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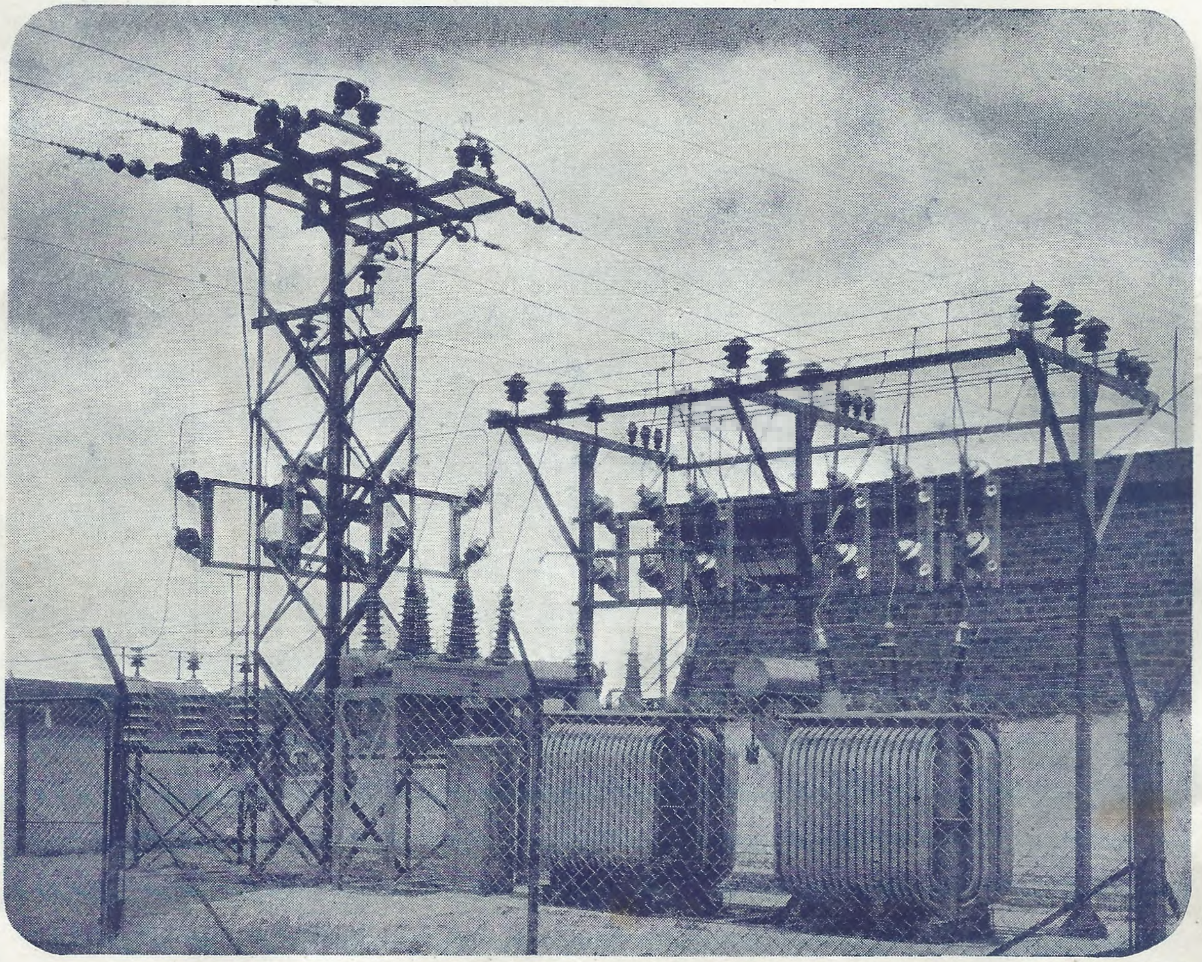
DECEMBER 1941



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No: 1074 Vol. XLVII No. 12

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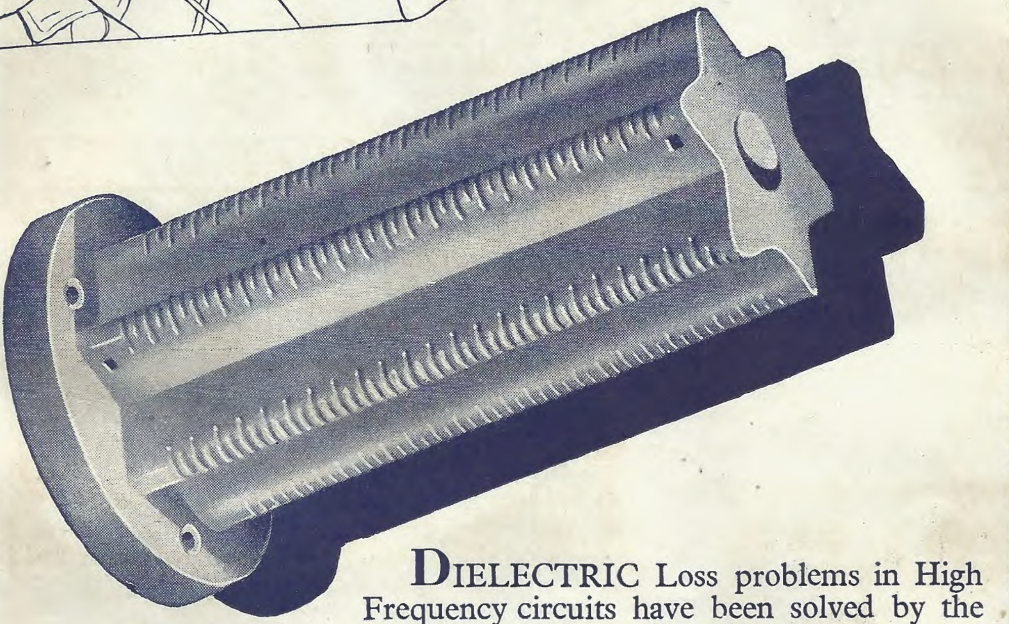

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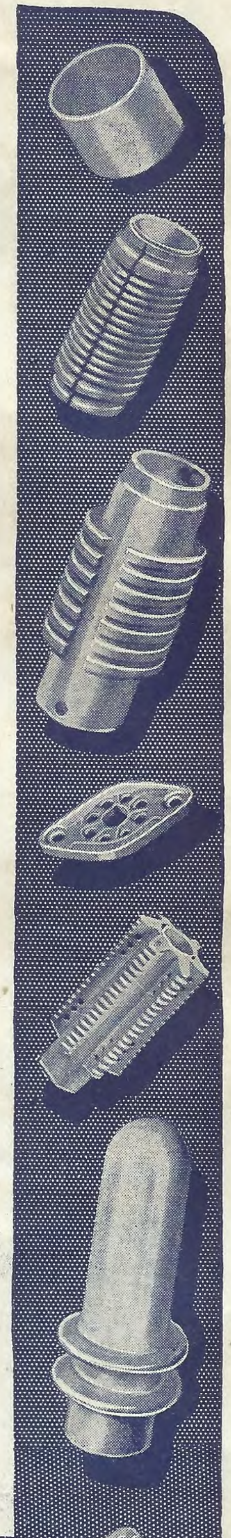

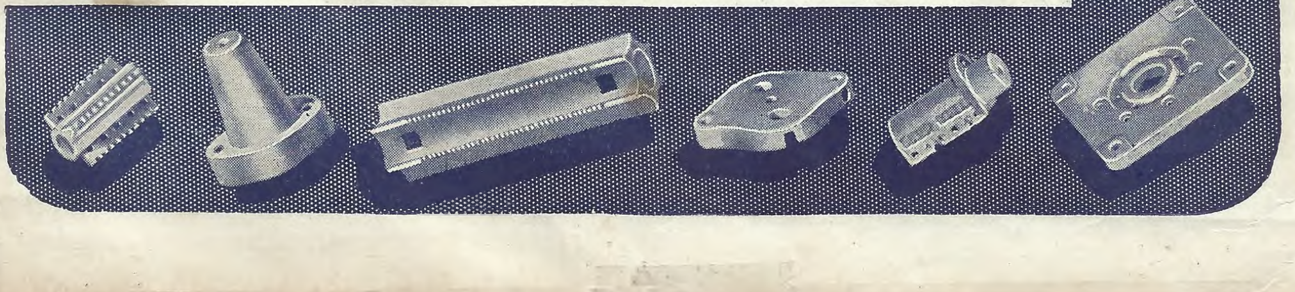

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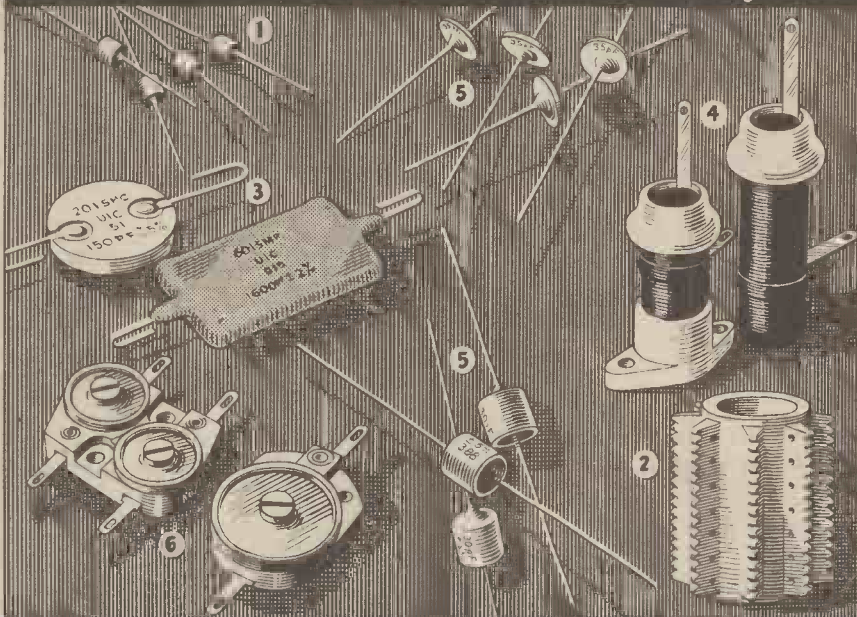

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C 100/400	100 MA	20-34 H	400 ohms	10/8
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See also our Classified Advertisement, page 19.

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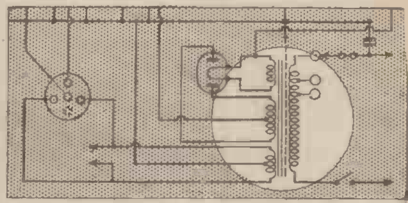

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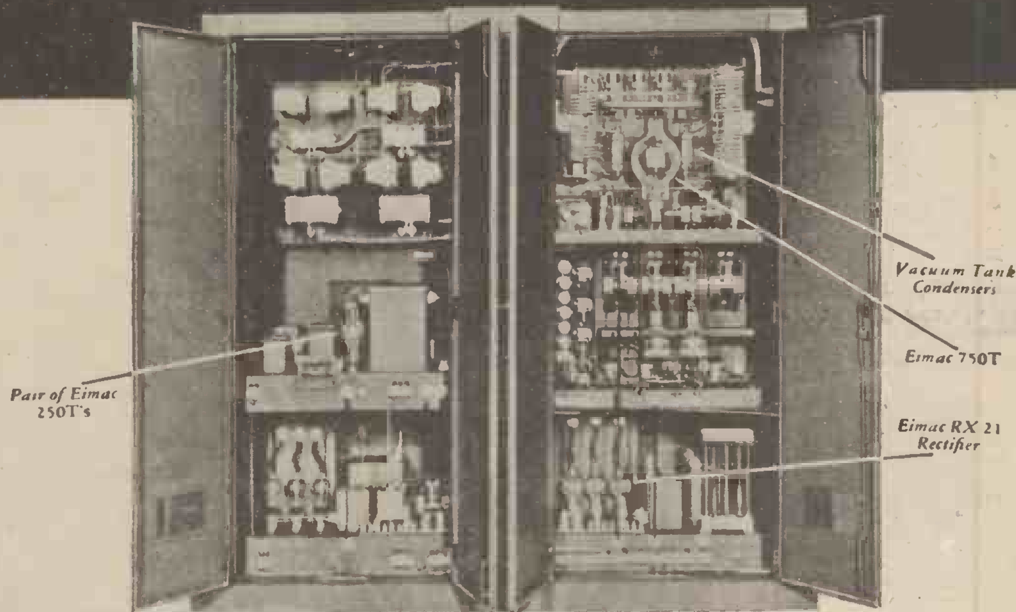

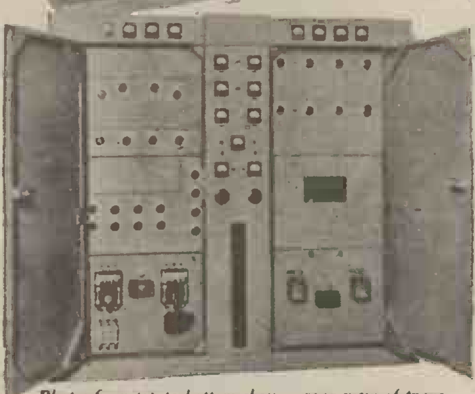

Photos from top to bottom show a rear view of transmitter, the remote control and a front view of the transmitter constructed by Maya Rebello & Comp. of Rio de Janeiro for the Brazilian army

With a single 750T in the final stage and a pair of 250T's as modulators this station puts 1200 watts on the antenna. Operated by remote control on four frequencies using phone, CW and ICW.

The transmitter was constructed by Maya Rebello & Comp. of Rio de Janeiro and employs Eimac RX 21 rectifier tubes as well as Eimac vacuum tank condensers in the final circuit. The design and construction does credit to its makers and the use of Eimac Tubes in the most important sockets is convincing evidence of their superiority and position in the world of radio.

