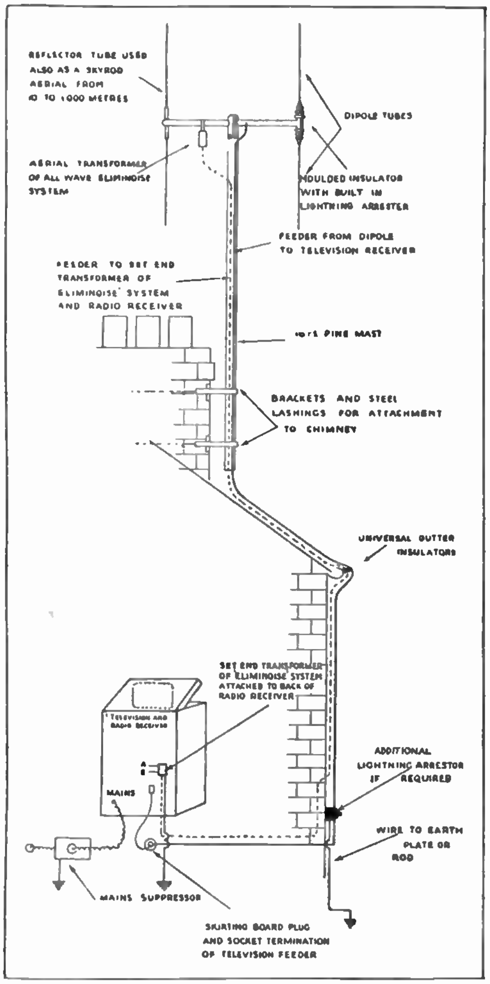
Bandspread tuning on seven short-wave bands and the television sound channels is provided in the Ekco Model A28.

33-100 and 12-37.8 metres, and is fitted with tropicalized components. The price of the home market receiver (Model A4653/1) is £15 15s, plus tax £3 7s 9d.

Three new domestic receivers are now in production by Masteradio, Ltd., 193, Rickmansworth Road, Watford. The Model D110 is a small table model for A.C./D.C. mains, housed in a moulded plastic cabinet with a choice of three colours. It covers short, medium and long waves and the price is £14 3s 6d, plus tax £3 3s. A similar chassis in a walnut cabinet (Model D110W) costs £15 4s 6d. A larger table model for A.C. mains in an acoustically designed two-colour plastic cabinet (Model D111) is priced at £18 7s 6d, plus tax £3 19s 4d. In each case the basic circuit is a four-valve superhet, plus rectifier.

BELLING-LEE QUIZ (No. 3)

A selection of answers to questions we are continually being asked by letter and telephone



Q.11. *Are masts supplied with Belling-Lee*[1] aerials ?*

A.11. Normally yes, but at the present time the bulk purchase of suitable wooden masts is almost impossible. That is why we ask customers to supply their own. It is generally possible to obtain a single one locally.

Q.12. *What kind of pole is required ?*

A.12. We specify turned pine 2½in. in diameter by approximately 16ft. in length. In practice any stout mast will do but the 2½in. diameter is important, as this has to fit pole clamps and a pole cap*.[2] Minimum length 10ft. depending on peculiarities of the site.

Q.13. *Would a metal mast adversely affect the picture ?*

A.13. In practice no, provided it is earthed. The presence of a conductor in this position between the dipole and reflector is taken into account in the design and suitably allowed for. The disadvantage is a mechanical one. A metal pole of the above mentioned dimensions is necessarily heavy, costly and difficult to handle on sloping roofs, etc.

Q.14. *Can a television aerial be used for broadcast reception ?*

A.14. Yes, in districts where there is little or no interference, many people have got into the bad habit of doing without an aerial and have never heard their sets at their best because they have always had to operate with the volume control unnecessarily full. When installing a television receiver a television aerial is almost essential, so when it is being erected an insulated lead should be taken*[3] from the metal cross arm to the broadcast receiver. This lead need not be disconnected when receiving television—it exercises a negligible effect.

*1 **L.502/L Dipole,** reflector and cross arm, chimney lashings (less mast), **£5 5 0**
Supplied also without reflector and/or chimney lashings from **£2 3 6**

*2 Belling-Lee Patent No. 526587.

*3 Belling-Lee Patent Nos. 520628, 519883.

*4 L.392/100 ... ... **£7 10 0**
L.392/120 ... ... **£8 6 0**
Including 2 transformers. Suffix No. denotes length of L.1221 Feeder Cable.

BELLING & LEE LTD
CAMBRIDGE ARTERIAL ROAD, ENFIELD, MIDDX

Q.15. *Can a television aerial be used as an anti-interference aerial ?*

A.15. Yes. A kit*[4] comprising transformers and cable is available, provision being made to secure the aerial transformer to the*[2] cross bar of the television aerial, the rest of the system being carried out as an ordinary anti-interference installation.

Q.16. *Must a dipole and reflector always point directly at the television transmitting station ?*

A.16. Generally yes, but an installation department or any people doing a large number of installations know that it is often advantageous to rotate the television aerial slightly one way or the other due to distortion of the polar diagram caused by local conditions at the receiver end. The rotation of the receiver aerial is also often used to improve the "signal to noise" ratio where there is local interference. See next question 1, repeated.

Q.1. *(Repeated from Quiz No. 1). What are the advantages obtained when using a reflector with a dipole ?*

A.1. (a) It is necessary in areas of weak field strength to increase the signal input to the receiver.

(b) The directional properties can be utilised as a means of minimising interference, particularly so, if the aerial can be installed in such a position that the location of the source of interference is placed behind the reflector in relation to the transmitter.

(c) By rotating the aerial, ghost image can be reduced or eliminated.

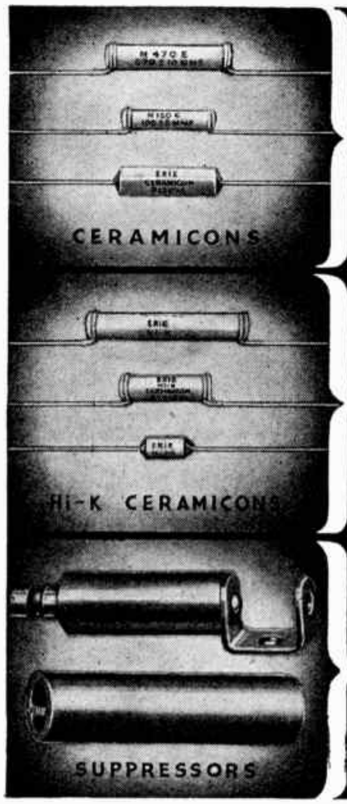
Q.17. *What type of plug and socket is recommended for use with L.336 balanced feeder ?*

A.17. The L.303*[5] range for skirting board terminations and wander plugs for the receiver. The L.303 range are flat pin plugs complying with BSS.613 and are available for flush mounting and proud mounting and in Brown and Cream (Cream in short supply).

*5	L.303/F 3-way socket flush mounting ...	3/- each
	L.303/P 3-way plug flush mounting ...	1/4½ each
	L.303/S 3-way socket surface mounting ...	2/9 each

Cream approx. 25% dearer

TO BE CONTINUED . . .



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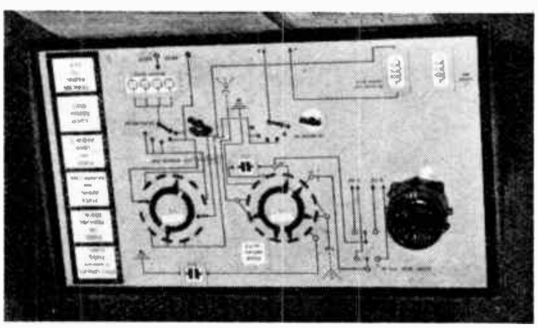
AIDS TO TRAINING

"Synthetic" Methods in the R.A.F.

By
M. G. SCROGGIE,
B.Sc., A.M.I.E.E.

DURING the war enormous numbers of people, most of whom possessed no previous knowledge of radio, had to be trained in the operation and maintenance of ever more complex equipment, in the shortest possible time. At the start, blackboard and chalk, and sometimes (but not always) a sample of the equipment to be taught, were the only training apparatus available. Anything else had for the most part to be extemporized from salvage by the instructors themselves, who were already fairly well loaded with teaching. Nevertheless, a mere selection of the aids developed for use in the R.A.F. Group concerned with radio training was sufficient to make up a large and interesting exhibition held recently at Cranwell.



Illuminated panels are used to demonstrate the functions of an aircraft aerial switch.

The exhibits represented great changes in methods of teaching. They were of two main categories: those designed to make the teaching more palatable and digestible, such for example as a mechanical model of wave motion; and synthetic devices such as the Harwell Box, into which radio signals and engine noises are fed, in order to simulate the surroundings of wireless operators in flight without having to provide aircraft.

Blackboard and chalk, even in the hands of the most capable lecturer, leave much to be desired. For some of the instruction they are being supplanted by cathode-ray tubes large enough to be seen by a whole class, or alternatively a number of small tubes mounted on the classroom desks and wired in parallel. A good example is the trainer for AI Mark X (American SCR-720). It consists of a boldly drawn circuit diagram the size of a blackboard, a working set of the equipment, and an outsize in oscilloscopes with two 12-in cathode-ray tubes. By means of push-button switches the instructor can connect either of the tubes to any important point in the equipment, and at the same time as the waveform appears on the tube an indicator lamp marks the corresponding point on the circuit diagram. Similar apparatus is used for a number of other circuits.

This scheme has many advantages. It saves the instructor's time in drawing diagrams, and is more legible (generally!). It is more convincing to the trainee, who sees an actual oscillogram coming from an actual set. The effects on waveform of operating the controls can be demonstrated. It adds usefully to familiarity with oscilloscopes. Direct correlation of the gear itself, its circuit diagram, and its oscilloscope pictures, is far more effective than blackboard sketches which have to be related elsewhere to the thing itself.

During the war radio and radar equipments were too numerous and transitory for such refined methods to be used universally, but in peacetime these difficulties should lessen.

Although the policy in R.A.F. instruction is towards study of the equipment itself rather than theoretical blackboard sketches, the external or even the internal appearance of a set seldom goes far towards enabling a trainee to grasp how it works. It is helpful therefore to demonstrate some of the more involved processes by means of aids that are part-model and part-diagram. For instance, the Type J aerial switch in the aircraft radio T1154/R1155 is connected to a diagram in which illuminated panels show the circuit changes as the switch is operated.