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The Wireless World

31st Year of Publication

Covering Every Wireless Interest

DECEMBER 1941

Proprietors :
ILIFFE & SONS LTD.

Editor :
HUGH S. POCOCK.

Editorial, Advertising and Publishing Offices :
DORSET HOUSE, STAMFORD STREET, LONDON, S.E. 1.

Telephone: Waterloo 3333 (35 lines)
Telegrams: "Ethaworld, Sedist, London."

△

PUBLISHED MONTHLY
Price : One Shilling
(Publication date 20th of preceding month)

Subscription Rates Home and Abroad 14/- per annum

Branch Offices :

COVENTRY:
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Telephone: Coventry 5210.
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The
Wireless World

COVERING EVERY WIRELESS INTEREST

ESTABLISHED 1911

Vol. XLVII. No. 1074 DECEMBER, 1941 Price One Shilling

Amateurs and Professionals

Should Post-war "Experimental" Transmitters Know Morse?

JUDGING by our correspondence, those whose interest lies in amateur transmission are more prone than any other section of *Wireless World* readers to making plans for the post-war era, and the time when they can resume their hobby. Of the many problems that have been discussed in our columns, none has aroused more interest than the question "Should Amateurs Know Morse?" Before attempting to find the right answer, it seems necessary to clear away a misconception that has tended to obscure the real issue.

What we and our readers describe as "amateur" transmission would officially be known as "experimental" transmission. Theoretically at least there is no basic difference, as regards the G.P.O. machinery for licensing, between (a) an experimental station set up by a great wireless company for the investigation of some vital problem by a highly trained team of engineers, and (b) the station of an amateur whose sole interest (whatever he may say on his application form) lies in achieving long-distance communication. Real experimental work and the "hobby" side of transmission must be divorced from each other before we can think clearly on any of its problems, including the present one.

Everyone expects the number of amateur transmitters to increase greatly after the war, and one of the strongest arguments adduced by those who think they should know morse is that, in a given frequency band, there is room for more CW than 'phone stations. That the amateur who knows morse can, with a given power, communicate over much longer ranges and make more contacts will also not be disputed.

Another telling argument is that morse helps to overcome the language difficulty, thus enabling amateur radio to play its part in fostering international friendship. The pronunciation difficulty disappears, and it is a fact that operators of different nationalities do manage to exchange ideas with little trouble, thanks in part to the use of an international jargon of abbreviations and codes, some official and some highly unofficial, that has gradually come into being. It is also urged that, in the case of emergencies and the breakdown of other forms of communication, messages can be handled better by telegraphy than telephony; that is certainly true if the operating is good.

Officialdom holds that amateurs should know morse in order to understand signals from government and commercial telegraph stations with which they may be interfering. In spite of one correspondent having brought forward specific instances of such uses of morse, we are not convinced that this argument is sound; it seems to date back to the days of spark transmitters and broadly tuned receivers. It would be more useful to insist that the amateur transmitter could be reached through the land-line telephone by a G.P.O. control centre.

Those who object to the morse qualification do so mainly on the grounds that it may prevent well-qualified scientific workers from obtaining a licence, though others adopt the somewhat negative attitude that telegraphy, as opposed to telephony, is a crude and technically uninteresting method of communication.

Nothing in Dispute

When the controversy started we remained neutral. Now, after reading carefully all the arguments on both sides, one comes to the conclusion that there is really nothing at issue between the apparently opposed schools of thought. The answer, then, to the problem that has been intriguing our correspondents seems to be clear. Amateurs—using that word in its true sense—*should* know morse, or they will miss something of what amateur radio has to offer them. Professional research workers, or others qualified to carry out serious investigations, need not. It has been argued that without knowledge of morse they cannot observe the common courtesies of non-interference within the experimental bands. But that is surely a difficulty that could be overcome by suitable channel allocations.

The same applies, more or less, to a hypothetical third class of transmitters—true amateurs who wish to confine themselves to telephony. There seems to be little reason why they should not be allowed, subject to rather drastic safeguarding regulations, to work in strictly limited channels.

Broadcasting Over the Mains

"Wired Wireless" Distribution Over Electric Supply Networks

By P. P. ECKERSLEY, M.I.E.E.

In this article the former Chief Engineer of the B.B.C. explains the technical means of putting into effect a project in which he has long been interested

ONE must assume that the object of a broadcasting service is to interest—which is also amuse—the listener. But there is no such person as *the* listener; the public is composed of all sorts of listeners with varying tastes and prejudices, so, in order to amuse "all of the people all of the time," broadcasting must cater for widely different tastes. It can only do this by simultaneously offering the listening public a large number of programmes to choose between. The listener should be able to listen "*à la carte*"; at present the poor chap has to "take the dinner."

It is not possible to give a multi-programme service by radio because of the limitation of channels. True, one can "hear" lots of stations, but they all send the same type of programme. There is no continuous service of jazz, talk, symphony, light music, plays or whatever there could be if there were enough channels.

If wires rather than wireless waves were used to link the listener to the programme source, theoretically, any number of channels are available for the diffusion of any number of programmes. Obviously, carrier transmission would be used; transmitters would send their output into the network. Receivers, physically connected to the network, would be tuned to this programme or that. It is a radio system which does not radiate? Therefore, the carrier frequency separation can be ideal for high-fidelity reproduction, the signals strong enough to overcome any noise, and the receiver robust and simple.

Existing Wire Networks, or —— ?

A national service of wire broadcasting demands the existence of a conducting network interconnecting every house in the kingdom. This network could be constructed anew to form the basis of a "general communication" system, or the existing telephone and "electric mains" networks could be employed by superimposing carrier currents.

Sooner or later—later, if we go on being stupid—a new network will be constructed. It is within the bounds of possibility that this could be designed to diffuse a large number of sound and vision programmes as well as being used for the private telephone system. The superimposition of facsimile would print newspapers and periodicals in peoples' homes and give a written message and telegraph service—all on a pair of wires! At present the idea is not feasible—"it would cost too much"—that is to say, it would cost three weeks' present war expenditure and earn a turnover around the hundred-million mark.

A start could be made by using existing networks to transmit, say, six sound broadcasting programmes. My friend and colleague, R. E. H. Carpenter, and I started, in about 1930, to see if the electric mains network could be used to distribute a broadcasting service. Obviously, the idea was based on using carrier currents which, of much higher frequency than the mains currents, could be injected into and picked off the network by the use of very simple filters, rejecting the 50-cycle currents and passing the high-frequency currents.

The mains network has an intrinsic advantage in that in this country it reaches five households where the telephone is only installed in one. Otherwise, I should guess that the telephone wire broadcasting system presents fewer problems.[1] The attenuation of the telephone pairs is less than that of a buried mains cable, and each telephone pair can be ideally terminated. The mains networks are interconnected in a complex manner, and have variable terminations. Nevertheless, if these problems of adapting the mains network, formidable as they appeared to us when we started, can be solved, the paramount advantage that the mains reach far more households remains.

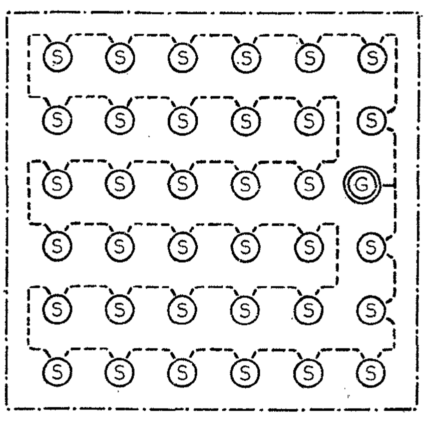


Fig. 1. Diagrammatic representation of layout of sub-stations and ring main.

The Transmission System

We think we have solved these problems. I propose to give a very general description of the system which has been perfected for transmitting broadcasting programmes over the electric mains. The system is applicable to the great majority of systems typically in use in this country for urban and suburban domestic electricity supply.

Before describing the broadcasting system it is necessary to explain the fundamentals of a typical supply system. This will be easier by reference to the diagram of Fig. 1. This is formalised. The dash-dot line represents the boundaries of a "supply area"—a London borough, a provincial town, or what would you? A dotted line represents a so-called "ring main," which, buried underground, weaves its way over the area, touching sub-stations S as it goes. It is energised from a source of power—the grid or a generating station—at G. The ring main carries power at voltages ranging between 6 and 33 kilovolts, and distribution is by "three phase."

Each sub-station contains a transformer, its primary energised from the ring main, the secondaries being connected to the street cables which take the supply from the sub-stations to the consumers' houses. The street cables, as shown in Fig. 2, run out from the sub-station, under and along the streets. The cables, as is seen from this typical picture, are intercon-

[1] Technical details of the Post Office project for broadcast distribution over the telephone system were published in *The Wireless World* for September, 1940 [Ed].

connected. The shape of the network is determined purely by the run of the streets. Branch feeders, not shown, run from the street cables into the houses lining the streets.

Fig. 3 shows the schematic connections of a sub-station. The power distribution system is shown in full lines, the added connections, necessary for injecting the carrier currents into the street cables, in dotted lines. Only one outgoing cable and the secondary windings of only one power transformer is shown, it being understood that there may be many street cables and several transformers. The primary of each transformer is energised from the higher voltage brought by the ring main. The potential points Ph1, Ph2, Ph3 (Fig. 3) produce voltages 120 deg. out of phase with one another, and from 200 to 240 volts above the "star" or "neutral" point N. This is at zero potential, and earthed at the sub-station, but, deliberately, nowhere else on the network.

Any number from two to fifteeen street cables may run out from a sub-station. Each cable contains four copper conductors. These are laid in insulation. The insulation is wrapped

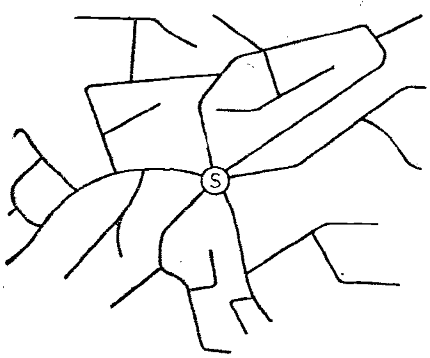


Fig. 2. Hypothetical layout of street cables.

in a lead sheathing S and this in turn has armouring outside it. The lead sheath plays an important part in the carrier current injection scheme and is, therefore, shown in the diagram. Armouring is not shown.

The three phases Ph1, Ph2 and Ph3 are connected to these cable conductors and the fourth conductor is joined to the earthed star or neutral point. The lead sheaths of all the cables are bonded together and are also bonded to the branch cables which connect the house wiring to the street cable conductors.

Fig. 4 indicates how the houses get a supply. Branch feeders, having a lead sheath but only two conductors, are joined between any one-phase wire and neutral. But to distribute the load evenly between phases, different houses are joined to different phase wires. In effect, a third of the houses are fed from one phase and neutral, a third of the houses from another phase and neutral, and the remaining houses from the remaining phase and

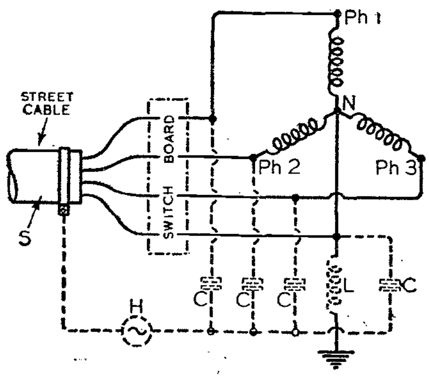


Fig. 3. Method of injecting radio-frequency currents into the supply network at a sub-station.

neutral. Thus the neutral goes into every house and any one phase into a third of the houses. Each house thus has a single-phase supply.

It will be appreciated that, so to speak, a network of copper and a network of lead bonded together joins groups of houses, anything from 300 to 1,000 in common practice, to a given sub-station. The basic idea underlying our method of carrier current superimposition is to treat all the copper conductors in the street cables as one conductor and all the lead sheathing of the cables as the other conductor. This forms a two-conductor transmission line. Thus, so far as the carrier current system is concerned, we have got to bunch all the copper conductors together at the sub-station. An outright physical connection of these conductors would short-circuit the mains. But if condensers of large reactance to the power current (of frequency 50 c/s) but small reactance to the carrier currents (the lowest frequency of which is above 20,000 c/s) are joined from each phase and the neutral conductor to a common point, then this point taps all the copper conductors in parallel. One terminal of this bunch point is used to form one conductor of a transmission line for the carrier currents, the other terminal being the cable sheath.

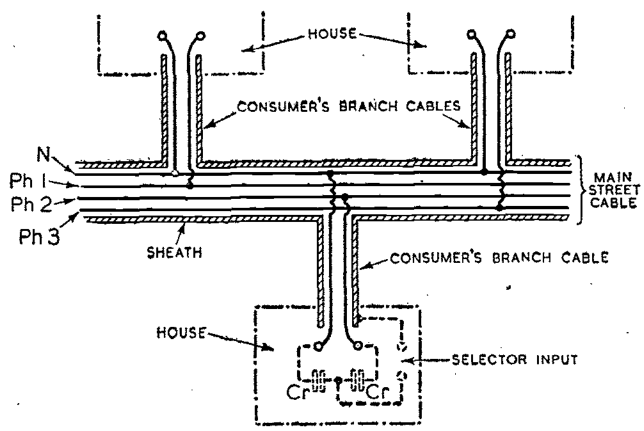


Fig. 4. How current from main street cable (shown in section) is fed to consumers' houses. The connection for a "selector," or mains broadcast receiver, is also shown.

This is illustrated by the dotted lines in Fig. 3. Through the four condensers, C, all the coppers are joined in parallel to one terminal of the carrier current generator H. The other terminal of this generator is joined to the cable lead sheath.

Isolating the Neutral Wire

It is the object of the scheme to raise all the copper conductors to the same carrier potential. It would not be possible to raise the carrier potential of the neutral conductor to the same potential as the phase conductors unless the neutral earth connection were interrupted by a choke L. This is designed to have a high impedance to the carrier currents, but virtually zero impedance to the power currents. Thus, so far as the power system is concerned, the neutral remains earthed, but in respect to the carrier currents the neutral is insulated from earth and can be raised to the same potential as the phase conductors.

Once this is done, then, clearly at any point on the network all copper conductors have the same carrier potential. Since the domestic load (lights, cookers, refrigerators and so forth) is connected between any one of the phase conductors and the neutral, obviously there is no difference of carrier current potential across the load. So the load may vary between an infinite and virtually zero impedance without disturbing the level of

Broadcasting Over the Mains—
the carrier currents thus superimposed.

Apart from the advantage that, with this method of carrier current injection, there is no necessity to fit an automatic gain control circuit in the house receivers, the scheme has the further merit of minimising "noises" developed across and by the load.

Because, as is seen from the dotted lines in Fig. 4, showing the connections for energising a house receiver in one house by the carrier currents, one terminal for the input to these receivers is found at the junction of two condensers *Cr* connected between phase and neutral. Any disturbances created on the mains containing components in phase opposition develop no voltage at the junction of the condensers. The majority of disturbances are phase opposed and so are not heard as interference noise.

"Selectors"—not Receivers

We like to call the house receiver "a selector" so as to underline the fact that it has few of the vices of a "wireless." It is energised as to its high potention point as described. Its earthy terminal must be joined, in effect, to the lead sheath of the incoming cable. The input impedance of the selector is purposely made very high. Thus if the path between the earthy terminal of the selector and the lead sheath is of high resistance, but lower than the selector input impedance, signals will not be diminished by this high resistance. Thus the earthy terminal of the selector may be connected to the third earthed pin of a three-pin power socket. If this is not provided, then the steel conduit in which the house wiring is run can be used. In the rare cases where cab-tyre two-conductor wiring is used an earth has to be found as for a wireless set.

It is insisted that, so far as the transmission system is concerned, the return is *not* an earth return, albeit the return conductor is earthed. The transmission line proper—the bunched coppers and the lead sheath—is a concentric cable, and the currents (which may be of the order of one or two amperes because the system is of very low impedance) flow only on the outer surface of the copper and the inner surface of the lead. These currents do not flow, in sensible quantities, in the high-impedance house wiring, nor into the high-impedance selectors; they exist to establish a potential on the low-impedance carrier network.

This rather long, but necessarily long, description, shows how, given a carrier current generator in a sub-station, all the houses fed from that sub-station can be given a programme supply. A thousand houses, at maximum, are fed from one sub-station; the average is more like five hundred. Thus, in order to cover an area, means must be devised to get a carrier current supply to each sub-station.

It would be wasteful to install separate transmitters in each sub-station. Thus our idea is to use repeaters in each sub-station which take a low-level supply from all the transmitters, located at some chosen point in the area, and amplify this to a value suitable for injection into the network. In fact, we require a scheme exactly similar to the power supply scheme illustrated in Fig. 1. That is to say, we want a pair of wires which follow the route of the ring mains, or at any rate which touches all the sub-stations, and which can carry the output of all the transmitters, each sending out separate programmes. This pair of wires must be tapped on to at the sub-station by the repeater input terminals.

Thus one method to achieve this would be to install all our transmitters at G in Fig. 1, energise the ring main with the carrier currents output from the transmitters, and tap the ring main on to the repeaters at each sub-station. But this presents difficulties. Kilovolts with thousands of kilowatts behind them terrify me, for one thing. Then the ring main has protective gear in its circuit which would impede the carrier currents. Condensers for by-passing the sub-station transformers would cost a lot of money and might break down. Power engineers hate one touching their sacred HT mains!

Using Inter-station 'Phone Lines

It is common practice to run ordinary telephone pairs in the same ducts which carry the ring mains. These are used by the engineers for talking from sub-station to sub-station and/or for operating protective gear. Since our currents are of super-audio frequency, we can use these pairs, even if they are being used to carry audio currents, to carry the high-frequency output from one set of transmitters—unique to the system—and distributing this combined output to the sub-station where it is picked up by the repeaters.

Thus, in sum, the basic conception is to install transmitters—as many as there are programmes to be supplied—at some point in the area and to take their combined output on a telephone pair to all the sub-stations in the area. In each sub-station, repeaters, giving equal amplifications to all the frequencies in the complex representing the several modulations of the several transmitters, each having a different carrier frequency, amplify the combined disturbance and feed it into the street cables at a suitable level and according to the scheme previously described.

The reader will, I am sure, appreciate a certain reluctance on my part to give a much more detailed description of a scheme which, owing to the blocking of vested interests, has never had a chance of being put into practice. One must still hope that some happy day we shall be allowed to see if it all works our commercially as well as it has, in demonstration, technically.

Meanwhile the following more quantitative information may be of interest.

Some Data

The power required per programme, per typical street cable, is of the order of 1 watt. The impedance per typical street cable varies, if not terminated, between 0.5 to 1.5 ohms, and is usually inductive. Thus the current per programme is of the order of 1 ampere per cable. A cable, a watt, an ampere, an ohm is a good rough guide!

We use carrier frequencies, for a six-programme system, of 26, 39, 52, 65, 78 and 91 kc/s. These are, in fact, derived from the harmonics of a master oscillator having a frequency of 13 kc/s. If the carrier frequencies were not thus "cogged"—if, in other words, each transmitter had a separate drive—the peak voltage of the combined equal output of all transmitters would be six times the peak voltage of one. This would require a repeater dealing with 36 times the power of one programme. By cogging the frequencies the peak voltage of the combined disturbance may be adjusted so that the repeater power is only a little more than six times the power required for one programme.

The lowest "house voltage" on a typical network energised by powers of the order given above is about 300 millivolts. This gives the required signal-to-noise ratio.

We have demonstrated a selector giving noiseless reproduction when plugged into the same socket as was being used to operate a flashing neon sign. We laugh at vacuum cleaners, refrigerators, light and power switches, and so forth.

The transmitters are designed on the asymmetric sideband principle. This has been discussed in published papers. Suffice it to say that we get a "level" audio output up to 8,000 c/s from the very simple and cheap selector, with a carrier separation of 13 kc/s. The extra harmonic distortion introduced by the asymmetric principle is of the order of 2 per cent. at 1,500 c/s; less at zero or other frequencies.

Our object has been to make the selector (house receiver) cheap to manufacture, easy to operate and pleasant to listen to. The superheterodyne principle is used and there are two stages, one a frequency changer, the other a combined second detector and output valve. The maximum "undistorted" power output is 2 watts; quite enough (too much?) for an average room.

There are two filters; one preceding, the other following, the frequency-changer valve. The first filter deals with the signal-frequency currents and has settings to give it the same band width of response over the six bands of frequencies representing the six programmes. The filter following the mixer and dealing with the intermediate-frequency currents has, as in common practice, a constant performance.

The user has no fine tuning to do. A rotating switch is provided which clicks into any one of six positions. Only when the click mechanism registers can the programme be heard. Thus no mistakes can be made; the filters are designed to give their correct responses at the given setting. This exact design is made feasible because the carriers are, compared with radio practice, of much lower frequency. The minimum ratio of maximum side band to carrier frequency is (say) 99 to 91 = 1.09 in the wire broadcasting system, but is 1,000,000 to 1,005,000 = 1.005 in average radio practice. This makes filter design for the carrier current scheme ever so much simpler.

The quotations we have had for manufacturing the selector in quantities shows that the cost is far less than for a radio receiver of comparable performance. But what can a radio receiver give, in variety of choice of programmes with clear reproduction—considering the carrier separations and relative levels—compared with a wire broadcasting system such as I have attempted to describe?

Wireless Engineering

Sir Noel Ashbridge's Review

IN his inaugural address as president of the Institution of Electrical Engineers on October 23rd, Sir Noel Ashbridge, B.Sc.(Eng.), who is Controller of Engineering of the B.B.C., stated that he felt the added responsibility of being the first representative of a new public undertaking to hold the office. Sir Noel, who is in his fifty-second year, has been with the B.B.C. since 1926. Immediately prior to that time he was at the Marconi Company's experimental station at Writtle, Chelmsford. He was knighted in 1935.

As is customary for the president, he dealt with the subject on which he has specialised for many years, and in doing so treated the subject as a general engineering one. He gave a very comprehensive review of the whole field of broadcasting in this country, "avoiding the more detailed and highly specialised questions." The international wavelength situation and its effect on this country was very thoroughly covered. Short reviews of the television and overseas services were also given. It was interesting to hear Sir Noel state that the expenditure on the London television service was, in effect, 30 times greater than would have been covered by a special licence fee of ten shillings from viewers.

He made some interesting observations concerning engineering training in his concluding remarks. "It has sometimes occurred to me," he said, "that the methods used in the medical profession to train students might be applied to engineering. Here, I believe, lectures and clinical work proceed side by side after the first two years or so. One might almost visualise the equivalent of clinical work, which is, I think, the right term applying to explanations of practical problems—so to speak—on site. This, of course, is not a new theme, . . . but a complete separation between theoretical and practical training is still common." Visualising that large numbers of war-trained students who have been through short courses and prematurely rushed into industry, "to meet exceptional demands which cannot possibly continue for long after the war," will have to be absorbed into peacetime activities as nearly allied to their wartime employment as possible, he suggested that some scheme of parallel factory and college work will be necessary if such men are to be capable of equipping themselves for higher posts while still supporting themselves. He pointed out that if nothing is done there will be a large number of unemployed and part-trained men attached to the industry, who will constitute a problem for years to come.

So far as frequency modulation is concerned, Sir Noel suggests that the advantage of frequency modulation may be exploited in connection with television services, since in most countries there are no commitments with regard to television systems.

"No thoughts on the work which should be undertaken in relation to broadcasting after the war would be complete without including the outstanding question of television," stated Sir Noel. "There will be the obvious necessity of a rapid restoration of the service, but it cannot be assumed that this should be immediately restarted without regard to the lapse of time which has taken place. It cannot even be assumed that the same fundamental standards of definition should be adopted. Not many budding industries in the nature of a public service have had the advantage (some people might say it was a disadvantage) of making a new beginning after two or three years of regular working, and it is hoped that the fullest advantage will be taken of this almost unique position."

Choosing Replacement Valves

An Official List

MANY valve types are scarce, and so, to assist in the choice of suitable alternatives, the British Radio Valve Manufacturers' Association has prepared a list of equivalent and "preferred" types.

This list, which has now been issued by *The Wireless World* in booklet form, costs 1s. through newsagents or booksellers. Direct from our publishers, by post, the cost is 1s. 1d.

Aerial Coupling

Which is the Best Circuit for All-round Efficiency?

By S. W. AMOS, B.Sc. (Hons.)

Attention to the design of the aerial coupling is worth while in all types of receiver, but is especially important in small, economical sets if an adequate performance is to be obtained. The article discusses the merits and shortcomings of well-known types of aerial coupling

A GOOD aerial coupling should give the best possible amplification and selectivity at all settings of the tuning condenser, should not unduly restrict the waverange of the circuit, and should be such that the readings of the tuning condenser are substantially the same no matter what the constants of the aerial system.

Any aerial-earth system contains inductance, capacity and resistance, and accordingly Fig. 1 (a) has the theoretical equivalent shown in Fig. 1 (b), where V represents a generator of alternating potential. This forms a series tuned circuit with a resonant frequency, the value of which is dependent upon the shape and size of the aerial system, and hence the amount of inductance and capacity present. Typical values for L, C and R for an average outdoor horizontal aerial are 20 μH, 200 $\mu\mu$F and 50 ohms respectively, giving a resonant frequency of 2,516 kc/s (119 metres).

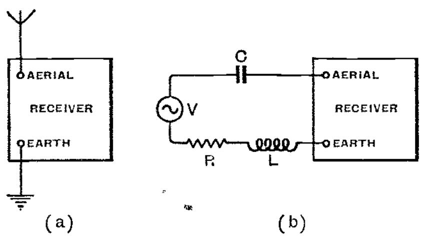


Fig. 1. The characteristics of any aerial-earth system (a) may be simulated by a series resonant circuit (b) in which the value of L, C and R are appropriately chosen.

These values of L, C and R will be used in some of the subsequent calculations.

In the early days of radio a type of aerial coupling frequently used is that illustrated in Fig. 2 (a), from which it can be seen that this is the simplest possible method of connecting an aerial to a tuned circuit. The theoretical equivalent of the circuit is given in Fig. 2 (b), from which it is clear that the aerial capacity C is effectively in parallel with the circuit L_1C_1. If C_1 has the usual maximum value of 500 $\mu\mu$F and if C is 200 $\mu\mu$F, then the greatest possible variation of capacity in the tuned circuit is from 200 $\mu\mu$F to 700 $\mu\mu$F, i.e., an increase of 3.5 times. The ratio of maximum to minimum wavelength receivable depends on the square root of this, and is hence 1.87, a value which might have some application in long wave circuits, and it would permit reception over a range of 1,070-2,000 metres, but which would be very inconvenient for general use on medium and short waves, where we want a value of 2.75 at least. It is clear, too, that the dial readings of condenser C_1 will depend on the constants, chiefly the value of C, of the aerial-earth system.

The selectivity of this system is very poor indeed. This, of course, was of no consequence in the early days of broadcasting. This simple aerial coupling thus has many disadvantages, but it should not, therefore, be assumed that the method is obsolete and completely useless, for it has an application in simple receivers used purely for high-quality reception of local stations. Here the good amplification is useful, and the lack of selectivity is an advantage, as it permits good reproduction of the sidebands and, if the receiver is insensitive and close to the transmitter, there is no possibility of interference from stations of neighbouring frequencies.