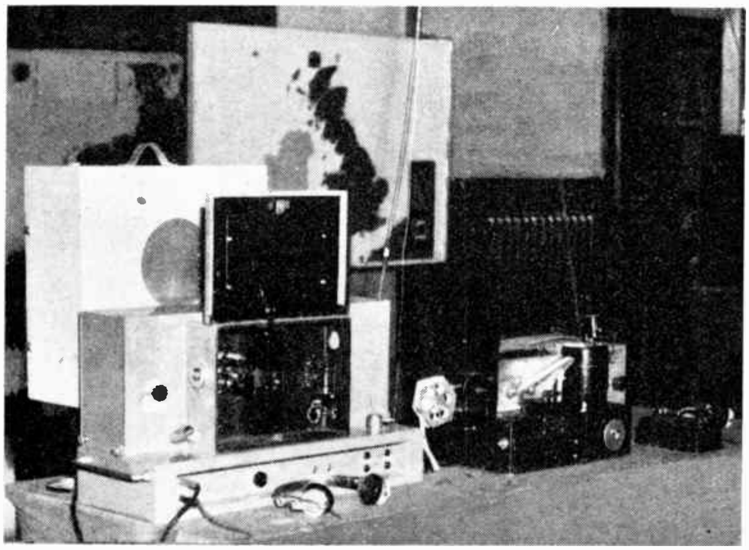
Another modern trend is to give the trainee opportunities for repeating demonstrations himself until they are thoroughly absorbed. The push-button devices already mentioned can be used for this. Another self-teaching aid is the Quiz Board, down one side of which are a number of questions, and down the other, in random order, are the answers. Question and answer can be selected by push-buttons; and if the trainee ventures the right answer he is rewarded by a green light. Any other answer results in a red light and (to rub it in) a blast from a horn.

A very important qualification in radio is being able to deduce the nature of a fault quickly from the symptoms. If this can be done without the aid of any instruments, so much the better. Devices for associating the fault with the symptoms include an R1155 receiver in which by means of a selector switch any valve heater could be open-circuited to simulate a faulty valve. Another, for teaching the use of the oscilloscope in tracing radar faults, is similar to the "live" circuit diagrams already described, except that, instead of being provided with push-buttons for selecting waveforms, the key points in the working equipment were brought

Aids to Training—

out through screws to the appropriate points on the circuit diagram. The instructor organizes a fault behind the board; and the trainee, armed with an oscilloscope, has to check the test points and deduce the fault.

The properties of centimetre-wave equipment were demonstrated by assemblies in which the output from a magnetron could be passed into waveguides fitted with all the gadgets known to modern electro-magnetic plumbing. The paths taken and the relative field strengths were indicated by neon lamps and explored in space by means of a vacuum-enclosed dipole and thermo-junction with indicating meter.



A morse transcription unit used to enable pupils to assess accurately their proficiency in sending. The tape from the undulator is passed through a transcriber, the speed of which can be varied.

Centimetre waves are used not only to demonstrate their own techniques but also for scale-down study of aerial polar diagrams. The output of a klystron can be coupled to any one of a number of model aerial systems, rotating at about 6 r.p.m. Radiation is picked up by a receiver a short distance away, and the amplified output displayed as the length of a radial line on a C.R.T., rotating in synchronism with the model aerial. The polar diagram of the aerial is thus continuously painted on the tube.

A synthetic trainer of true scientific elegance is Type 54, for simulating flight conditions with H2S radar. H2S, it will be remembered, is the centimetric radar with a rotating scanner mounted on the underside of a bomber, showing on a plan position indicator a picture of the terrain beneath within a controllable radius. The scaling-down necessary to enable echo pictures to be obtained from an indoor model of the country is effected by replacing radio waves travelling at 300,000,000 metres per second by supersonic sound waves travelling in water at about 1,500 metres per second. One mile can therefore be represented by about 8 millimetres in the model, which consists of a sheet of glass forming the bottom of a tank of water a few feet square. The glass is left smooth to represent water and sandblasted to represent land, with towns built of grains of corundum.

The scanner of the H2S set is replaced by a quartz crystal mounted over the glass model at a distance representing to scale the height of the bomber. By means of its mounting the crystal can be moved about to simulate the flight of the imaginary aircraft; if necessary, under the control of a Link Trainer. These movements are traced on a glass map forming the lid of the tank.

The crystal is rotated at the scanning speed and pulsed at the normal pulse frequency, setting up a beam of sound waves in the water at 14.5 Mc/s, which is the H2S intermediate frequency. Echoes impinging on the crystal generate piezo-electric voltages which are passed straight to the I.F. amplifier, from which point the normal H2S equipment is used; and the P.P.I. traces simulate effectively those that would appear in a flight over real country. The trainee radar operator is able to practice bombing runs, and as a check on the accuracy of his work the position on which the bomb would have fallen is indicated on the map.

STABILIZED POWER UNITS

A SERIES of voltage-stabilized supply units is being produced by S. Szymanski and O. Dzierzynski, 95, Strodes Crescent, Staines, Middlesex. The units are electronically controlled and are notable for the large number of independent supplies available from each instrument. As an example, the Model 3S/46 gives three adjustable and stabilized H.T. supplies: 250-700 V, 200-50 mA; 120-350 V, 200-80 mA; 40-120 V, 70-25 mA—all stabilized to within 2 per cent. In addition there are A.C. auxiliary circuit supplies of 2, 4, and 6 V, 2 amps; 1, 4 and 5 V, 3 amps and 300 V centre tapped, 80 mA. Two grid bias supplies of 0-45 V D.C. with common positive and negligible ripple content and a 3,000 V D.C., 5 mA supply for C.R. tubes complete the picture.

The three stabilized voltages have + and − insulated from the chassis and can be connected in series.

POLYTHENE AT V.H.F.

AN interesting letter by J. G. Powles and W. G. Oakes appears in *Nature* for June 22nd, 1946, regarding the behaviour of polythene at high frequencies. As might be expected, the power factor increases with frequency for the lower radio frequencies, rising from 0.9×10^{-4} at 100 kc/s to about 2.6×10^{-4} at 1,000 Mc/s (30 cm wavelength). At higher frequencies, however, the rise is not continued; there is a flat maximum around 1,500 Mc/s and thereafter the power factor falls. At 10,000 Mc/s (3 cm) it is down to some 2.2×10^{-4} and the curve falls quite rapidly at higher frequencies.

The reason for this rather unexpected state of affairs does not seem to be fully understood.

AMERICAN SERVICE VALVE EQUIVALENTS

CORRESPONDING CIVIL TYPES

WE published in the August, 1945, issue a list of British Service valve equivalents, and since then many readers have written asking if we can identify various American types. No claim to completeness is made for the following list, but we have found that it answers all the enquiries we have so far received and we think that it will be useful as it stands.

The short list of "JAN" serials at the end of the main list gives the few types in which the "JAN" number differs from the normal civil number.

To avoid confusion with R.A.F. types, some of which also bear "VT" numbers, two appendices are given. Appendix A indicates those valves which are not immediately distinguished by their British or American bases, and Appendix B gives types which have different "VT" numbers in the British and American Services.

Suffixes A, B, C, D to a "VT" serial generally distinguish between M, G, GT or GT/G, though not necessarily respectively.

Service Number	Civil Type
VT24	864
VT25	10
VT27	30
VT28	24A
VT29	27
VT30	01A
VT31	31
VT33	33
VT35	35/51
VT36	36
VT37	37
VT40	40
VT44	32
VT46	866
VT47	47
VT48	41
VT49	39/44
VT50	50
VT52	45
VT55	865
VT56	56
VT57	57
VT58	58
VT59	59
VT62	801
VT63	46
VT64	800
VT65	6C5
VT66	6F6
VT68	6B7
VT69	6D6
VT70	6F7
VT73	843
VT74	5Z4
VT75	75
VT76	76
VT77	77
VT78	78
VT80	80
VT83	83
VT84	84/6Z4
VT86	6K7
VT87	6L7
VT88	6R7
VT89	89
VT90	6H6
VT91	6J7
VT92	6Q7
VT93	6B8
VT94	6J5
VT95	2A3
VT96	6N7
VT97	5W4
VT98	6G5/6U5
VT99	6F8G
VT100	807
VT101	837
VT103	6SQ7
VT104	12SQ7
VT105	6SC7
VT107	6V6
VT109	2051
VT111	5BP4/1802-P4
VT112	6AC7/1852
VT114	5T4
VT115	6L6
VT116	6SJ7
VT117	6SK7
VT118	832
VT119	2X2/879
VT120	954
VT121	955
VT124	1A5GT
VT125	1C5GT/G
VT126	6X5
VT131	12SK7
VT132	12K8
VT133	12SR7
VT134	12A6
VT135	12J5GT
VT136	1625
VT137	1626
VT138	1629
VT139	VR150/30
VT145	5Z3
VT146	1N5GT
VT147	1A7GT
VT148	1D8GT
VT150	6SA7
VT151B	6A8GT
VT152	6K6GT
VT153	12C8
VT154	RK47/814
VT161	12SA7
VT162	12SJ7
VT163	6C8G
VT164	1619
VT165	1624
VT167	6K8
VT168A	6Y6G
VT169	12C8
VT170	1E5GT
VT171	1R5
VT172	1S5
VT173	1T4
VT174	3S4
VT175	1613
VT176	6AB7/1853
VT177	1LH4
VT178	1LC6
VT179	1LN5
VT182	3B7/1291
VT183	1R4/1294
VT184	VR90/30
VT185	3D6/1299
VT188	7E6
VT189	7F7
VT190	7H7
VT191	316A
VT192	7A4
VT193	7C7
VT194	7J7
VT197A	5Y3GT
VT198A	6G6G
VT199	6SS7
VT200	VR105/30
VT201	25L6
VT202	9002
VT203	9003
VT205	6ST7
VT206A	5V4G
VT207	12AH7GT
VT209	12SG7
VT210	1S4
VT211	6SG7
VT212	958
VT213A	6L5G
VT214	12H6
VT215	6E5
VT216	816
VT221	3Q5GT/G
VT222	884
VT223	1H5GT
VT224	2C34/RK34
VT225	307A
VT226	3EP1/1806-P1
VT228	8012
VT229	6SL7GT
VT231	6SN7GT
VT233	6SR7
VT234	HY114B
VT235	615
VT236	836
VT237	957
VT238	956
VT241	7E5/1201A
VT243	7C4/1203A
VT244	5U4G
VT245	2050
VT247	6AG7
VT250	EF50
VT255	705A/8021
VT259	829
VT260	VR75/30
VT264	3Q4
VT266	866Jr.
VT268	12SC7
VT269	717A
VT286	832A
VT287	815
VT288	12SH7
VT299	12SL7GT
JAN-3B-22	EL1C
JAN-38142	45 Special
JAN-UH50	834
JAN-VT25A	10 Special

APPENDIX A

Service Number	Civil Type U.S.A.	Civil Type British
VT52	45	EL32
VT75	75	KT66

APPENDIX B

Civil Type	Service Number U.S.A.	Service Number British
6J7G	VT91A	VT74
RK34	VT224	VT61
807	VT100	VT60
832	VT118	VT88

RADIO AUSTRALIS

Wireless in the Commonwealth : Openings for British Goods

From a Correspondent

AUSTRALIAN radio is slowly but surely taking its post-war shape. First efforts of manufacturers to catch up with a receiver demand starved over the war years have as yet not been completely successful. Various bottlenecks in production such as the shortage of parts, i.e., loudspeakers, variable condensers and electrolytic condensers, added to industrial hold-ups, have tended to slow things up. Nevertheless, a good range of broadcast, dual wave and kit sets is gradually becoming available.