The first step towards improving the selectivity of the arrangement in Fig. 2 was made when a fixed or variable

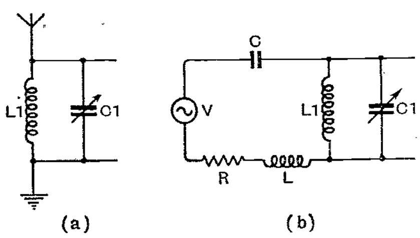
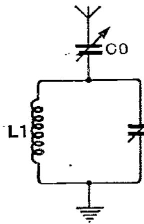


Fig. 2. The direct-coupled aerial circuit (a) has the theoretical equivalent given at (b).

condenser Co was introduced into the aerial lead as shown in Fig. 3. Theoretically this simply reduces the effective value of the aerial capacity C, and the practical consequences of this are an improvement in selectivity and an extension in waverange. Moreover if Co is very small compared with C the dial readings will be independent of the constants of the aerial. Many such condensers were, and still are, marketed in impressive boxes, and all sorts of fantastic claims—and charges—were made for them.

Fig. 3. The introduction of a small series condenser Co in the aerial lead will improve waverange and selectivity at the expense generally of amplification.



Suppose we wish to calculate approximately the value of Co which will permit reception of the medium waveband 200-550 metres. The capacity variation needs to be 7.56 : 1 (i.e., $2.75^2 : 1$). Neglecting stray capacities, we can see that this variation is possible when $\text{Co} = \frac{500}{7.56 - 1} = 80$ $\mu\mu$F approximately. Since strays may account for some 30 $\mu\mu$F, a smaller value, say 50 $\mu\mu$F, should be used in practice. Two 0.0001 μF condensers in series will give this value.

The variation in amplification at various frequencies given by such a circuit as this is shown in Fig. 4, in which curve (a) applies to the circuit of Fig. 2, and curve (b) applies to that of Fig. 3, the series aerial condenser being taken as of 50 $\mu\mu$F capacity. The effect of the condenser is to move the peak considerably towards the high frequency end of the spectrum, so much so, in fact, that it does not fall within the range of medium waves at all. As a consequence, the amplification over the medium-band range is reduced.

The effects of aerial capacity are particularly marked in the case of short-wave circuits. Consider such a circuit which includes a coil of 8 μH inductance, and a parallel tuning condenser of 100 $\mu\mu$F maximum capacity. Allowing 4 $\mu\mu$F for valve capacities and 7 $\mu\mu$F for the minimum capacity of the tuning condenser, by application of the formula $\lambda = 1885\sqrt{LC}$, the waverange can be shown to be 17.7 to 54.4 metres, which includes most of the interesting short-wave transmissions. If a normal outdoor aerial is connected directly to such a circuit according to the circuit of Fig. 2, the tuning capacity is just "swamped," and recourse to $\lambda = 1885\sqrt{LC}$ again shows that the tuning range obtained is 78 to 92 metres, which does not include any of the desired band! If we do not wish to disturb the calculated waverange unduly the circuit of Fig. 3 can be used, and, if we decide to include the 19-metre band, Co must not exceed 2 or 3 $\mu\mu$F. Capacities as small as this can be made by running two pieces of wire about 20 S.W.G. in Systoflex sleeving parallel for an inch or so. This calculation shows very convincingly the need of an aerial with a very low capacity for use on the short waves. A short vertical rod answers this requirement well. The series condenser method of aerial coupling is not, however, well suited to use on short waves and some of the methods which follow are instead recommended.

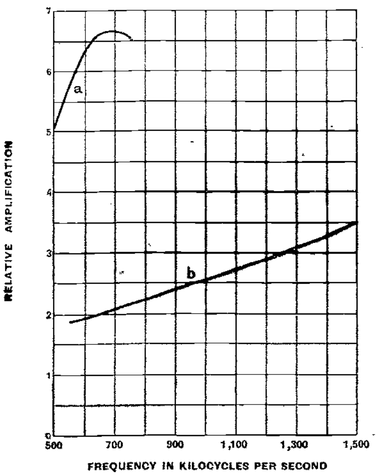


Fig. 4. Experimental curves showing the variation of amplification with frequency of a medium-wave coil of 157 μH inductance in parallel with a variable condenser of 500 $\mu\mu$F maximum capacity (a) with an average aerial connected directly to the high potential end, and (b) with a series aerial condenser of 50 $\mu\mu$F. For both curves the projection on the frequency axis gives the waverange covered by the circuit.

Another method of increasing the selectivity of the circuit of Fig. 2 is by connecting the aerial to a tapping point on the coil, as shown at Fig. 5 (a), the theoretical equivalent of which is given at Fig. 5 (b). This has the practical consequences, as before, of effectively reducing the capacity due to the aerial, which is thrown across the coil, and so improving the waverange coverage and the selectivity. It is a very simple matter to calculate roughly the capacity "reflected" into the tuned circuit L1C1. If the

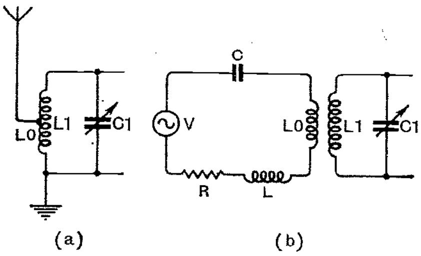


Fig. 5. Another method of improving the performance of the circuit of Fig. 2 is by the use of the tapped aerial coil shown at (a). The theoretical equivalent is given at (b).

"tapped" part of the coil Lo contains $\frac{1}{k}$ of the total number of turns on the tuning inductance, then the "reflected" capacity is $\frac{C}{k^2}$. Thus if L1 has 60 turns, and the aerial is attached to a point 20 turns from the earthy end, and if the aerial capacity is 200 $\mu\mu$F, then the capacity effectively in parallel with the tuning system is $\frac{200}{9}$, or 22 $\mu\mu$F. By increasing k sufficiently, it would appear that selectivity and waverange could be improved indefinitely, but in practice it is found that the amplification falls off fairly quickly as the tapping point approaches the earthy end of the coil. The reason for this is not difficult to understand. Reference to Fig. 5 (b) will show that the maximum voltage is developed across L1C1 when maximum current flows in (L+Lo)C, and this will occur at the resonant frequency of the circuit (L+Lo)C, which is given by the usual formula $\frac{10^6}{2\pi\sqrt{LC}}$,

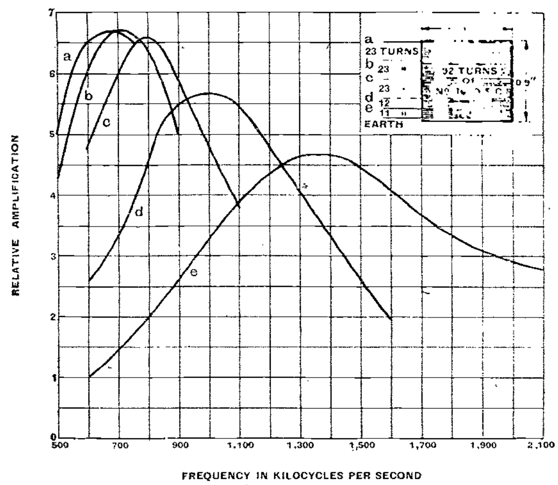


Fig. 6. Experimental curves showing the amplification of a 157 μH inductance (sketched in the inset) with an average aerial attached to various tapping points. As before, the horizontal extent of each curve measures the waverange secured with each tapping, using a normal 500 $\mu\mu$F tuning condenser.

where L is, in this case (L+Lo) and is expressed in μH, and C is expressed in μF. Now for maximum amplification the resonant frequency must clearly fall inside the frequency range it is desired to receive and, as L and C are both fixed, this requirement sets a lower limit to Lo and hence to the "lowness" of the tapping point. If Lo is small the resonant frequency will lie outside (above) the desired range. The observations illustrated in graphical form in Fig. 6 were made on the 157 μH coil, the details of which are given in the inset. An average aerial and a normal tuning condenser were used. The selectivity of such an arrangement increases very rapidly as the tapping point approaches the earthy end of the coil due to the decreasing load reflected into the tuning circuit, and, from Fig. 6, it is clear that the waveband coverage increases also. The curves show, too, that the amplification is substantially the same for tapping points between the high potential end and the middle point of the coil: for tapping points lower than the centre, i.e., nearer the earth connection, the amplification falls off rapidly. It is clear, therefore, that the best performance as regards amplification, selectivity and waverange is obtained with the aerial attached at the approximate middle point of the coil.

For such a connection the "reflected" capacity is one-quarter of the aerial capacity, i.e., is about 50 $\mu\mu$F for an aerial in which C=200 $\mu\mu$F. Curve (d) of Fig. 6, and curve (b) of Fig. 4, both apply to circuits with "reflected" capacities of 50 $\mu\mu$F, and hence with the same waverange. The superiority of the tapped coil with regard to amplification is clearly shown by a comparison of the two curves.

Although low tapping points give

Aerial Coupling—

poor amplification, some extensive waveranges can be secured with the aid of them. Suppose, for example, a medium-wave coil of 157 μH is tapped so that one-tenth its total number of turns are included in the aerial circuit. The "reflected" capacity is $\frac{200}{10^2}$ or 2 $\mu\mu$F. With careful attention paid to choice of a tuning condenser with a low minimum capacity the total strays can be reduced to about 30 $\mu\mu$F, giving a capacity variation of 17 : 1, and hence a wavelength variation of about 4 : 1. If the maximum wavelength received is, as usual, 550 metres, then the lowest obtainable is 140 metres.

The difficulty with all the methods of aerial coupling described up to now has been that the factors selectivity, amplification and waverange are interdependent. Increase of amplification is usually achieved at the expense of selectivity and waverange and vice versa. The transformer method, the theory of which is in many ways very similar to that of the tapped coil, offers better possibilities of giving a superior performance in these three respects, as the degree of coupling between primary and secondary windings can be varied (it was fixed, of course, in the tapped coil).

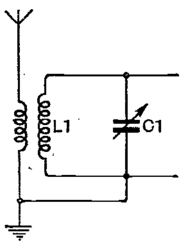


Fig. 7. The transformer method of aerial coupling is probably the best of all, provided great care is taken in its design.

The effect on selectivity and amplification of varying the degree of coupling is illustrated by the curves of Fig. 8, which is reproduced from an article by Reed.* It is clear from this that the optimum coupling for amplification does not give best results as far as selectivity is concerned, but it also shows that there is one particular degree of coupling—actually one-half the value for optimum amplification—which gives 80 per cent. of the maximum possible selectivity and the same percentage of the maximum possible gain. This degree of coupling is clearly a very good compromise, and RF transformers are best designed with reference to it. It is somewhat unfortunate that there appears to be no simple rule for calculating degrees of coupling between coils, which means that this particular method of aerial coupling, though theoretically very good, is not perhaps ideally suited to the requirements of amateur experimenters, who, without the aid of elaborate equipment, would be forced to employ the age-old method of trial and error to find the right degree of coupling. For those the tapped coil is easier to construct, and its performance is simpler to calculate.

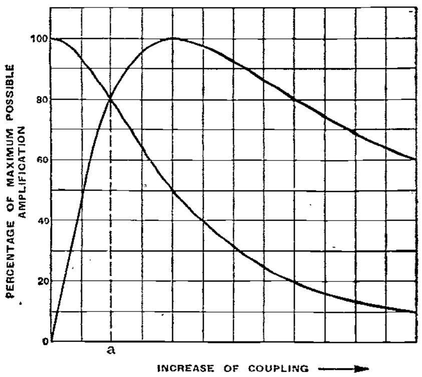


Fig. 8. The selectivity and amplification given by an RF transformer depend on the degree of coupling between primary and secondary according to these two curves. The coupling represented by (a) gives clearly the best compromise between amplification and selectivity.

In conclusion it may be said that, although some of the simple circuits described initially have applications in specialised instances, the best aerial coupling for general use employs either the RF transformer or the tapped coil, of which the former, if carefully designed, is the better.

* "The Design of HF Transformers," by M. Reed. *The Wireless Engineer*, p. 349. July, 1931.

Wireless and Waste Paper

EVERY reader must be aware of the appeal made by the Ministry of Supply for waste paper. This item, like so many other familiar things in everyday life, has acquired a new and important significance at the present time, as every scrap of waste paper that can be salvaged and passed along to the collecting centres is needed for munitions.

Naturally we like to feel that the waste paper which we contribute is going to be turned to some wireless use, but unfortunately paper is but little used in the make-up of wireless apparatus. It is true that substances like paxolin and bakelised paper play their part, more especially in the composition of coil formers. However, the paper which is employed for this purpose is of a very high grade—as is the fine tissue used for paper condensers—and will certainly not be made from the waste paper which we contribute. But it must not be forgotten that wireless instruments, whether produced for the Services or for domestic use, are of a very delicate nature, and will need a good deal of packing material, and we certainly can visualise our waste paper being put to good use for the protection of Service wireless gear.

New R.C.A. Record Changer

MANY of the 1942 series of R.C.A. Victrola radio gramophones recently announced in America are to be fitted with a new automatic record changer which plays both sides of each record without turning it over.

The essential feature of the new design is a tandem tone arm with two pick-up heads, one of which is used to play the underside of the record. A special light movement with a permanent sapphire needle has been designed, which will follow the groove faithfully with less pressure than is required to lift the record or cause it to slip on the diminutive turntable, which, with underside playing, must be smaller than the title label.

Up to fifteen records are stacked on three automatic release supports arranged round the outside of the record. The bottom record is dropped on to the turntable and played in the usual way by the top pick-up. At the end of the record the arm swings out, the turntable is stopped and restarted in the opposite direction, and the bottom pick-up is gently raised into contact with the run-in groove of the underside of the record.

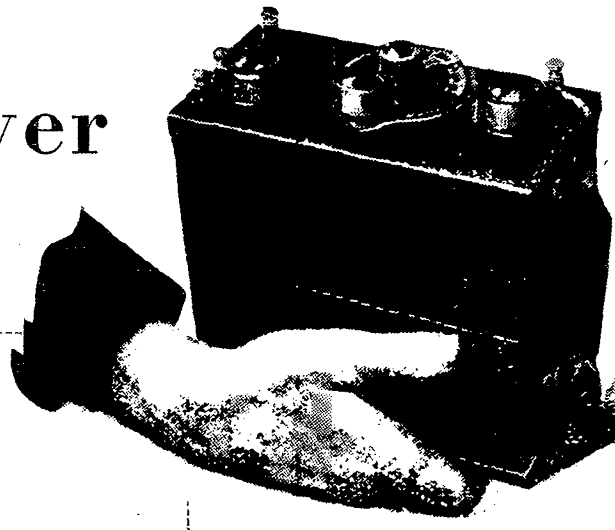
In the latest R.C.A. Victrola record changer a divided tone arm with two pick-up heads is arranged to play both sides of each record without the necessity for turning it over.

Finally, the dual tone arm swings clear of the record, which is then gently deposited through a slot into a felt-lined compartment at the side.

"Total War" Receiver

A Lightweight Portable for Emergencies

By W. H. CAZALY



Here is a type of "stand - by" receiver that almost everyone needs nowadays. The design is sufficiently flexible to allow a wide choice of components ; even the "junk-box" may be counted upon to provide many of them.

THE design of unorthodox receivers with miscellaneous circuits and components has acquired a new and serious significance in these times, and it is worth while to review the possibilities inherent in the "junk-box." Many cases of servicing and new construction will increasingly rely on it. No apology is made, therefore, for presenting this effort at adapting the use of odd components to suit wartime conditions.

The circuit employed in this case is given in Fig. 1. Needless to say, once one starts this sort of thing, the variations of arrangements that leap to the mind are endless ; to discuss them even in part in an article such as this is out of the question. This circuit was finally chosen, after a deal of experimenting and calculation, because it seemed to conform to the purpose in mind—that of producing a compact, sturdy, self-contained receiver, with the minimum of special components, that would keep the owner in touch with official sources of broadcast information on both the SW and the medium wave-bands, in the event of extraordinary situations arising. Reliable headphone reception is provided on two SW bands covering from well below 15 metres to over 80 metres, and also from 200 to 500 metres ; loud speaker output is obtained if required on the MW band and on some of the SW stations ; HT consumption at from 50 to 70 volts is of the order of 2.5 to 4 mA, and LT power may be derived either from cycle lamp batteries or, with slight circuit alterations, from a small accumulator.

The practical model made up by the author is shown in an accompanying photograph. Of course, innumerable modifications in layout are possible, provided fundamental principles are borne in mind. It was built that way because, in that form, despite its obviously "home-made" appearance, is fitted comfortably into a biscuit tin measuring $3\frac{1}{2} \times 3\frac{1}{2} \times 7\frac{1}{2}$in., the lid being used as a "chassis" or base upon which all the components are mounted, while another tin of the same size attached, as shown, held the HT and LT batteries. The aerial and earth consist of lengths of flex carried when not in use on wire hooks

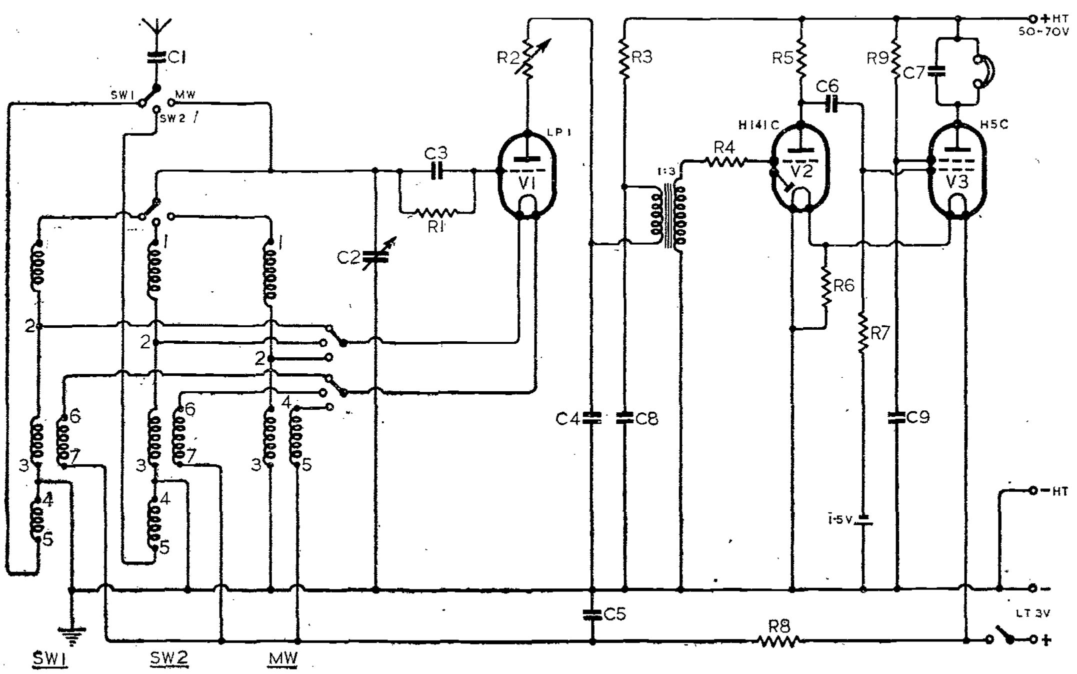


Fig. 1. Complete circuit diagram. The frequency bands covered are, approximately, 600-1,500 kc/s, 4-12 Mc/s and 12-21 Mc/s. (Much depends on stray capacities.) Values of components are : C1, C3, 0.0001 μF ; C2, C4, C7, 0.0005 μF ; C5, 0.01 μF ; C6, 0.005 μF ; C8, 4 μF ; C9, 0.25 μF. R1, 2MΩ ; R2, 10,000 Ω ; R3, 2,000 Ω ; R4, 1MΩ ; R5, R9, 100,000 Ω ; R6, 28 Ω ; R7, 1MΩ ; R8, 10 Ω. Filament characteristics of the valve types shown : V1, 2 V, 0.1 A ; V2, 1.4 V, 0.05 A ; V3, 1.4 V, 0.1 A.

"Total War" Receiver—

soldered on the side of the case, each being provided with a crocodile clip. To put the set into operation, it is only necessary to unwind the aerial, fling it out and clip it up to some high support, clip the earth to the nearest convenient earthed point (even a metal skewer stuck into moist ground will do), connect the headphones (which may conveniently be a light pair with tape headbands), and switch on. The whole forms a box shape that is easily packed or carried with other belongings when on the move.

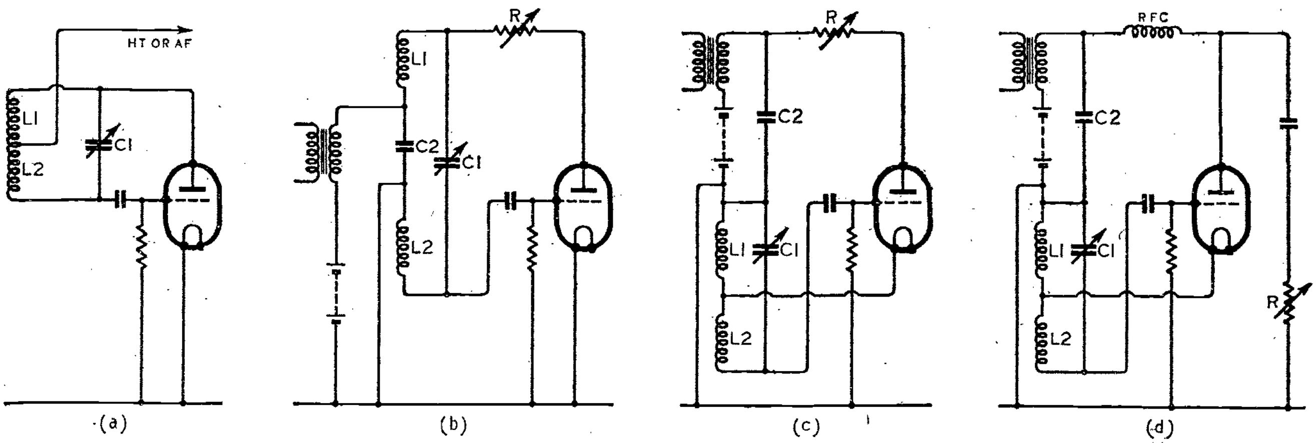


Fig. 2. From the basic Hartley of diagram (a) the three other circuits can be derived. Corresponding components bear similar reference lettering. Comparing these circuits with Fig. 1, C1 here corresponds to C2, C2 to C4 and R to R2.

There is, of course, more in these simple designs than meets the eye. The most important factor of all is the control of reaction; unless this is extremely good, reception on the SW bands with this type of receiver is very unsatisfactory. First of all, it is necessary to obtain oscillation with the low anode voltage available. Some thought and care in construction must be expended over the portions of the circuit involved. The "classical" magnetic feed-back system is excellent for MW bands, but uncertain at higher frequencies. The Colpitts is excellent for high frequencies, but the use of series tuning condensers curtails the coverage on MW. The Hartley is excellent on both, but needs to be modified to get rid of certain disadvantages that are present in its basic form—see Fig. 2 (a). Here, it will be seen, the tuning condenser is "live" on both sides to both HT positive and to RF. These disadvantages are removed by adopting cathode coupling, which, as shown in Fig. 1, is embodied in the receiver. The action of this circuit is perhaps best understood by deriving it in steps from the basic Hartley (see Fig. 2). The tuning condenser may have one side put at earth potential as regards DC from HT without affecting the principle of operation by including a "blocking" condenser C2 in Fig. 2(b). This still leaves both sides of it "live" to RF, however, and this is avoided by a slight rearrangement of the components, as shown in Fig. 2(c), in which the rotor (moving vanes and spindle) is tied down to chassis. This has a further advantage in putting the reaction control resistance effectively at chassis potential as regards RF, which avoids "hand-capacity" effects, although it is still necessary to insulate this component from chassis from a DC and AF viewpoint—but this is easily done with fibre bushes. The arrangement now becomes substantially that of Fig. 1. It will be observed that control of reaction consists essentially of controlling the capacitative path for HF from the anode of the detector valve to the chassis; for this reason R2 in Fig. 1 must have very low self-capacity. It might further be argued that R2 need not be in the path of the DC anode current, since variable composition resistors in such positions are notoriously noisy; some such arrangement as that in Fig. 2 (d) might be adopted. The objection to this idea is that it is difficult to substitute a choke in place of a resistance in this particular instance, because chokes usually have resonances at RF that are apt to be exceedingly troublesome in the control of reaction, especially when, as in this case, they are required to be effective from 15 metres to 500 metres. A suitable choke was found to have a wide field and to be excessively bulky. A resistance, therefore, becomes necessary in place of the RFC in Fig. 2 (d), but if it is fixed at, say, 10,000 ohms, which is satisfactory over all the frequencies involved, it very considerably reduces the anode voltage and the AF developed across the transformer primary, and so may make reaction hard to obtain at the higher frequencies, and certainly reduce the overall gain at AF. As a matter of fact, a certain amount of AF gain is lost even with the arrangement finally adopted, shown in Fig. 1, since R2 always has a certain amount of resistance; but the loss is comparatively small, and the simplicity and saving of space and excellence of control are adequate compensations. As was said earlier, once one starts discussing variations of these circuits, endless avenues of possibility open up; if readers think something else would be better, they have only to try it.

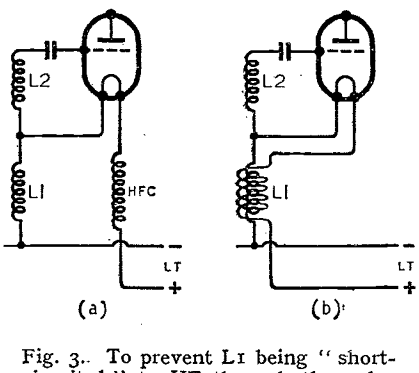


Fig. 3. To prevent L1 being "short-circuited" to HF through the valve filament, an RFC is included in the positive filament lead as shown in (a). This choke would have a great many turns and be of low resistance—a bulky component. The alternative is to wind both filament leads into a coil, one winding on top of the other and insulated from it by the enamel of the wire, as in (b). The double winding then acts in two capacities: as half of the tuning coil L1, L2, and as the + and — filament leads to the valve.

For the same reason—to avoid the use of specially designed and awkward chokes—half of the tuning coil consists of a double winding that also carries the filament current of the valve. This double winding may be regarded as a single winding *from the point of view of RF*; it consitutes L_1 of Fig. 2 (c) and (d). An alternative arrangement, if space is not an important consideration, would be to make one path of the filament current a low-resistance RF choke, as in Fig. 3 (a), designed not only to reduce the filament current as little as possible, but also to be effective from 15 to 500 metres; such chokes are bulky and their fields and resonances are very troublesome; the only advantage would be a slight simplification of the tuning coil windings. The system is therefore adopted of so constructing the double winding of L_1 that it constitutes effectively a single winding as regards RF, but carries the filament current to and from the valve electrodes, as in Fig. 3 (b).