It may not be generally known that Australian manufacturers have been able, behind a very high tariff wall, to found a very large business, and at this date an imported receiver is a rarity. Australian broadcast receivers are first-class articles. Largely of American design and mostly with an American valve kit, they give first-class results.

Customs duties leave a very small field for the British manufacturer. There is, however, scope for some lines of S.W. components. The writer had occasion recently to approach the "sole" agents in Australia for two well-known brands of English S.W. components which sold well in the pre-war days. One firm had no stock at all, the other almost none.

Broadcasting. — No concrete plans have as yet been formulated for the future of F.M., television or facsimile. The present A.M. service is a combination of national (Government-owned) and commercial stations. Powers range to 10 kW in the case of national stations and 2 kW in the case of commercial stations. The commercial stations are entirely dependent on income from advertising.

There is a good deal of dissatisfaction among the commercial stations on the questions of power and frequency; on these they claim parity with the national service. There are still some 900 ungranted applications for commercial station licences. When a licence is issued a chorus of protest arises from the have-nots, and the usual vigorous protests were made when a licence was recently granted to the Queensland Labour Party. The administration of all radio is firmly in the hands of the Postmaster General, who in effect makes the regulations and interprets them too. Certain quarters are now asking that the whole of radio administration be taken from Ministerial control and placed in the hands of a Federal Communications Commission.

At the present time the Federal Parliament is being advised on broadcasting matters by a standing committee of both sides of the House who take evidence at the request of Parliament. They have issued ten reports which deal with such matters as station licences, sex broadcasts and salaries for staff of the Australian Broadcasting Commission who are responsible for the national programmes.

This committee has recently taken evidence on the desirability of setting up F.M. and television services, but no report has been issued to date. Broadcasting circles are hardly satisfied with the slow-moving methods of this committee, claiming that technical progress is being impeded.

Amateurs.—The re-licensing of amateurs has been going on steadily since January, some 1,500 licences having been issued. The new amateur requirements have been set out in a new set of regulations issued by the P.M.G.'s Department in a booklet called "Handbook for the Guidance of Experimental Wireless Stations." Principal changes from pre-war licences is the grading of operators' licences "A" and "B," and the provision of two classes of stations, "A" class with a final plate input of 100 watts, and "B" class with a similar input of 50 watts. Frequencies available until recently have been 28-29, 50-54, 166-170 and 1,345-1,425 Mc/s, but the bands 14.1-14.3 and 7.15-7.2 Mc/s have just been allotted.

Aviation. — Radio facilities, greatly expanded during the war, have now been established on a firm footing. A complete string of Aeradio stations has been established, with D.F., navigational and communication facilities on the main airways. These are likely to be further expanded and improved as the Government has established its own Airlines Commission and is shortly to enter the Interstate Airways business in competition with private airlines.

Communications.—It is proposed that legislation will shortly be brought before Parliament to enable the Government to take over the communications facilities of Amalgamated Wireless, Ltd. This step is said to be in accordance with Empire policy. This action will be somewhat peculiar, in that the Government already controls 51 per cent of the £1,000,000 capital. The Government is still negotiating with the management on the matter of compensation. Amalgamated Wireless will presumably concentrate on its industrial activities, which are already large.

M.S.U.

Another contribution from Australia, in the form of a letter from a reader, is printed below.

British Test Equipment

IT was with considerable interest that I read your article in the February number on the Physical Society's Exhibition. This, together with numerous letters which have appeared in your pages from time to time concerning British radio equipment for the overseas market, has prompted me to make this approach to you.

As a physicist in the Australian Munitions Supply Laboratories, having the supervision of the General Physics Laboratory, including an expanding electronics group, I am required to select the equipment necessary for the work. I regret that very rarely have I been able to recommend the purchase of British test instruments, the majority of the orders being placed in the U.S.A. The manufacturers of American test equipment evidently consider it worth while to make known their products to the world. By turning to a readily available trade index one can usually find dozens of manufacturers of a given type of instrument, and from so large a choice it is rare if a suitable standard instrument cannot be chosen. They advertise their instruments in the trade and professional publications with a wealth of technical data, thus enabling the reader to determine their suitability for his particular requirement. As an example of this one need only peruse the pages of *Electronics*, or the *Proceedings of the Institute of Radio Engineers*, to be able to choose instruments for almost any requirements in the field of electronics. Further, one need only send a request for data to most of the manufacturers in U.S.A. to receive very expeditiously volumes of valuable performance data, characteristics and all necessary purchasing information.

If one wishes to buy British the story is a very different one. It is a matter of some difficulty to find the names of even two or three manufacturers of a required instrument. Often no British instrument can be located. No British publication carries advertisements in any way comparable with those in *Electronics* either in range of products or technical information supplied. When the name of a possible manufacturer has been obtained, a request for information has generally produced the minimum data necessary to comply with the request. Thus on the score of publicity alone the chance of an order going to Great Britain is small.

Then, of course, there is the great drawback of non-standardization of components and valves, particularly valves. There is an obvious objection to holding in stock a spare set of valves for each test instrument. This is unnecessary with the majority of American test instruments, for when a valve becomes faulty a standard one is drawn from the ordinary valve stock. This objection also applies to the use of British types of valve in constructional work. The idea of designing equipment to use British valves is rarely worth considering.

We did have hopes in Australia that Great Britain would attempt to attract orders from the Dominions in the immediate post-war period. We realize that Great Britain is working under difficulties incomparably greater than those encountered by the American manufacturers. We would prefer to buy British equipment. Unfortunately, it would appear that even if Britain desires a market here, the race for orders is already lost. In our own case plans for the next year have already been made and we still don't know what Britain can offer us in the way of equipment, even less are we aware that British instruments are comparable with the American competitors.

In conclusion, may I state that I have recently requested information from the four British manufacturers whose address I have been able to obtain concerning the performance and availability of their products. I await the replies with interest. A. W. Pybus, M.Sc.

Ascot Vale, Victoria,
Australia.

BOOKS RECEIVED

Radio-Communications.—By W. T. Perkins and R. W. Barton. The authors have used the question and answer technique in producing this book which is intended for those intending to take the City and Guilds of London Institute examination in radio-communications. The thirteen chapters deal, *inter alia*, with components, valves, receivers, A.M. and F.M. transmitters, power supplies, aerials, ship-shore radio, landlines, measuring instruments and interference. The final chapter outlines some 22 experiments and the book concludes with a section giving tables and data. 312+viii pp., with 184 diagrams. George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. Price 12s 6d.

Soul of Lodestone.—By Alfred Still. The author traces the story of magnetism through the ages from Greek mythology to the present time. The book includes an extensive bibliography and numerous quotations from authoritative works on the subject. 233+x pp. Murray Hill Books, Inc., 232, Madison Avenue, New York, 16, U.S.A. Price $2.50.

Varnished Cloths for Electrical Insulation.—By H. W. Chatfield, Ph.D., B.Sc.(Hons.), and J. H. Wredden. The results of the authors' investigations into the use of various fabrics and methods of impregnation in providing high-class insulating cloths are given in this book. The authors have brought together in one volume the results of the researches carried out by the manufacturers of textiles, varnishes and electrical equipment. 255+xiv pp, with some 75 illustrations and diagrams. J. & A. Churchill, Ltd., 104, Gloucester Place, London, W.1. Price 21s.

RANDOM RADIATIONS

By "DIALLIST"

Shock Tactics

ALL who went through the radar course at Watchet during the war (as hundreds of *Wireless World* readers probably did) will remember "Nobby," to say nothing of his awful little dog, Percy, who went through life with the ineradicable conviction that table legs and lamp-posts were one and the same thing. Nobby was in charge of the lab., where he spent his time in guiding students in their practical investigations of the forbidding array of complex circuits that go to make up a radar set. If the circuit on which you were engaged wasn't working properly, you sought Nobby's fatherly aid. No matter how high the voltages involved, it was a point of honour with Nobby never to switch off before going in up to the elbows amongst the maze of wires. Of course, he must have been more or less shock-proof, you say. Far from it; he got just what was coming to him in the way of shocks and his reaction in the shape of skyward leaps and naughty words were much the same as yours and mine. His fingers were covered with burns due to encounters with unexpected "hot spots"; but switching off he regarded as something pusillanimous, something definitely not done by the best people. Once when he was rather shakily recovering after "buying" 500 volts on my particular bit of apparatus I ventured to remonstrate with him, telling him that he really ought to make a point of switching off. "Wastes too much time," he said! I'd like to meet this hero again—provided he didn't bring Percy.

□ □ □

Positive and Negative

REALLY it's about time that in schools and other places where they teach they scrapped the old erroneous idea of a "positive current" and adopted in its stead the conception of a current as a flow of electrons. I cannot see any point in retaining a view which is utterly wrong, especially as it makes things far more difficult for the student when he comes to electro-magnetism and its applications and to electronics. One objection often advanced to the change-over from wrong to right is that so many of the ancient rules and aids to memory would have to be dropped or changed. Many of them could actually be scrapped and a very good thing too! No need to bother about idiotic imaginary men swimming in currents, or to wonder whether its the right or the left hand whose thumb, forefinger and second finger must be arranged in odd ways if you remember the one fundamental rule that the magnetic field round a conductor carrying a stream of electrons towards you has a clockwise direction. Matters such as the polarity of electro-magnets and the direction of induced currents then present little difficulty. The Army gave a good lead during the war. We found it infinitely easier and quicker to teach the elements of electricity if we started off right away with the conception of an electron current. There could be no better time than the present for making the change everywhere; school textbooks are largely out of print and there is a golden opportunity of correcting the ancient error in the new ones that will presently be appearing.

□ □ □

A Workshop Warning

IN my own den I have just fitted up one of the new 40-watt fluorescent tube lights and I find its white "daylight" a real joy to work by at night. If you're thinking of doing the same, here is a tip that you may find of value. For all their usefulness, these lamps, with the severely "commercial" holders and reflectors that are the only fittings now available are *not* beautiful. You will probably feel that, much as you would like to have the fluorescent tube when you are working, an ordinary lamp and shade would be preferable when a friend comes in for a chat. Easily managed, and here's how it's done. To a joist in the ceiling fix a good strong batten lampholder. Into two other joists, suitably spaced, screw two large brass cup hooks. Attach two lengths of brass chain to the holder of your fluorescent lamp and provide it with a suitable length of good flex, fitted with a bayonet connector. In the 40-watt model the choke and the condensers are built into the holder. To bring the lamp into use, hang it up by the chains and insert the adaptor into the batten holder and there you are. Have in reserve an ordinary pendant lamp and shade with a bayonet adaptor at the end of its flex. Then to take down one kind of light and put the other in its place is a matter of a couple of minutes. One word of warning about fluorescent tubes. Do not install one in your workshop if this contains any fast-running power-driven machines such as a lathe or a drill. The tubes have a 50-cycle flicker which is imperceptible in the ordinary way. But it may "strobe" a fast-turning pinion, wheel or chuck so that it appears to be motionless and—well, need I say more?

□ □ □

Pilot Lamps

ONE of the very weak spots of present-day receivers is the pilot lamp, or perhaps I should say the pilot lamps, for many sets contain two or more of them used as dial illuminators. The life of these lamps is apt to be so short that they are a continual worry to service-men —and to set designers. After studying an oscillogram kindly sent to me some time ago by a reader I'm surprised that any lamp with a metal filament ever survives the switching-on process more than a few times. As you know, the resistance of a cold metal filament is very low. This oscillagram shows current leaping to ten times its working figure immediately after being switched on and taking an appreciable fraction of a second to drop to normal. What we seem to need for pilot lamps is some kind of protective device, to be connected in series with them, containing an element which has a high resistance when cold and becomes a better and better conductor as it warms up.

□ □ □

Up-the-pole-arization

A KIND correspondent has sent me a cutting from a lay paper containing an article in which the reader is promised knowledge without tears of everything that matters about F.M. In excited anticipation of finding a crystal-clear exposition of a subject so hedged about with difficulties for the wet-nose listener I plunged into the article. Are you by any chance a little shaky about the basic difference between A.M. and F.M.? Well, here is what it has to tell you. The simplest explanation, says the writer, is that, whereas A.M. sends out waves which go up and down, F.M. sends out waves which go from side to side! I deduce, my dear Watson, that the gifted writer had been in conversation with someone who knew his onions and that that someone had passed from the respective merits of A.M. and F.M. to those of horizontal and vertical polarization. It could, though, be argued that A.M. as we know it is an "up and down" business, since all broadcast transmissions are vertically polarized, whilst F.M. in this country is a "side to side" affair in that the B.B.C.'s experimental transmissions using this system are horizontally polarized.

BOOK REVIEW

Alternating Current Measurements at Audio and Radio Frequencies (2nd Edition). By David Owen, B.A., D.Sc., F.Inst.P. Pp. 120 + vii, with 80 diagrams. Methuen and Co., Ltd., 36, Essex Street, London, W.C.2. Price 5s.

THIS revised edition of a book that first appeared in 1937 still serves a most useful purpose by providing information, in concise form and at a moderate price, on a selection of the best methods of measuring inductance (self and mutual), capacitance, A.C. resistance, voltage, current, and frequency. The author has succeeded in covering theory and principles adequately while being thoroughly practical.

The first chapter recapitulates as much A.C. theory as is necessary to a clear understanding of bridge and resonance methods, and there is also a chapter on conditions of accuracy in bridge methods. The remaining five chapters deal with specific methods. In these, theory is applied in comparing their respective merits, and practical points are illustrated by examples. The order of accuracy is everywhere indicated. Methods for mutual inductance, so often neglected even in large texts, are included in considerable variety, and at greater length even than methods for capacitance. The quantities involved and the mode of operation and of working out results are clearly and concisely set out. In this an important contribution is made by the diagrams, which, although not of the highest standard of draughtsmanship, deserve praise for their clarity.

As the book is one of a series intended to supply readers with "a compact statement of the modern position" in their subjects, however, it is a pity that revision was not carried further, as at this date there is a slightly archaic flavour, especially in the chapter devoted to R.F. measurements, comprising one-third of the volume. For example, the statement that "at high frequencies bridge methods are in general no longer suitable" can hardly be squared with the modern position, in which bridges are commercially available up to at least 60 Mc/s. The wavemeter circuit diagram (Fig. 55) with terminals for a coupling coil in series with the calibrated oscillatory circuit, and a variable condenser across phones and H.T., among other strange features, suggests the early 1920s. The present generation, too, is so used to thinking of coils as synonymous with inductors that the expression "inductive coils" may seem tautological; and the use of the word "coil" for a non-reactive component may confuse some.

With this one qualification, the book can be highly recommended, especially to students who want something clear and more concise than the large textbooks.

M. G. S.

SHORT-WAVE CONDITIONS

Expectations for September

By T. W. BENNINGTON

(Engineering Division, B.B.C.)

DURING July the average maximum usable frequencies for this latitude were almost the same as during June, both day and night. The midnight M.U.F. was, in fact, little lower than that for noon, and frequencies as high as 17 Mc/s could have been regularly used till long after midnight on most routes. As was expected, the daytime M.U.F. was relatively low, and communication on exceptionally high frequencies by way of the regular layers was therefore very infrequent, especially to countries in the Northern Hemisphere. This situation should soon change considerably, as is indicated in the forecast given below.

Sporadic E was, however, very prevalent during the month and a considerable amount of communication on very high frequencies by way of this medium was possible out to medium distances, as had been forecast in this column.

Several ionosphere storms occurred and some were of a more severe nature and caused more interruption to communications than is often the case in July. The worst one appeared to be associated with an exceptionally large sunspot which crossed the sun's central meridian on July 26th. The most disturbed periods were 3rd-4th (slight), 18th-20th (severe on 19th) and 25th-28th (very severe 26th and 27th). Incidentally a "very great" magnetic

Short-wave Conditions—

storm also occurred on the 27th, and on this day the interruption to communications was on a world-wide scale.

Several "Dellinger" fadeouts, also apparently associated with the large sunspot, occurred during daylight hours on 21st, 23rd, 24th and 25th.

Forecast. — In September the seasonal effect in the Northern Hemisphere is such as to produce an increase in F-layer daytime ionization, and, as there is also at the present time the rapid increase in sunspot activity to enhance this effect, a very considerable increase in the daytime working frequencies to most parts of the world is expected to occur during September of this year. The night-time frequencies for long-distance transmission will, however, decrease somewhat as compared with August.

Amateur transmitters working the 28 Mc/s band may expect very many more opportunities for DX contacts, especially with distant countries in the Northern Hemisphere, than they have had of late, provided that they work the band at the right time of day.

Sporadic E is likely to decrease considerably in the frequency of its occurrence during the month, and medium-distance transmission on high frequencies by way of this medium should be much less frequent than of late, though it may occasionally occur. It is not expected that the normal E layer will often control transmission for any distance in these latitudes during September.

Below are given, in terms of the broadcast bands, the working frequencies which should be regularly usable during September for four long-distance circuits running in different directions from this country. In addition a figure in brackets is given, which indicates the highest frequency likely to be usable for about 25 per cent of the time during the month for communication by way of the regular layers:—

Montreal :	0000	11 Mc/s	(18 Mc/s)
	0200	9 ,,	(14 ,,)
	0800	11 ,,	(18 ,,)
	1000	15 ,,	(22 ,,)
	1100	17 ,,	(26 ,,)
	1300	21 ,,	(31 ,,)
	2000	17 ,,	(26 ,,)
	2200	15 ,,	(22 ,,)
Buenos Aires :	0000	11 Mc/s	(17 Mc/s)
	0400	9 ,,	(15 ,,
	0900	15 ,, or 17 ,,	(23 ,,
	1100	21 ,,	(30 ,,)
	1400	26 ,,	(34 ,,)
	1800	21 ,,	(30 ,,)
	2100	17 ,, or 15 ,,	(23 ,,
	2300	11 ,,	(19 ,,
Cape Town :	0000	11 Mc/s	(17 Mc/s)
	0600	17 ,,	(24 ,,)
	0700	21 ,,	(31 ,,)
	1100	26 ,,	(35 ,,)
	1600	21 ,,	(31 ,,)
	1900	17 ,,	(24 ,,)
	2100	15 ,,	(21 ,,)
	2300	11 ,,	(19 ,,)
Chungking :	0000	9 Mc/s	(15 Mc/s)
	0200	11 ,,	(17 ,,)
	0500	15 ,, or 17 ,,	(24 ,,
	0800	21 ,,	(29 ,,)
	1400	17 ,,	(26 ,,)
	1600	15 ,,	(21 ,,)
	1800	11 ,,	(17 ,,
	2200	9 ,,	(15 ,

Ionosphere storminess is quite likely to be particularly prevalent during September, and periods of poor short-wave communication must be expected. Although one cannot be at all certain, it would appear that such disturbances are more likely to happen within the periods 1st-3rd, 10th-13th, 19th-21st and 28th-30th than on the other days of the month.

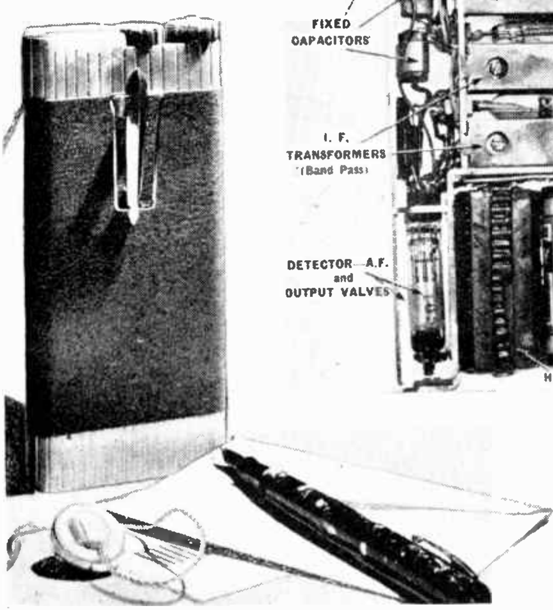
Footnote. — Readers of this column may be interested to know of a prediction of the sun's activity during the next several years, recently published by M. Waldmeier, of Zurich Observatory. According to this the coming maximum is expected to be higher than the last and to occur in the latter part of 1947. Thereafter the sun's activity should gradually decrease till about 1954, the whole cycle thus occupying less than ten years. Usable radio frequencies are, of course, high at the maximum and low at the minimum.