The choice of a detector valve is fairly wide, since it is only necessary that its characteristics should be such that the changes in conditions brought about by reaction control should have the minimum effect on its behaviour and that its R*a* should be low. To avoid bulk, the older type of screen-grid or pentode non-vari-mu HF valve is not used. The newer smaller valves with vari-mu characteristics and somewhat critical electrode potentials do not apparently lend themselves well to really smooth reaction control without high anode potentials; backlash is very annoying. There are, however, many triodes that behave excellently, especially when control is obtained, not by greatly varying the anode voltage and so the mu and R*a*, but by varying, as is done in this case, the amount of RF feed-back alone. On the higher frequencies, however, the triode must have a comparatively low R*a*, even if it has a correspondingly low mu. One of the "1st LF" type —R*a* about 8,000 to 12,000Ω—is suitable.

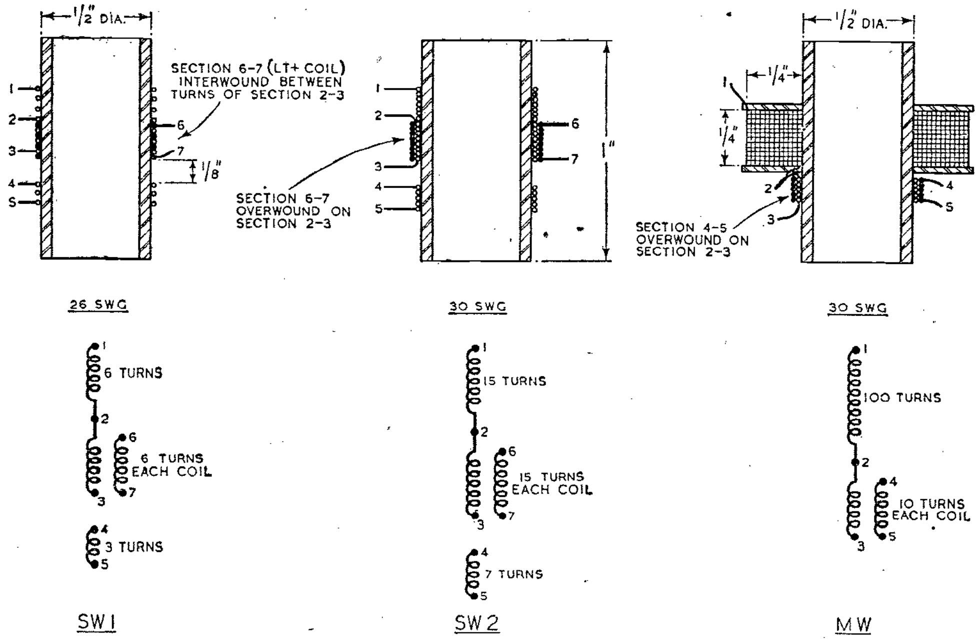


Fig. 4. Coil winding details. SW1 wound with 26 SWG enamelled wire, 1-diameter spacing between turns of sections 1-2 and 2-3; LT + filament winding (6-7) in same direction, wound into the spaces between the turns of section 2-3. SW2 wound with 30 SWG enamelled wire; sections 1-2 and 2-3 close wound; LT + filament winding (6-7) wound in same direction over section 2-3. MW coil wound with 30 SWG enamelled wire. Section 1-2 loosely pile wound to fill ¼in. square former space. The coupling coil (corresponding to L_1 of Fig. 3b) consists of 2 layers, each of 10 turns, of the same wire, close wound and close to section 1-2 and in sense as if continuing winding.

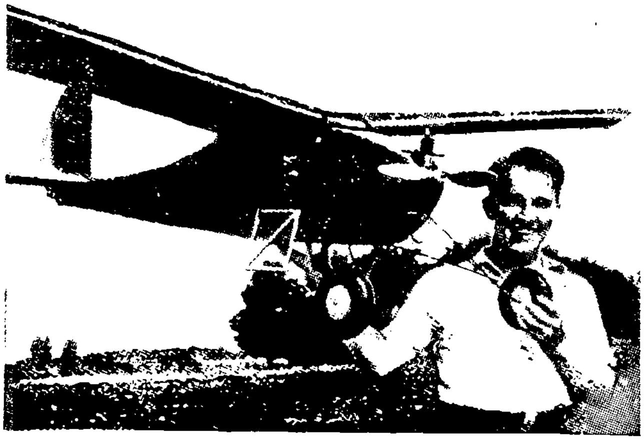
Concerning the choice of components generally, the following remarks may be of assistance.

The coils, of which the constructional data are given in Fig. 4, should be carefully made and conform fairly closely to the dimensions given. The tuning condenser actually used in default of anything better is an aluminium one; it was washed in strong soap and water and dried thoroughly, to clean it and improve the surface of the vanes—aluminium is attacked by alkali. A brass condenser would probably give better results. The coils are mounted directly on the 4-pole 3-way Yaxley type switch—which happened to be handy in the junk-box —by stiff wire leads. The use of plug-in coils is apt to give rise to hand-capacity effects besides being cumbersome. Of course, if a switch of this kind is unobtainable, it may be necessary to cut out one of the SW or the MW bands and use a simpler switch. The valves are "de-capped"—i.e., the bases are removed, and connections are made directly to the leads from the electrodes coming through the glass pinch—in the case of the AF valves for saving of space, and in the detector for efficiency; the composition bases of detector valves give rise to surprisingly high losses at high frequencies that may make all the difference to reaction. The AF transformer need be only a poorish component—a really good-class one might give rise to threshold howl despite the presence of R_2 in series with the primary. The two AF valves shown are of the 1.4-volt variety, and as they are in series and the diode-triode (of which the diode is unused) filament current is 0.05A, while that of the output pentode is 0.1A, a 28Ω resistance is connected in parallel with the filament of the triode, to pass the needed 0.1A for the output valve. This resistance, and the 10Ω R_8, are constructed of resistance wire on small slips of insulating material. A few inches of 36 SWG Eureka are sufficient—the exact lengths, depending on the thickness of the resistance wire available, may be calculated from data given in wire tables. Of course, all the valves may, if desired, be of the two-volt type, if corresponding and obvious changes in filament wiring are made.

Perhaps the author may be permitted to mention that the desire for and notion of this receiver was provoked by his experiences in France during the retreat to Dunkirk, when English broadcasts of news bulletins picked up on the "domestic" receivers taken out by his unit for purely entertainment purposes sometimes proved, during those anxious days, almost the only effective means of finding out what was happening, what parts of the country were likely still to be open, and of planning movements in the event of losing touch with HQ. He does not wish to risk being "caught blind" in the future.

Progress in Telearchics

Controlling Model Aircraft by Wireless



This plane, winner of the National Contest held at Detroit, has an 8-ft. wing span and weighs 8 lb. including 2 lb. of radio gear and 2 oz. of petrol. Rudder and elevator controls operated by the solenoid - escapement system are employed. The drop-door shown gives access to the wireless apparatus.

TELEARCHICS, or the distant-control of mechanism, has been a subject which has always interested not only the wireless enthusiast, but also the ordinary man in the street, and in no direction is this interest more strongly shown than in the radio-control of model aircraft. Turning to *The Wireless World* of nearly 30 years ago, we find that in September, 1913, an account was given of the great interest taken by the general public in the radio-controlled model aircraft which were being demonstrated at the Earls Court Exhibition, a demonstration in which a number of model battleships were successfully bombed, the bomb-releasing mechanism being also controlled by wireless.

After that we don't hear much of radio telearchics for thirteen years, until in 1926 this journal gave constructional details of wireless apparatus used to control the movements of a model boat. No great interest was shown, however, probably because at that time there were so many and varied other applications of wireless which claimed the attention of both technicians and the general public. It has been left to the U.S.A. to develop the science of modern radio telearchics, and, judging by a report published in the American amateur radio journal, *QST* (from which the illustrations in this article are taken), of the aerobatics performed by several radio-controlled model aircraft at the eleventh meeting of the National Model Airplane championship meeting at Chicago in July, simply amazing progress has been made.

Among the feats performed by the eight radio-controlled planes which took the air were taking-off, spot landing, figure-of-eight flying, cross-country flights to a given objective, spins, power-dives and, most astonishing of all, a perfectly executed demonstration of looping-the-loop, in which the plane took off under radio control, climbed to 1,500 feet, power-dived to within a few feet of the ground and then climbed steeply and turned over on its back in a graceful loop at a height of about 300 feet.

Model Aircraft Up-to-date

The main thing that will interest the wireless man will be the means whereby the radio control is carried out. First, however, a word must be said about model aircraft as they understand the term in America. We must get rid of any preconceived ideas of small boys launching elastic-propelled aircraft for a brief and usually inglorious "flight." The model aircraft in America are all driven by miniature petrol engines, some of which approach 1 h.p. Even the quarter horse-power models have speeds of 20 m.p.h. or so, and flights of a quarter of an hour's duration are daily accomplished. The aircraft themselves may weigh anything between 5 and 25 lb., and in the case of some the wing-span is 15ft. Those of 6ft. span are "midgets."

Every year a national championship competition is held, at which there are a large number of entries—at the 1941 meet there were 2,000 contestants—as well as a large number of other meetings in various parts of the country. These national model aircraft meetings apparently started in 1930, but it was not until 1937 that a radio-control event appeared on the programme. This must be reckoned as the official birthday of radio-controlled aircraft flying, for although there had been much talk, and a great deal of unsubstantiated, but possibly true, claims made previously, there appears to be nothing "official" before the summer of 1937.

Radio control was first applied in 1937 to model sailplanes, that is to say, gliders. The control was simple, and applied to the rudder only. Although complex arrangements of selector switches such as are used in automatic telephone exchanges were suggested—and have since been adopted—they were too complicated and required too much battery weight to be a success in those early days, and so we find a very simple arrangement being used consisting of an escapement wheel driven by an elastic-powered motor.

The escapement wheel is very similar to that of a clock, except that there are only four teeth. A simple solenoid is used to allow one tooth to "escape" each time the magnet is energised. The rotary motion of the wheel is converted to the reciprocating motion needed by the rudder by means of a very simple "link" connection. Its *modus operandi* can be clearly seen in Fig. 1. Since there are four teeth to the wheel, the rudder will go through a complete cycle of movements for every four operations of the relay, centre, full left, centre,

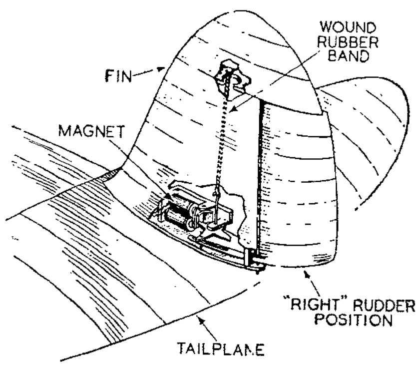


Fig. 1. The simplest system. It will be clearly seen the star escapement wheel, which rotates through a quadrant at every impulse of the solenoid, is directly coupled to the tiller by a link connection.

full right. By using a larger number of teeth it seems fairly clear that intermediate rudder positions could be obtained.

Now the obvious disadvantage of this method is that movements of the rudder must be in sequence, and to repeat any movement it is necessary to go through the whole sequence of movements. Thus, if the rudder has been turned to the left, and then returned to centre by a further impulse from the relay, it is not possible to turn it left again until it has been turned to the right and again returned to centre. The disadvantage is not so great as it seems, however, as the whole sequence of rudder movements can be run through in a fraction of a second, so that the plane gives no more than a "flicker" in its attempt to obey the unwanted movement which the rudder momentarily urges upon it when passing through the sequence. This argument applies also when an additional control unit is used to operate the horizontal rudder, or elevator as it is usually called.

The Modus Operandi

This simple elastic-powered escapement-control system must not be confused with an earlier system used by experimenters in which the solenoid, instead of being used to release the escapement, was linked to the rudder in an attempt to operate it direct. Such arrangements were never very successful, as they needed quite considerable power.

Before dealing with more complicated systems of control we must now turn to the method whereby wireless is used to energise the escapement-releasing relay. It will be opportune to discuss it in full here, since the purely wireless part of the business is more or less the same, no matter whether the actual method adopted to control the rudder, etc., is simple or complicated. What is needed is a receiver which, on the receipt of pulses from a comparatively low-powered transmitter situated within about a couple of miles radius, will be sufficiently sensitive to bring about an appreciable change in the anode current of its output valve. This change of current is used to operate a sensitive relay, which in its turn closes the circuit of the escapement-releasing or other controlling relay.

Of course, if bulk and weight are no object, nothing is easier than to design such a receiver. It was found that the change in anode current needed to operate a sensitive relay need not be more than one milliamp. or so; and, even in the early days when two or three valves were used, it was found possible to keep the total weight of the wireless equipment down to three pounds, thus enabling it to be used even on model gliders, which are capable of carrying about five pounds.

However, inventors were soon busy, and one American firm produced a special gas-filled triode to enable an efficient single-valve receiver to be used, and a single valve is now the general rule. This resulted in the weight of the radio equipment being reduced from three pounds to little more than one pound in cases where simple systems of control were used.

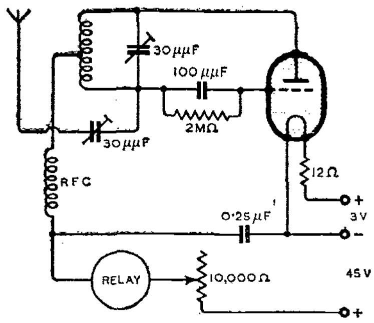


Fig. 2. The aircraft super-regenerative receiver employs a gas-filled triode. The tuning coil, which is approximately centre-tapped, consists of 8 turns of No. 14 gauge bare wire wound on a ½ in. phantom former. The choke consists of 40 turns of No. 30 D.S.C. wound on a 3/16 in. former.

Another development which contributed materially to this weight reduction was the production of a sensitive and reliable relay weighing only two ounces, or about one-quarter of the weight of relays previously used. The sensitivity of these relays is extremely high, and some of them will work on a power of less than one milliwatt.

The circuit which seems to be universally employed is that of the super-regenerator, but this is not very surprising when it is remembered that the wavelength used for control lies in the five-metre band. At first an 80-metre wavelength was employed, which, curiously enough, was approximately that used in the case of *The Wireless World* radio-controlled model boat in 1926. It was quickly found, however, that for various reasons a five-metre wavelength was more suitable. One reason was that the problem of receiver design was simplified.

The comparatively short range of the direct ray on the five-metre band is an advantage rather than otherwise, as it limits the risk of a transmitter interfering with other services. There is no object in having a greater range since radio-controlled model aircraft are not normally flown more than two miles or so from their base, as it is not, of course, possible to control their movements effectively unless they are well in sight. For this reason, also, the power of the transmitter used for control is quite small, as low as five watts in some cases, although the average power used seems to be round about the 20-watt mark, one or two rather complicated arrangements using up to 60 watts.

There is little need to say much about the transmitters, which are conventional five-metre outfits designed to give several spot frequencies round about the five-metre mark. The actual number of channels used depends on the number of controls on the aircraft, and also the method of control used. Thus, in the escapement system already described, if the rudder only is controlled, then only one channel will be required, another channel being necessary for the elevator, and another for motor speed control, and so on. Other more complicated arrangements may require two channels for each control. Each channel normally means a complete receiver, or, in other words, a valve and its associated components. An alternative method is to adopt a pulsing system like that of the automatic telephone in order to control the various channels, and this system is actually used by many designers.

The Joystick Principle

One of the most interesting parts of the apparatus is the actual ground control unit, apart from the transmitter. At first simple keying was adopted, a dash being sent out to operate the escapement or other controlling relay. It was soon found, however, that the operator forgot in which position he had last left the rudder; and, desiring to turn sharp left to avoid a tree, he would fail to remember if one pulse would do the job, or if two preliminary sequential pulses were first necessary in order to bring the rudder to the right and back to centre once more. The result was that crashes were frequent.

Many ingenious solutions to the problem have been found, but probably one of the best is based on the joystick principle. Control is effected by means of a specially constructed switch which is so arranged that it not only resembles a joystick, but the position of the switch handle gives a direct indication of the position of the rudder in the plane which it is controlling. When the switch is to the left, the rudder is to the left, and so on.

Progress in Telearchics—

When the switch is at the midway position, the rudder is likewise positioned, but the operator, who may want to move the rudder to the left, cannot tell whether he need only push the switch to the left or whether the rudder first requires to be taken over to the right and then centred again. Therefore, a ratchet is attached to the joystick so that it can only be moved in sequential order. In some cases, telephone switches of the central-zero type have been adopted for this purpose.

Usually, the control panel is not built into the transmitter, but is mounted on a light camera tripod and attached by a long length of twisted wire to the main unit. This is done so that the operator can take up the most advantageous position for observing the movements of the plane, such as on a mound or even up a tree. Transmitters are usually designed to take all their power from a car battery, and are mounted near the parked car, a simple type of telescopic aerial being employed.

More Elaborate Systems

On the plane, battery weight must, of course, be considered, but, fortunately, in recent years the development of the so-called personal receiver in America has made battery manufacturers weight-conscious, and it is possible to buy 45-volt HT batteries weighing only 5 oz. Since the standing plate current is under 2 milliamps, no trouble arises on account of ampere-hour capacity. For filament lighting flashlight batteries are normally employed. These provide filament current for several hours continuously. In cases where electric motors are used for controlling the plane, flashlight cells are also used to provide the 4½ volts necessary.

It is not surprising that right from the beginning attempts have been made to supersede the escapement system, with its need for sequential operation, by other systems in which instantaneous reversal of rudder or other controlled member can be obtained without going through the complete cycle of movements. For this purpose great use has been made of the small reversible electric motors produced for push-button receivers. Many arrangements employing these motors have been developed, some simple and some elaborate. In general, with these systems the relays may be considered as switches which turn the motors on or off, and these switches are "open" when receivers are "idling" (no pulses being received), and the motor turns either when a signal comes along, or when, for some reason, the receiver suddenly goes dead and the plate current drops to zero. Systems which employ these motors are gradually displacing older arrangements.

The Interference Problem

By far the most elaborate of these motor arrangements is that used by the first-prize winner at the 1941 national meet, and it is worth explaining in some detail. The whole plane only weighed five pounds, and, in view of this fact, it is astonishing what an elaborate system of control was used. The plane had two standard manufactured receivers, one working the rudder with continuously variable movements, and the other controlling the engine revolutions. The rudder was normally held over at full left, presumably by spring loading. A variable-speed DC motor operating it through a fluid-drive clutch tended to pull it over through the centre position to full right. The amount by which the rudder was pulled over depended on the grip exerted by the fluid-drive clutch, which, of course, was itself dependent on the motor speed.

The job of the ground control unit was, therefore, to control the motor speed. This was done by providing at the ground control point a similar motor having its speed controlled by a series rheostat, the handle of which constituted the joystick. This ground motor controls the keying of the transmitter in such a way that the corresponding motor in the plane runs at the same speed, the rudder being deflected in the manner already described.

The engine of this plane had two timers, one set for full speed and one for slow. Normally the full speed timer was connected, but the controlling signal caused it to be displaced by the slow speed one.

The second-prize winner at the show was the plane which looped the loop, as already described. In this aircraft there were rudder and elevator control, motor speed control and motor-off control, the latter being effected by breaking the ignition circuit for a sufficient time to allow the motor to "die." Only one receiver was used, but there was a very elaborate dialling and pulsing arrangement, on the principle of the automatic telephone, and the ground-control unit represented a miniature automatic telephone exchange with all its pulsing relays and selector switches. The radio equipment on the plane weighed 3½ lb., about one-third that of the remainder of the plane, including the engine.

Another competitor used a battery of door-bell pushes on his control unit, with rows of synchronised dial lights to indicate the position of each control on the plane.

The mystery ship of the meeting, which was not actually tried out in the air, was entered by Purdue University. It had a 14-valve receiver and employed some system of audio-frequency selection, incorporating tuned reeds.

One interesting problem is that of interference to the planes from amateur transmitters, which may happen to be working on a frequency which one of the aircraft controlled is using. On one occasion a plane which was 1,200ft. up refused to obey the ground control, and careered round the country in a large circle indicating half-rudder position. When finally brought to earth all controls were found to be in order, and it was concluded that the rudder control had been "held" by a neighbouring amateur transmitter.

In view of the enormous strides made between the initial meeting in 1937 at which radio control first made its appearance and the latest meeting held only four years later, very big developments are expected next year. More especially is this so as more and more amateur transmitters and model aircraft enthusiasts are collaborating in experimental work, and manufacturers are turning their attention to the production of specialised components for this entirely new field. For obvious reasons, we are not likely to see any developments in this country until after the war, but a field day of this nature might prove a useful and pleasant change to the customary amateur DF field days held over here. There will certainly be scope for the exercise of all the ingenuity and skill in radio matters of which the amateur transmitter in this country is capable.

The Wireless World Diary

AS supplies of *The Wireless World* Diary and Reference Book for 1942 are limited, to avoid disappointment readers are advised to obtain their copy immediately from a bookseller, stationer or bookstall. The reference section includes all the usual features as well as one or two additions, one of which gives the times, as compared with GMT, of the major cities of the world. The price, including purchase tax, is 2s. 9d.

Developments in Broadcasting

I.E.E. Wireless Section Chairman's Address

THE assistant chief engineer of the B.B.C., Mr. Harold Bishop, C.B.E., B.Sc. (Eng.), who is the new chairman of the Wireless Section of the Institution of Electrical Engineers, gave a very comprehensive review of the technical developments in broadcasting and the trend of progress up to the outbreak of war in his inaugural address on November 5th. He dealt with the more detailed and highly specialised questions which Sir Noel Ashbridge avoided. Mr. Bishop joined the Marconi Company in 1922 and in the following year joined the staff of the British Broadcasting Company at 2LO.

In his review of the construction of studios and their characteristics he dealt with the programme input equipment. The period of two years before the war saw the growth of a new conception in the handling of programme material. The principle of the new scheme outlined by Mr. Bishop is that the control of dynamic range and balance of a studio programme is carried out during both rehearsal and transmission from within the studio's control cubicle, a small room adjacent to the studio. The studio and cubicle are provided with all the necessary technical equipment to enable producers to rehearse their programmes both artistically and technically.

"The years immediately preceding the war saw the rapid development of high-power transmitters having so-called high-efficiency or power-saving modulation systems," said Mr. Bishop. "Of these, the well-known Class B modulation systems, in which the modulator output is coupled to the anodes of the main high-frequency amplifier, claimed the most attention, and many transmitters employing this circuit are now in service. The economy in power cost as compared with the cost of operating the older type of high power anode-modulated transmitter using modulators operating in the Class A condition, or the equally well-known HF power-amplifier type of transmitter is substantial. For example, for 100 kW radiated, a Class B transmitter requires 300 kW input whereas the older type requires 460 kW. Assuming a transmission time of 5,000 hours a year and electric power at 0.75d. a unit, the annual saving amounts to about £2,500. If this is multiplied by the number of transmitters in service, the importance of this technical development is seen to be very real."

Mr. Bishop pointed out that it had been suggested that the days of amplitude modulation on medium waves are numbered by the development by Armstrong in the United States of a practical system of frequency modulation using ultra-short waves of the order of 7 metres or less. "It is, of course, too soon to say," he added.

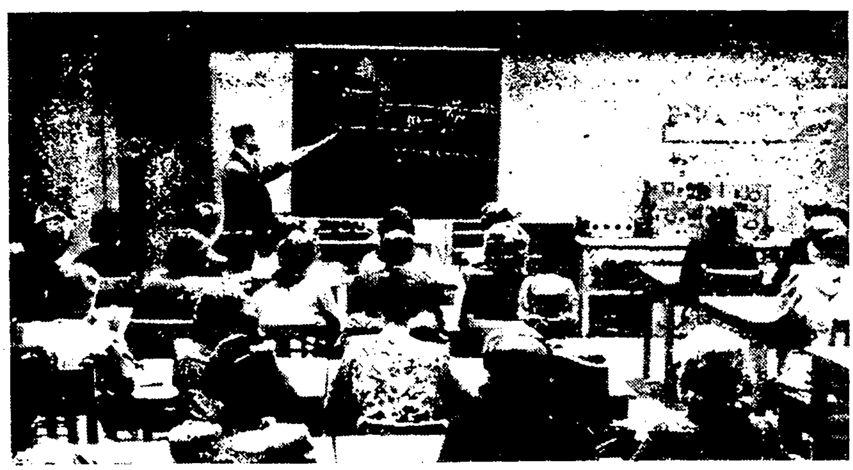
Frequency Stability

Dealing with the use of quartz crystals for the frequency control of modern transmitters, he said that in the oscillator circuits developed by the B.B.C. the supply voltage frequency co-efficient had been reduced to a negligible value. It can now be said that the cause of frequency instability—of the order of $\pm$ 1 part in 10^8—lies in the quartz plate and mounting.

A large number of Post Office crystals are now in use in B.B.C. transmitters and their average long-time frequency stability over a period of a few months is of the order of $\pm$ 1 part in 10^7, while the short-time frequency stability over a period of a few days is $\pm$ 3 parts in 10^8, provided that the crystals are installed in high grade constant temperature ovens.

International comparisons carried out in 1939 by simultaneous measurements of stable broadcasting stations by the R.C.A., New York, the U.I.R. station at Brussels, and the B.B.C. measuring station cited by Mr. Bishop, showed agreement between these centres of better than 1 part in 10^6 on the short-wave signals measured, the comparisons being limited in accuracy by short-wave fading phenomena.

Mr. Bishop suggested that, in the straitened conditions of post-war finance, the public will have little money to spare for anything which is not an absolute necessity. He pointed out that whereas the pre-war receiving set gave value for money, the post-war product will have to be still more attractive if it is to achieve the success that public interest can give it. Reliability in use and improvements in servicing will be expected by the listening public, and to achieve both objects a greater measure of component standardisation seems essential. "In particular," said Mr. Bishop, "the component for which a measure of standardisation is outstandingly necessary is the valve. There should be a drastic limitation in the number of types to reduce cost and achieve simplification. The type of valve determines to a large extent the type of circuit, and in so far as the number of valve types would be limited there would be a measure of circuit standardisation, but further standardisation of circuits would seem to be unnecessary and undesirable."



CONTROL ROOM TECHNIQUE being explained to women operators at the B.B.C. The diagram shows the listening room, or cubicle, referred to by Mr. Bishop, and on the right can be seen some of the associated apparatus.

THE WORLD OF WIRELESS

RAW MATERIALS

Alternatives Adopted by R.C.A.

RESEARCH for alternative materials for use in receivers, necessitated by the demands of national defence in the United States, has resulted in the production of many newly developed substances by R.C.A. Laboratories.

Aluminium was one of the first items essential to receivers affected by the priorities control. In order to save the 74 tons of aluminium used for the cans screening IF coils, of which four million were used in R.C.A.-Victor sets last year, the cans have been replaced by cardboard tubes, coated with a moisture-resisting substance and a sheet of copper foil.

Plastics are under consideration to replace the metal housing that protects loudspeaker cones. They can also be used in a number of other parts in both radio and gramophone equipment. But even plastics are likely to need curtailment, because defence needs have created a shortage in the supply of formaldehyde, required to manufacture the synthetic resin used as a base in some plastics.