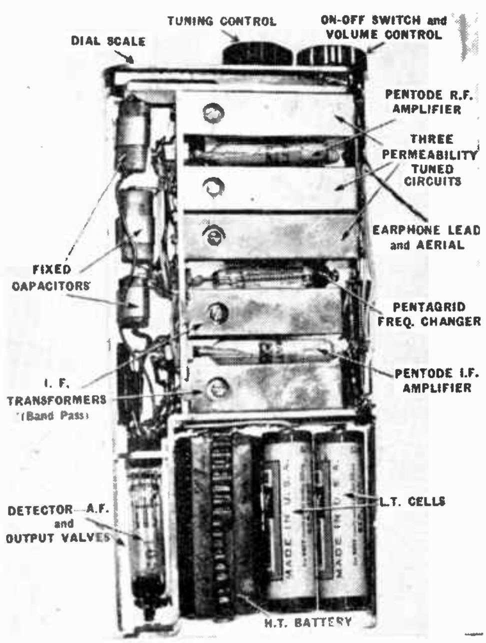
POCKET RADIO

WITH the general release of "sub-miniature" valves, developed by the Raytheon Manufacturing Company for the proximity fuse, the Belmont Radio Corporation of Chicago has produced this pocket receiver. It is a five-valve superhet, the case for which measures 3in wide, ¾in thick and 6¼in high and weighs only 10 oz with batteries. Some idea of the compactness of the construction will be gained from the photograph of the interior.

The five valves, each of which measures 1 9/16in long and is oval in cross section—0.4 × 0.3in—weigh about half an ounce. The H.T. voltage required for these miniature valves is only 22½.

A miniature earpiece is used with the Belmont Pocket Receiver which has been photographed . .





. . with a fountain pen for the purpose of comparison. The annotated view of the chassis shows the disposition of the main components.

LETTERS TO THE EDITOR

Internal-fitting Earphones ✦ Pulse Modulation ✦ Impregnated Winding

Hearing-Aid 'Phones

WITH reference to the letter from A. P. R. Mackie in your July issue, may I point out that the earpiece described by me in *Wireless World* of June is intended to work as an air conductor, and it has been shown that it has a smaller bone conductor component than an ordinary Post Office telephone receiver? It does not compete in efficiency with the latest miniature crystal earpieces, but while these are inclined to have an upper frequency response, the shell earpiece, as I have called it, can very easily have its response tailored, and if required it will give a very level response over a wide range, or it can even be made to accentuate the bass by varying the masses and springs (rubber pads) and the damping. The mathematics are very complicated, but theory confirms practice in this matter. In fact, far more amplitude can be delivered by the shell than is allowed by the mechanical restrictions to be found in the small diaphragm associated with a miniature electromagnetic receiver.

I think I am not laying myself open to contradiction if I state that the shell earpiece is considerably more efficient than any bone conductor that has been produced; also that it has all the practical advantages of a bone conductor receiver without the necessity of a head band; but I agree with Mr. Mackie that a number of sizes of receivers will have to be in stock against only a number of anatomical fittings, but this is a point where the manufacturers will have to make provision and good service should obviate the difficulty.

C. M. R. BALBI.
Durban, Natal.

"Miller" Integrator ?

I HAVE noted with interest M. G. Scroggie's suggestion, in your June issue, that the Miller Integrator should be re-named "Blumlein."

The problem of correctly attributing many of the wartime electronic developments is clearly going to present many difficulties, although few of the circuits are of such broad significance as the so-called "Miller" integrator.

I agree with Mr. Scroggie that the present name is inappropriate but, although not wishing to detract in any way from the many achievements of the late A. D. Blumlein, would enquire how Mr. Scroggie's suggestion can be reconciled with British Patent 575,250, recently issued to Messrs. A. C. Cossor and J. W. Whitley (with whom, incidentally, I am in no way connected).

R. J. F. HOWARD.
Walton, Staffs.

Pulse Terminology

IN your issue of April, 1946, "Cathode Ray," in an article entitled "Pulse Modulation," gives useful information on various aspects of a transmission system which has very great possibilities. However I think that the choice of certain descriptive terms is not exactly happy. May I suggest the following definitions.

(1) When the time of occurrence of one or both edges of the pulses of one class in a train of pulses of the same class (the pulses having constant amplitude) vary in accordance with a modulating intelligence, the pulse train is said to be "Time Modulated." The general term "Time Modulation" should be applied to all such transmissions.

(2) When a train of pulses of one class (the pulses having constant amplitude and duration, and in the unmodulated condition one of the pulses periodically occurring during successive equal time periods) is time modulated in accordance with a modulating intelligence within limits such that one pulse of said class always occurs during each of the successive equal time periods, the pulse train is said to be "Phase Time Modulated."

(3) When a train of pulses of

Letters to the Editor—

one class (the pulses having constant amplitude and duration, and in the unmodulated condition, *n* of said pulses, where *n* is a number equal to or greater than unity, periodically occur during successive equal time periods) is time modulated in accordance with a modulating intelligence in such a manner that, over a succession of the successive equal time periods, the number of pulses of said class occurring during one or more of said time periods varies within the limits *n* plus and or minus *n/r*, where *r* is preferably greater than unity; the pulse train is said to be "Frequency Time Modulated."

(4) When the durations of the pulses of one class (in a train of pulses of the same class, the pulses having constant amplitude) vary in accordance with a modulating intelligence, the pulse train is said to be "Duration Time Modulated." The terms "Width" or "Height" are to be deprecated in this connection. The word "Duration" has been used in this sense for a number of years by earlier workers.[1]

These three systems of time modulation can each be characteristic of the phase, frequency or amplitude of the modulating intelligence. Thus Duration Time Modulation can be characteristic of the phase of a signal, the phase in turn being characteristic of the amplitude.

"Cathode Ray" is in error in saying that Frequency Time Modulation has not been used. In actual fact this is the most widely used system,[2] being in daily use for photo-radio transmission over world-wide circuits. At the receiving station a train of time modulated pulses of constant amplitude and duration has a time modulation which is characteristic of the variable frequency of a signal, this variable frequency being characteristic of the contrast of the picture being transmitted.

Two practical examples of time modulation may be of interest. When riding in a train running alongside a row of equally spaced fence posts, the apparent spacing of the posts can be modulated by turning the head quickly in the direction of travel, giving the effect of closer spacing, while turning the head quickly in the opposite direction gives the effect of wider spacing.

Again, when travelling in a train, and when passing a station name board at such a speed that it cannot be read in the normal manner, sometimes it is possible to read the name if the head is turned quickly in the opposite direction to that in which the train is travelling.

"Cathode Ray" is wrong in saying that a road sweeper would have missed his vocation if he indulged in some form of frequency modulation in his disposal of refuse.

I remember that in the days of unsurfaced roads, in a small country town, it used to be the practice to sweep the mud into small heaps of fairly constant size but spaced according to the amount of mud, this varying on different parts of the road. After a suitable interval for draining away surplus water, a horse-drawn cart travelled at walking pace alongside the mud heaps, two men walked alongside and without stopping the horse shovelled up the small heaps of mud into the passing cart. The shovelling energy, over equal periods of time, varied in accordance with the frequency of the heaps.

W. A. BEATTY.
London, W.13.

[1] "Proposals for Television and Broadcasting Transmission Systems," W. A. Beatty, *Journal Brit. I.R.E.*, March-April, 1945. Bibliography gives a number of references to time modulation.

[2] "Facsimile by Sub-Carrier Frequency Modulation," R. E. Mathes and J. N. Whitaker, *R.C.A. Review*, October, 1939.

The author of "Pulse Modulation replies as follows:—

I AM grateful to W. A. Beatty for the information that pulse frequency modulation is widely used.

With regard to the terms for different kinds of pulse modulation, he proposes to add one—"Time Modulation"—to cover the three types that I called "Pulse Phase Modulation," "Pulse Frequency Modulation" and "Pulse Length Modulation." If such a term is wanted, I hardly think anyone will quarrel with the choice of the word "time" for the purpose. I can't quite see, however, why it is necessary to drag in the same word in all three sub-types too; surely "phase," "frequency" and "duration," in this connection, imply time? The word "pulse," which I used instead, really is necessary, to distinguish them from C.W. systems. W. A. Beatty's substitution of "time" for "pulse" seems to me a change very much for the worse. But I entirely approve "duration" instead of "length," and perhaps weakly used the latter because "Pulse Duration Modulation" seemed rather a mouthful. These things always become abbreviated to letters, however, and "P.D.M." is not only technically more precise but less liable to be confused with a well-known French railway company than "P.L.M."

I would have liked Mr. Beatty, or anyone else to comment on my one original suggestion—"wave pulses." There is a crying need for such a term, because as far as I know there just isn't one at all at present to refer to groups of R.F. waves. They are commonly called "pulses," which is obviously wrong and very liable to confuse.

I didn't intend to suggest that the frequency-modulating road sweeper wouldn't be excellent at the job, but that he ought to be in a more intellectual one!

Readers who may practice time modulation in railway compartments should, I suggest, take care that their gestures are not misinterpreted. "CATHODE RAY."

"Tropicalizing"

THE treatment applied to radio components to render them suitable for tropical use is a problem faced by many of your readers during the war, and is of importance in Britain's export drive. In components such as transformers and chokes, it is essentially the problem of preventing the corrosion of metal parts and guarding against mould growth in windings, etc. This latter is frequently dealt with by processes of vacuum impregnation with suitable varnishes, the essential purpose of which is to prevent the ingress of moisture. It is recognized that such a method is not always successful, and I think that some of my observations during my work in the high vacuum field may throw some light on the mechanism of such failures.

Reference to my letter in

Nature, dated 5th Jan., 1946, supporting the experimental work of Dr. Reekie, (*Nature*, 156, 367 (1945)), shows that very fine channels of the order of 10^{-3}mm, and under, will admit water in preference to air, owing to the high pressure due to the surface tension of water. Thus it might be that imperfections in the impregnation would admit either water or air, or both. It seems significant that the better the impregnating process, the more likely it is to leave the finer leaks which admit water only. This moisture is not likely to be expelled by the heat generated in the coil during service.

The answer, therefore, seems to be either to seal the component hermetically, or to adopt an open construction. For tropical use the former is the only solution; while for temperate climates the latter might be cheaper and better, as any moisture entering the coils would automatically evaporate owing to the warmth generated during service.

At the very high pressures developed by surface tension and osmosis the question of vacuum becomes meaningless when dealing with the risk of very small channels of the order indicated. It might be worth while inviting the observations of your readers, who may perhaps be able to throw even more light on this subject.

Reading. O. P. SCARFF.

MANUFACTURERS' LITERATURE

Bulletin No. 42, issued by Aero Research, Duxford, Cambridge, describes the part played by Ardux cement in the construction of the Mark IV land mine detector. It also gives some particulars of Ardux 120 for bonding metals and other nonporous materials to wood, laminated sheet, etc.

Data sheets for "Midgetron" valves for hearing aids and portable receivers have been received from Park Royal Scientific Instruments, 52, Minerva Road, London, N.W.10.

Specifications of a constant-voltage high-tension supply unit (Model 101-A) and a high-voltage test set (Model 301-A) are given in illustrated leaflets issued by All Power Transformers, 8a, Gladstone Road, Wimbledon, S.W.19.

Technical details of the "Lectrona" permanent magnet loudspeaker and output transformers are given in a leaflet issued by Edstone, Ltd., 41, Spencer Street, London, S.W.1. The 8-inch diaphragm is provided with a dustproof centring device.

RECENT INVENTIONS

A Selection of the More Interesting Radio Developments

CAVITY RESONATORS

A BI-METALLIC plate or strip, which flexes under the action of heat, is arranged to alter the shape, and therefore the tuning, of a hollow resonator. The device may be used to offset any frequency drift, due to ambient changes of temperature, or to the heat generated under working conditions.

The tuning of a resonator mounted inside a sealed electron-discharge tube, for velocity modulation, can be adjusted within limits by deliberately applying heat from an external battery to the bi-metallic control element.

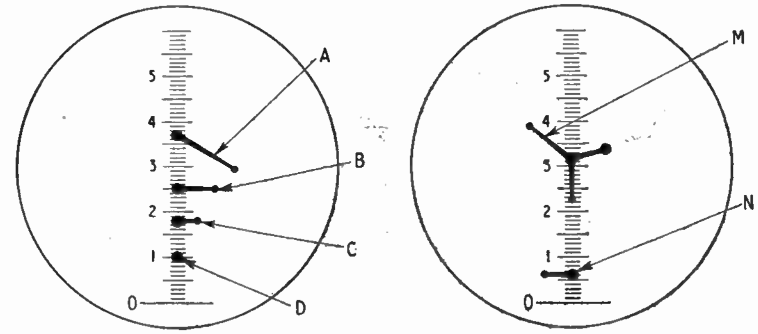
The M-O Valve Co., Ltd.; N. L. Harris; and J. W. Ryde. Application date, April 22nd, 1940. No. 574934.

RADAR PRESENTATION

RELATES to equipment for assisting a fighter pilot to detect and close-in on an enemy craft, at night, or under conditions of bad visibility.

Exploring pulses are radiated, and the echo signals are presented against the time base of a cathode-ray tube to indicate the distance of the enemy craft, in known manner.

The incoming echoes are picked up by four separate aerials, which are respectively selective to directions above and below, and to the right and left of the axis of the pursuit plane. For part of the duration of each echo pulse, the combined input from all four aerials is applied additively to produce a distance-indication along the time base of the C.R. tube. During the remainder of each echo pulse, the directive effect of each aerial is brought



(a) (b)

Target indications in airborne radar

into play, the voltage difference between the up and down aerials being applied across one pair of deflecting plates, and the difference between right and left aerials being applied to the other pair of plates. The trace thus produced on the fluorescent screen will then show the relative position of the hostile craft, as well as its distance.

In diagram (a) the indication A shows the presence of a craft nearly four miles away, to the right, and slightly below the pursuit machine. B, C and D show subsequent indications as the fighter banks to the right, and closes on its target. In diagram (b) the trace M represents a flight of three enemy machines, about three miles away. One lies straight ahead, and a little below, whilst the other two are above, one to the right, and one to the left. The indication N shows a friendly escort, nearly a mile away, flying on a level with, and to the left of the pursuit plane.

Standard Telephones and Cables, Ltd. (assignees of E. Labin). Convention date (U.S.A.), March 13th, 1941. No. 574676.

GRAMOPHONE REPRODUCTION

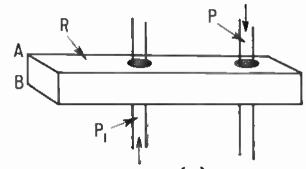
WHEN recording sound, it is usual to contract or reduce the amplitude of loud passages, and to increase that of quiet passages, the correct balance being restored in reproduction by applying a suitable expansion control to the gramophone amplifier. Although one setting of the expansion control is usually sufficient to play the whole of any given record, different records may require different settings. In this respect, however, all records fall within one or other of a few distinct groups.

According to the invention, a small paper ring is pasted over the centre of each record, the ring being divided into black-and-white radial zones, which vary in number according to the particular group into which the record falls. The ring is viewed by a photo-electric unit, which, as the record rotates, generates a current with a typical A.C. component. This is passed through a frequency discriminating circuit, and automatically applies the appropriate degree of expansion control to the amplifier.

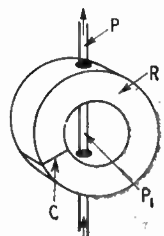
The British Thomson-Houston Co., Ltd., and A. P. Castellain. Application dates, August 24th, 1943, and January 13th, 1944. No. 574557.

GENERATING MICROWAVES

AN electron stream is passed twice through a hollow resonator R, diagram (a), first at P and then at P_1,



(a)



(b)

Cavity resonance generator

in the direction of the arrows. Any lack of uniformity in the stream as it enters will be sufficient to impulse the resonator, thus velocity-modulating or "bunching" the outgoing stream, which then provides inductive feed-back as it re-enters at P_1.

The intensity of the internal electric field varies sinusoidally from zero at both the closed ends to a maximum at the centre of the resonator, so that the degree of feedback is determined by the position of the low-potential entry at P relatively to the high-potential entry at P_1. The output is drawn off by a small loop (not shown) inside the resonator.

By bending the resonator into a ring, as shown in diagram (b), with the two closed ends abutting at C, the same effect is secured without having to divert the electron stream. Alternatively, the resonator may have the shape of the letter J, so that the stream can pass straight through electrodes at the upper end of the short limb and at the lower end of the long limb.

Patelhold Patentverwertungs-und-Electroholding A.G. Convention date (Switzerland), September 1st, 1942. No. 573193.

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.

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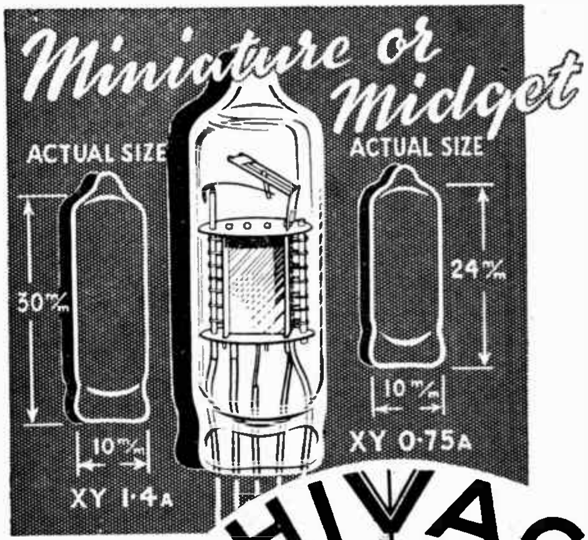

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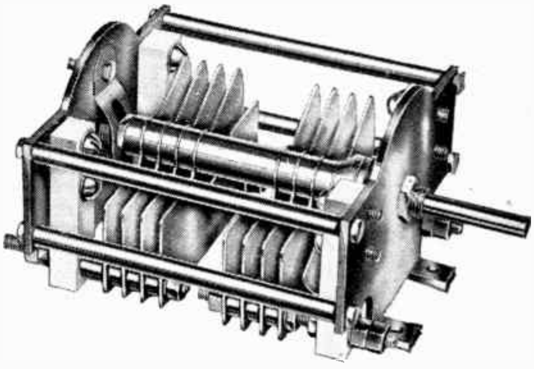

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WARNING

Readers are warned that Government surplus components which may be offered for sale through our columns carry no manufacturer's guarantee. Many of these components will have been designed for special purposes making them unsuitable for civilian use, or may have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such components purchased.

NEW RECEIVERS AND AMPLIFIERS

Alt 88s and other types of communication receivers, enquiries invited.—Alert Radio Co., 27, Temple Fortune Mansions, N.W.11. Speedwell 4352. [5755

14 watt amplifiers for mike or gramo operation, low intermodulation distortion, 25gns; transformers (bakelite impregnation, special stalloy), from £1/2/6; castings, turning, duraluminium cases and decks to customers' specification.—R.R. Development Laboratories (consulting engineers), Barnard Rd., Bradford. [5801

FIDELITY with sensitivity, genuine offer to build 4v T.R.F. ac/dc semi-midget receiver, Litz M. & L. coils, first-class results with improved and tested circuit, diagram and instructions to genuine enquiries 4/6 refunded on kit purchase, complete kit incl. drilled chassis, screws, etc., only £3/15, 6½in L.S. and trans., with 4 specified valves, £3/12/6.—T. R. S., 33, Meadvale Rd. E. Croydon. [5354

KITS, kits, kits, 2 waveband, all mains 4 valve, tube line-up, 6K7, 6J7, 25Z6, 25L6, polished aluminium chassis, really first grade components, station named dial, delivered complete to last nut, full wiring instructions; price £7/8, c.w.o. or c.o.d.—Isherwoods, 81, Plungington Rd., Preston, Lancs. Tel. 3348 Preston. Radio repairs est. 1936.

TELERADIO offer following kits: 4v 2-wave t.r.f., Mullard E valves, £4; 3v 2-wave t.r.f. battery £3, 3v 4-watt ac/dc amplifier, £2/10; 5v Midget superhet, either long, medium or short wave, £6/10; blueprints with list of parts and instructions, 2/6 (superhet 5/-), all less valves, speaker and cabinet; send 2d. stamp for further particulars and comprehensive list of components.—Teleradio, 157, Fore St., London, N.18. Tot. 3386. [5674

BRIERLEY "Ribbon" and "Armature" pick-ups. Please write your name and address in block letters and include 3d. for booklet containing illustrations, responsive curves, technical details, delivery and prices. These booklets explain aspects of pick-up design, developments, including the "floating element" design, leading to the use of ¼ and ⅛ oz downward pressures; the importance of adequate and constant point pressure and its practical achievement; correct point shape; the relation of pick-up weight, point pressure and vertical motion, etc., etc.—J. H. Brierley, Ltd., 46, Tithebarn St., Liverpool, 2. [5701

19 60watt U.D.O. class A rack mounted amplifiers; 6 intermediate voltage amplifiers for use with the above, all aluminium panels, complete with 3in 0.150ma flush-mounted meters in each anode circuit, all complete with valves; 1 3-phase 400v motor generator, 5.5kw (750v) dc output, for supplying h.t. for above amplifiers; also 1 3-phase 400v motor generator, 500v, 2.5 amp dc output, suitable for radio relay station or amateur transmitters.—Further details or inspection at J. S. Ramsbottom & Co., Ltd., radio and electrical engineers, Bow St., Keighley. Tel. 3774

EXCEPTIONALLY high fidelity amplifiers incorporating the new cathode follower output circuit and flexible bass and treble tone control, now available for home constructors; to music lovers these amplifiers set a new high standard of reproduction; 7watt and 3watt amplifiers and radio tuner unit; full drawings and point-to-point wiring diagrams 2/6 each, 5/- the set of three; separate components or complete kits of parts for all units available, including ready drilled chassis. Send stamp for details and price lists. All types of components available c.o.d.—Send your requirements (post only) to Charles Amplifiers, 14, Lapstone Gardens, Kenton, Middlesex.

RECEIVERS, AMPLIFIERS—SECOND-HAND

EDDYSTONE 358 communications, new condition; best offer accepted.—Box 1104

NATIONAL H.R.O. Senior with ac power supply and full set of nine coils in case, all in new condition; £55.—Harris, Strouds, Bradfield, Berks. [5703

HALLICRAFTER S20-R, as new; £30 or near offer.—43, Nightingale Rd., Carshalton, Surrey. [5676

PYE television receiver, complete unit without case but with aerial and suppressor; offers.—Box 1092. [5721

HALLICRAFTER Skychief, new valves, EF50 preselector; offers.—Write, 1, Hurst-court Rd., Sutton, Surrey. [5769

A.C.S. RADIO, 44, Widmore Rd., Bromley, Kent, offer small selection com. sets, radio receivers and amplifiers; list free.

G.E.C. 6-volt receiver, 12-550m, 4 ranges, 2 watts output, £20; quantity s.w. components.—Ilsley, Waterworks, Andover, Hants.

SALE.—National H.R.O. receiver with crystal gate, practically unused, complete with speaker, 6v power pack, coil range 0.05-30 megs.; reasonable offer.—Box 683. [5640

R.A.F. 1155a, modified, with power pack, spkr., 'phones, £28; 8-valve commercial relay rec., coverage 150kc/s to 21mc/s, £18.—Gascoine, 23, Nottingham Place, W.1. [5864

H.R.D. and power pack coils, Eddystone 358x, McMurdo silver, Cossor double-beam oscillograph, 343 Cossor oscillator, Avo.7, Avo.40, 807 valves; amateur giving up.—Box 1091. [5719

R.C.A. A.R.88 communications receiver, as brand new 14 valves, 550K/cs to 33 M/cs, 2 complete spare sets valves; free delivery by road anywhere in England.—Offers over £55 to Box 967. [5690

ARMSTRONG 9-valve 4-waveband chassis, push-pull output, separate power pack with super quality output transformer feeding the PX4's into Vitavox 12in speaker, superb quality; £21 the lot.—Box 1537. [5799

QUALITY radiogram kit, partly assembled, all cert. new, complete, valves, circuit, W.W., q. 8w, amp, 3-wave superhet with pre-amp, tun. ind., massive power pack, also el. gr. motor, Baker's 12in 3-cone eng. spkr.; £40 or offer, must sell.—Box 936. [5682

AMATEUR wishes to dispose of all his equipment, including signal gen meters, transformers, valves, two communication receivers by Hallicrafter, also 1155B converted and with power unit 20- and 4-watt amplifiers, 12in and 18in speakers, etc.—Irish, 144, Adelaide Rd., London, N.W.3. [5722

18-VALVE Scott radiogram, 230 volts A.C., remote tuning, mixed record changer, 4 to 2,200 metres unbroken, variable selectivity, contrast expansion, bass and treble controls, recording channels, magnificent modern cabinet, perfect condition; £175.—Crampin, Waltham, Lincolnshire. Tel. 2265. [5653

R.1155 R.A.F. receivers as described in *Wireless World* last month, excellent condition, £15; can be supplied modified for civilian use, receivers already purchased expertly modified to your requirements, and amplifier/power packs supplied.—R.T.S., Ltd., 8, Gladstone Rd., Wimbledon, S.W.19. Tel. Lib. 3303. [5659

4-WATT Hi-Fi ac gramo amplifier in steel case, £6; Rola 8in P.M., unused, suit above, £1; 8in energised with X— former, unused, £1; superhet. kit, 3-band coil pack, 2-gang condenser, dial, 2 i.f.t., new, £3; Klaxon worm reduction motor, adaptable for recorder, £3; magnetic cutter 600Ω, 30/-; offers considered.—Ellis, 55, Chalkhill Rd., Wembley, Mdx. [5711

TEST EQUIPMENT

COSSOR Model 343 ganging oscillator; £35.

COSSOR Model 3389 impedance bridge; £18. MULLARD oscilloscope Model 3152/65; £60. AUTOMATIC coil winding, Douglas wave winder, complete with motor and gears; £75. —Box 1090. [5718

F. D. COSGROVE, radio and electrical equipment engineers, are now producing various types of radio and test equipment; details free on request.—185, Langley Rd., Slough, Bucks. [5369

OSCILLOSCOPE.—Constructor offers drawings and full instructions to build your own oscilloscope; all details of circuit, components values and lay-out, 3/6.—20, Malzeard Rd., Luton. [5569

COSSOR 339 oscilloscope, £25; Linaglow sig. generator, £14; radio wave valve tester, £15; Ferranti testmeter, £7; 0-259 micro-ammeter, £2; 0-5 milliammeter, £2, 0-100 milliammeter, £2; all as new.—BM/TTB London. [5686

STABILISED power supply unit, comprising three independent outputs up 1,000v, 250 ma dc, 300v 5ma, different ac low voltages, bias voltages up 40v, etc., in black crinkle finished ventilated steel case, available in limited quantities.—Box 1308. [5768

AVOMETERS.—Model No. 7, £19/10; Universal Avominors, £8/10; dc Avominors, £4/4; B.P.L. signal generators, £21; c.w.o.; immediate delivery; bridges, valve testers, quick delivery; please state requirements.—Young, Radio Service, Southwick, Sussex.

FOR sale, Weston Analizer 772 (20,000 o.p.v.), Yankee valve voltohmmeter, Avo's, etc.; no fancy prices.—BCM/METERS, London, W.C.1. [5651

COMPREHENSIVE Mullard Universal test equipment as used by makers for all American and English types to latest 1.4v, includes 525 punched bakelite cards with data, quick push-button control, self contained for all possible radio tests; nearest offer £65.—Woodcroft, Merdon Ave., Chandlersford, Hants

FOR sale, thermionic voltmeter Moullin patt. D, Wheatstone bridge Gambrell, millivoltmeter Unipivot, Cambridge & Paul, and various multipliers for same; micro-ammeter, 0-15, Onwood; electrometer, Dolazalek; galvanometer, mirror; also a number of other electrical instruments; all these instruments are in very good condition; view by appointment after 7 p.m.—Wilson, 22, Ashcombe Ave., Surbiton, Surrey. [5789

DYNAMOS, MOTORS, ETC.

M.G. set, input ⅓hp 230volts, single phase, 50 cycles, 1,440revs, output 10volts 8amps dc; £10 or nearest offer.—Box 1364.

BATTERY chargers for home and export, 4 models 2-6-12v, 1, 2 or 4amp dc, any mains voltage; generous trade terms. Write for catalogue. Tel. Hoddesdon 2659.—The Banner Electric Co., Ltd., Hoddesdon, Herts.

ROTARY converters, E.D.C. 180 watts, 110v dc to 230v ac, £14; Crypto 300 watts, 220v dc to 230v ac, £17; Crompton 1,500 watts, 250v dc to 110v ac, £25; several others.—Harris, Strouds, Bradfield, Berks.

TUNER unit, 16-50, 200-550, 800-200, 3 valves, dial, etc, £6/10; ac/dc or ac output units, ac/dc, 4½ watts, 2 valves, £2/10; ditto, 4 valves, 8 watts, £3/15; power units, ac/dc, Barretter rectifier, £2/10; chassis to take 3 units, 6/-; speakers, 8in, 27/6; 6in, 24/-; sheet aluminium, 16g, 2/6 sq ft, cut to size; chassis made to order.— R. T., 64, St. Leonards Rd., S.W.14. [5796

NEW LOUDSPEAKERS

£5/18/6.—New Baker Super Quality 12in Auditorium permanent magnet speaker with triple cone, by Bakers Selhurst Radio, the pioneer manufacturers of moving coil speakers since 1925, wide frequency range, even response, ideal for quality reproduction, fitted with magnet, having exceptionally high flux density in the air gap suitable for public address equipment when quality reproduction is first consideration; send 2½d. stamp for leaflet giving details of above and constructional details of a new acoustic chamber designed to extend loud speaker frequency range.

£8/19/6.—New Baker super power cinema permanent magnet speaker with 18in triple cone of new design, giving wide frequency response free from objectionable resonances; speech is clear and natural and music is reproduced with exceptional realism; fine engineering job, extremely sensitive; ideal for public address equipment when power handling capacity, plus realistic reproduction, is required; prompt delivery per pass. train.—Bakers Selhurst Radio, 75, Sussex Rd., S. Croydon (Croydon 4226).

LOUDSPEAKERS, SECOND-HAND

12in Goodmans, £3/10; K12/20 Vitavox, £5/10.—R. K. Wilson, Alnwick. [5772

MAGNAVOX 66, 2,000Ω, rectifier; offers.—113, Hazel Rd., Huyton, Liverpool. [5713

VOIGT light twin, with rectifier; offers.—Pearson, Coupe Green, Hoghton, Preston.

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THE CDP recording machine, £25 complete; please write for details.—Bourne Instruments, Bourne, Lincs. Tel. 224. [5759

PRESTO, Junior, portable disc recorder, new condition, microphone, blanks, etc.; £85. —"Strathdee," Studley Rd., Torquay [5738

COILS for "W.W." tone control and filter circuits (Brierley & Hartley spec.), high fidelity, mic. line and output transformers; s.a.e. full list.—R. Clark, 30, Langland Cres., Stanmore, Middx. Wor. 5321. [5685

EXPERT non-metallic needles.—We have over twenty-five years' experience in the selection, grading and special treating of Thorn needles; for use in pick-ups; type A thick, type B thin, 3/- per 10, including purchase tax; sharpener, 7/4; guaranteed harmless to the record.

EXPERT GRAMOPHONE & RADIO, Ltd., Ingerthorpe, Great North Rd., London, N.2.

PROFESSIONAL recording equipment, MSS recording machine, 20watt amplifier, complete, £100, new, from stock; blank discs, etc.; full range Sound Sales equipment available, Garrard transcription motors and playing desks.—Liverpool Sound Studios, 83a, Bold St Liverpool [5348

HIGH grade amplifiers of special design for recording, modulation of transmitters, musical instruments, P.A. shortly available, push button operated automatic disc recording machines.—Recordomat Co., Ltd., 19, Exmouth Market, E.C.1 Terminus 7802-3.

STANDARD Telephones 4021 moving-coil mike, with table stand, condition perfect; best offer over £30.—Box 987. [5695

ADAPT your silent projector for sound, complete 16mm and 9.5mm precision-made sound heads now available for the following projectors: Pathe 200B, Bolex G, Bolex D, Kodascope C, easily attached in a few minutes; 9.5mm model £21, 16mm model £22/10, including P.E.C. exciter, lamp and full instructions; enquiries for other makes invited.
COMPACT 15-20-watt amplifier for use with above, £12/17/6, complete with case, ready for use; all sizes of speakers supplied; terms, c.w.o.—A. E. C. Cine, 9, Larbreck Av., Blackpool, Lancs. 5725

VALVES

HUTCHESON RADIO Cottingham Rd., Hull.
VALVES, thousands available, list prices; speakers, Rola 8in. 24/-, Celestion 6in 27/-; volume controls, 3/9, with switch 5/-; electrolitics, 8mfd 450v 4/6, 8x16x16mfd 450v 12/6; resistors, ½w 6d., 1w 1/-, 2w 1/6; spanners, King Dick, ring and adjustable.
SEND list for requirements; guaranteed service; terms, c.w.o., pro forma c.o.d. [5804

4 807 valves, new condition; offers.—Hattie, 76, High St., Johnstone, Renfrewshire.

OFFERS wanted for quantity of American Acorn valves, types 954, 955, 956, all unused.—Box 1107. [5751

1T4, 955, 9003, 25/- each; 807's, 20/- each, or offers; 6N7's, offers; all new, boxed and guaranteed.—Box 1110. [5752

1R5, 1T4, 1S5, 3S4, 25/- each; EF50, 12/10; RL16, 20/-, all unused; 6A3, 10/-; P625A, 5/-.—Box 1094. [5654A

ALL types of valves supplied, list prices, enquiries invited; voltage regulators, 150/50; gas gap protectors 991.—Alert Radio Co. 27, Temple Fortune Mans., N.W.11. Speedwell 4352.

COMPONENTS—SECOND-HAND, SURPLUS

VALUE! Matt has it.

SPECIAL offers, all new goods.
VOLUME controls (Centralab), less switch, 2/6; with switch, 3/6.
RESISTORS, ½ watt, assorted values, 4/- doz; 0.3 mains droppers, 3/9 ea.
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LINE cord, 0.3 amp (60 ohms per ft), 2-way 1/- yd. 3-way 2/- yd.
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YAXLEY type 2-way rotary switches, 5/-; tubular condensers, 0.1+0.1+0.1 (cans), 2/6; Resistances, brand new wire ended, ¼, ½ and 1 watt, assorted values, 30/- per 100; ¼ watt only, assorted values, 20/- per 100; ½ watt, 22/6 per 100.
SOUTHERN RADIO SUPPLY Co., 46, Lisle St., London, W.C. Gerrard 6653. [5903

UNIVERSAL ELECTRONIC PRODUCTS (G8UO), 36, Marylebone High St., London, W.1. Tel. Wel 4058.
WE stock a comprehensive range of the type of components essential to the needs of the amateur transmitter and experimenter, including meters, transformers, paxolin, polystrene, aerial equipment, Denco and Raymart products, etc. Send s.a.e. for lists.
OUR works, under the personal supervision of G8UO, are equipped to undertake the construction of all types of radio and electronic equipment, from an extension spindle or small chassis to a complete 500watt transmitter. We are practical people and amateur enthusiasts are always welcome—call in next time you are in town. [5852

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HEADPHONES. Single low resistance phone for circuit testing or house telephone, 60 ohms, bakelite case and cap, best British make, with headband and cord, **8/6.**

High resistance double headphones, as new, with headband and cord, type S.G.B. light weight, sensitive to crystal, **22/6**, delivery from stock.

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RELAYS. Below are some of the types we have available; send us your enquiries, we have large stocks all in new condition for immediate delivery. New Siemens Relays, 500 + 1,000 ohms, 2 makes, **10/-**; 2 makes 1 S.P.C.O., **12/6**; 3 makes 1 nreak, **12/6.** 500-500 ohms S.P.C.O., **10/-**; 200 ohms 1 break 1 S.P.C.O. slugged, **12/6**; 10,000 ohms S.P.C.O., **21/-.** Send for Special Leaflet. Relay Contact Assembly, thermal action, **12/6.** Siemens' High-speed Relays in heavy brass case, **£3/5/-.** Telephone type No. 6. 2-coil polarised, S.P.C.O., 6-volts 25 ma., 325 ohms, **8/6.** No. 1A, S.P. on-off, 2 volts 40 ma., **5/-.** Relay movements, 1,000 ohms, less blade and contact, **2/6.** Moving-coil relays by Weston, Elliott and Sullivan.

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AUTOPULSE PUMPS, 12 volt Petrol Pumps, in new condition, **35/-.**

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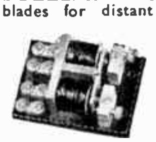

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Telephone : MACaulay 2159

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MAINS Trans 300-0-300, 110ma, 5v 2a,6. 3v 3a, 22/6; Electrolytics, 2mf 250v, 1/9; 4mf 350v, 2/-; 4mf 500v, 2/11; 8mf 500v, 3/3; 16mf 500v, 4/-; 32mf 250v, 3/6; 20mf 150v, 2/9; 20mf 50v, 2/-; 40mf 50v, 2/6; 200mf 12v, 2/-; 250mf 25v, 2/-; 500mf 12v, 2/6; Mansbridge Condensers, 1mf 350v, 9d.; 2mf 400v, 1/6; 4mf 450v, 4/-; 0.5mf 400v, 6d.; Mica, 0.0001-0.0005, 4d.; 0.002-0.007, 5d.; 0.01, 6d.; 0.01 2,200v Test, 9d.
SILVER Mica, 50-5000pf, 6d.; Tubulars, 0.01, 0.02, 0.05, 6d.; 0.1 350v, 7d.; 0.1 500v, 9d.; 0.25 500v, 9d.; 0.5 350v, 1/-; Resistors, ¼w 3d., ½w, 4d.; 1w 6d., 2w 10d., 3w 1/3, all values.

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ALL-WAVE superhet kit, 16-47, 200-550, 800-2,000 metres, a.v.c., high "q" i.f.s. ext. l.s. and p.u. sockets, 8in spkr., uses model 20 coil pack, fully aligned and tested, ac model, £12, ac/dc, £12/10.
MODEL 20 coil pack, aligned and tested, only 5 connections, 39/6; i.f. trans. 465Kcs, high "q," aligned and tested for gain, 17/6 pair; model 20 tuning heart, fully assembled, with 3 valves, £6/15/10; handsome tuning scale, glass, esc., and s/motion drive for above, 12/6; amplifier kits, really well-designed, ac models, 6watt, £7, 12watt, £11; ac/dc, 5watt, £7, 15watt, £12; tuning units, 3w/band s/het type, assembled cpte. with valves, ac or ac/dc, £6/17/6; TRF type, two med. wave stations only, high fidelity design ac or ac/dc, £6; other kits available, send 1d. for lists, circuits and tech. desc. for any above, 2/6; post trade only at present, send c.w.o. if possible—saves clerical work, orders over £5 post free, no c.o.d. under £2.

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HENRY'S RADIO & ELEC. COMPONENTS, 5, Harrow Rd., Edgware Rd., London, W.2. Pad. 2194. Hours: 9.30-6 o'clock Mon.-Sat., Thurs. 1 o'clock.
T.C.C. and B.I., 8mfd. 500v wkg., 3/-; 8x8mfd. 500v. wkg., 6/-; metal rectifiers, input 200-600v, output 300ma, 30/-; 4mfd. 1,000v wkg., 7/6 each; oil-filled 1mfd. 1,000v wkg., 3/-; oil-filled 2-gang 0.0005 standard condenser, with trimmers, 12/6; 4-gang 0.0005 standard condenser, 10/-; Amphenol valveholders, 4-, 5- and 7-pin, English and Mazda Octal, Int. Octal 4- and 5-pin U.X., 9d each, 7/6 doz; T.R.F. M and L wave, with reaction, 8/6 pr. with circuit coils; T.R.F. med. wave coils, 5/- pr. with circuit; i.f. transformers, standard 465k/cs, iron cored, 15/- pr.; standard 110 k/cs, small cans, air-spaced trimmers, 12/6.

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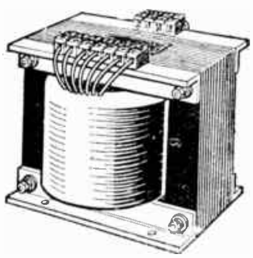

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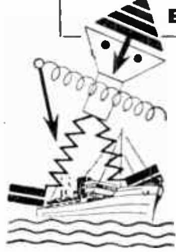

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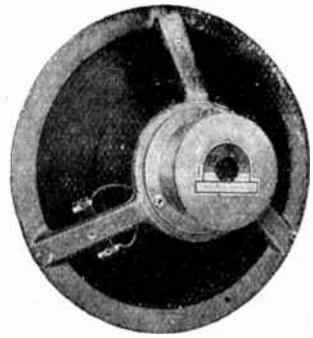

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