It was therefore decided to find an alternative for plastics. The answer was a felted substance made from shredded wood, cardboard and paper scraps, and sulphite pulp. Moulded and treated with a moisture-resisting impregnant, it proved to be as tough as either wood or plastics. Moreover, by the use of thermofusion, metals can be bonded to it.

Experiments are also being conducted with Lignin, a by-product of paper mills, as a substitute for plastics.

A replacement has also been found for the phenol-formaldehyde resins used to impregnate paper tubes upon which coils are wound.

The practically non-existent supply of aluminium for ordinary commercial purposes posed a knotty problem for the manufacturers of electrical transcriptions (special recordings), used for broadcasting. The properties of aluminium which make it more desirable than anything else are perfect surface flatness and rigidity. It has been found that certain types of ceramic materials, including glass, can be used satisfactorily.

Another development of even farther-reaching effect has been made by the chemists in R.C.A. Laboratories. The supply of shellac, an important ingredient in a gramophone-record compound, which comes chiefly from India, is fast dwindling. By improving on shellac's properties of durability, plasticity under heat, hardness at ordinary temperatures and resistance to mechanical wear, the research workers have developed a new process which greatly conserves the ingredient's use to possibly three to four times normal expectation.

RECORDINGS: Preference for "Hill and Dale" in U.S.

IT is interesting to note that according to a recent survey conducted among broadcasting stations in America there is a growing use of vertical, or "hill and dale," recording for electrical transcriptions. The percentage of stations in favour of it is approximately 43, as against 35 for lateral recording, the remainder having no preference. The actual percentage of vertical recordings being employed is, however, roughly only 22, whilst 57 are lateral-cut recordings. Electrical transcriptions usually take the form of 16in. discs, the playing speed of which is $33\frac{1}{3}$ r.p.m. The remaining 21 per cent. of the recordings used for broadcasting are ordinary commercial gramophone records.

The statistics from which these figures are gleaned were issued by the Recording and Reproducing Standards Committee of the U.S. National Association of Broadcasters, as a result of a questionnaire sent to 197 stations in an endeavour to formulate standards that will tend to bring about uniform quality of reproduction of transcriptions with a minimum number of reproducing equipment adjustments.

The questionnaire reveals that nearly 31 per cent. of all broadcasting time is devoted to recordings.

FM AND THE AURORA BOREALIS

A GOLDEN opportunity for frequency-modulated broadcasting to prove its claim of freedom from interference was provided during the recent display of the aurora borealis, which played havoc with amplitude-modulated transmissions in the Northern Hemisphere. Reports published in the American Press declare that except for sporadic freak long-range reception at distances as great as thousands of miles, FM transmissions were virtually unaffected by the black-out which prevailed.

HT BATTERY SUPPLIES

Hopes of Improvement

COMMENTING on the statement made in the lay Press that more HT batteries will soon be available, *The Wireless Trader* points out that, although manufacturers have been asked to increase battery production to the limit of their capacity, it would be misleading to suggest that increases will immediately be "substantial" or that—short of a miracle—the supply position by the end of the year will reach normality over the whole country. However, in consultation with the manufacturers, the Board of Trade has done what it can to ease the difficulties of labour and material that are restricting supplies, so far as they are likely to be eased in view of the overriding claims of the war effort.

ELECTRON MICROSCOPE

High Voltage for Deeper Exploration

IN a successful endeavour to see deeper into the sub-microscopic world, R.C.A. Laboratories have operated an electron microscope at approximately five times the voltage previously employed. This higher voltage permits the exploration of materials and organisms two or three times thicker than previously.

The experimental use of potentials as high as 300 kilovolts does not increase the resolution of what may be seen through the electron microscope. It does, however, make it possible to see internal details of some specimens to better advantage. The effect of the increased voltage is to cause the electrons to travel at two or three times the velocity of the commercial electron microscope.

Except for the design of the high-voltage generator, which is housed in a steel tank 5 feet in diameter, 6 feet high and (filled with oil) weighs 3 tons, the instrument is fundamentally the same as the standard model which operates from the ordinary power supply.

WRUL AND WRUW

THE World Wide Broadcasting Foundation, which operates the two 50-kW international short-wave stations WRUL and WRUW situated at Scituate, Mass., has been granted permission to erect a third station on the same site. It will operate at 6.04, 11.73, 11.79, 15.13, 15.35 and 17.75 Mc/s with a power of 50-100 kW.

It will be recalled that the United States Reconstruction Finance Corporation recently granted the sum of

$40,000 to the Foundation, which is a non-profit-making concern operating the stations "for enlightenment." It was suggested at the time that this indicated concrete Government interest in a counter-propaganda campaign.

THE PRESS AND BROADCASTING

Newspaper Ownership of Stations Criticised

THE U.S. Federal Communications Commission is investigating the question of newspaper ownership of broadcasting stations. It would appear from the opening statement by the chairman that the question of joint control over newspapers and broadcasting stations, which has been a topic of interest for some time, has been brought to a head by the application for FM licences by newspapers.

The F.C.C. chairman pointed out that the applications for FM stations by newspapers "raise the question of the extent to which, and the circumstances in which, grants to newspapers will serve the public interest."

It is interesting in this connection to note the statement issued by *The Detroit News*, owners of the stations WWJ and W45D (FM). "As the founders of the first commercial broadcasting station WWJ, which we have operated daily since 1920, we ask for nothing more than a dispassionate examination of our record of service for twenty-one years, including our pioneer efforts towards the development of broadcasting in ultra-high frequency, and more recently in the frequency modulation fields. . . . The original intent of *The Detroit News* in entering the radio field was to further reliable methods of communication as a natural step in the advancement of journalism, and increase our service to the public. To this end we operated our station for five years without accepting any revenue of any kind from any source. . . . It would seem to us fundamentally unjust to judge any application for a new licence or the continuance of an old one on any other basis than the good character, fitness and responsibility of the individual applicant."

Despite the fact that the chairman stated that the F.C.C. had an open mind on the question of newspaper ownership, *Broadcasting* declares that "His interrogation of witnesses indicated he was seeking to build a case against the propriety of joint newspaper ownership and operation of broadcast stations."

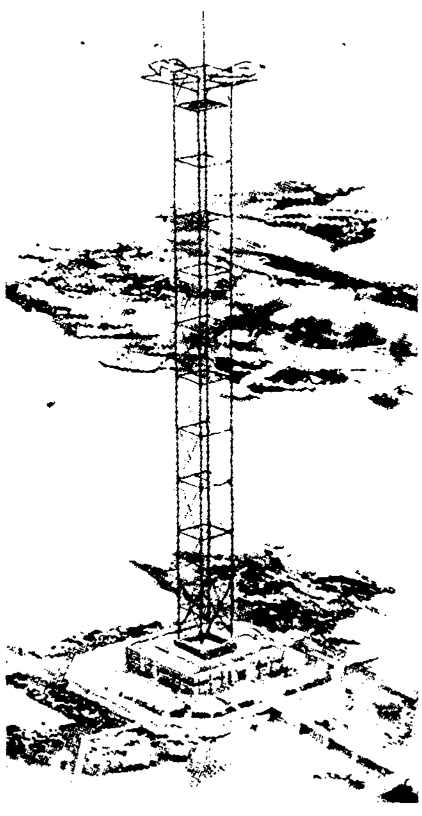
Of the 882 stations in the States, 298 were linked "by ties of ownership with newspapers or with persons associated with newspapers."

COLUMBIA TRANSMITTERS

New Short- and Medium-wave Stations

WITH the transfer of Columbia's international short-wave station WCBX from its original site at Wayne, New Jersey, to Brentwood, Long Island, a marked improvement in its reception has been noted in this country. The transmitter is temporarily using only one aerial directed towards Europe and three directed towards Latin America. It will be remembered that it was planned to erect a new 50-kW transmitter, which will have the call letters WCRC, on the same site. This transmitter, which has been granted the frequencies 6.12, 6.17 and 21.57 Mc/s, will probably be testing by the time these notes are in print.

Near the site of the short-wave stations is Little Pea Island, in Long Island Sound, which was little more than a patch of rugged rocks until the CBS engineers built a man-made "island," 150 feet square, on it to accommodate the new CBS medium-wave key station WABC. The 50-kW station, using a 410-foot mast radiator with a hinged capacity top, made its debut in October.



COLUMBIA'S KEY STATION. The 410ft. mast and station buildings of WABC.

This novel station site was chosen after exhaustive tests, as it provided a direct sea path for the station's signals to its service area. The island has been renamed Columbia.

MAGNETIC STORMS

EXPERIENCE has shown the engineers of R.C.A. Communications that magnetic storms have more effect on transmissions travelling east to west and west to east. During the display of the aurora borealis, therefore, they transmitted messages to London via Buenos Aires, where they were automatically relayed. Success was also achieved in reaching Europe by resorting to the use of long waves, generated by Alexanderson alternators at the R.C.A. station at Rocky Point, Long Island. These alternators, of 1918 vintage, are the only ones in service in the U.S.A., and are held in reserve for such emergencies.

AMERICAN "NATIONAL" NETWORK

PLANS to use the 880-odd broadcasting stations in the United States for the purpose of radiating announcements and communiqués in the event of a national emergency have been outlined by the U.S. Defence Communications Board. The scheme is to link all stations as one great network, and at the same time to link neighbouring stations to a regional defence centre.

It is stated that nearly 500 stations are already connected to the nucleus of the network, and that only 12 of the remainder are situated at some considerable distance from existing programme lines.

FROM ALL QUARTERS

Mr. Baird and Cable and Wireless

ARRANGEMENTS have been made by which Cable and Wireless will obtain the collaboration of Mr. J. L. Baird, who has accepted an appointment as Consulting Technical Adviser to the company as from November 1st.

I.E.E. Premiums

IN announcing the awarding of the various I.E.E. premiums for papers read before the Wireless Section, Mr. T. E. Goldup, who in Mr. W. J. Picken's absence took the chair, stated that the Institution premium of £25 had been given to C. F. Booth for his paper on the application and use of quartz crystals in telecommunications. This is the fifth time in ten years that the Institution premium has been awarded for papers read before the Wireless Section. The Ambrose Fleming premium of £10 was awarded to N. M. Rust, O. E. Keall, J. F. Ramsay and K. R. Sturley for their paper reviewing broadcast receivers. A premium of £10 was awarded to C. A. Mason and J. Moir for their

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paper, "Acoustics of Cinema Auditoria," and another of £5 was awarded to R. H. Barfield for his paper on the performance and limitations of the compensated loop direction finder.

R.S.G.B.

THE Officers of the Radio Society of Great Britain have all been nominated to serve again during the coming year. The election will take place in January.

G.E.C. Short-wave Station

THE international short-wave station of the General Electric Company, KGEI, on Treasure Island, San Francisco, has been granted permission to increase its power from 20 to 50 kW. Its location is changed to Belmont, California.

British People's Set ?

IT was proposed at the annual meeting of the Scottish Radio Retailers' Association that representation should be made to the Ministry of Supply suggesting the production of a standard receiver, the advantage being ease of servicing due to the use of standard components.

Marconi's Tomb

IT was recently announced from Rome that the body of Marconi had been placed in a mausoleum on the site where he conducted his early wireless experiments.

"Talking Books" Tax Free

GRAMOPHONES specially designed for the reproduction of "talking books" for the blind have been granted exemption from Purchase Tax.

B.B.C. News Bulletins

AMONG the 65 news bulletins in 25 different languages broadcast in the B.B.C.'s European and Near East service there are now only two in English. The times (BST) of these and the short wavelengths on which they are radiated are marked with an asterisk in the following list of B.B.C. transmissions of news in English.

0200: 31.32, 31.25, 25.53.
0300: 49.10, 31.32, 31.25, 25.53.
0530: 49.10. 31.32, 31.25, 25.53.
0715: 49.10, 31.55, 25.53, 19.66, 19.60, 16.86.
0900: 49.59*, 41.96*, 41.49*, 31.55, 30.96*, 25.53, 25.29*, 19.82, 19.66, 19.60, 16.86, 16.84.
1200: 25.53, 19.82, 16.84, 16.77, 16.64, 13.97.
1400: 25.53, 19.82, 16.84, 16.77, 16.64, 13.97.
1700: 31.75, 25.53, 19.82, 19.66, 16.84, 16.77.
1900: 31.55, 25.53, 19.82, 19.66, 16.84.
2145: 31.25, 25.53, 19.82, 19.60.
2215: 31.32, 31.25, 25.53, 19.82.
2300: 49.59*, 41.96*, 41.49*.
2345: 31.32. 31.25, 25.53.

I.E.E. Wireless Section

AT an informal meeting of the I.E.E. Wireless Section on Tuesday, November 25th, at 4 p.m., Mr. P. R. Coursey will open the discussion on ageing tests of radio components, with particular reference to atmospheric conditions. On Wednesday, December 3rd, at 4 p.m., Mr. E. Colin Cherry will read a paper on the transmission characteristics of asymmetric sideband communication networks.

WLWO

THE 75-kW international short-wave station WLWO operated by the Crosley Corporation at Cincinnatti, U.S.A., is now radiating programmes for Europe on 15.25 Mc/s from 16.30 to 22.45 (BST).

Dr. Zworykin Honoured

DR. VLADIMIR K. ZWORYKIN, Associate Director of R.C.A. Laboratories, has been presented with the Rumford Award by the American Academy of Arts and Sciences in recognition of his research work in the development of the electron microscope. Dr. Zworykin, who invented the Iconoscope, and has made numerous contributions in the field of the electron multiplier and photo-electric cells, was born in Russia and served in the Signal Corps of the Russian Army during the Great War. He joined the Westinghouse Company in 1920 and R.C.A. in 1929.

Records Teach Marine Engineers

RECORDINGS are now being made at sea of the characteristic sounds of internal-combustion engines, showing effects of incorrect valve adjustments, etc., to assist in the training of men for engine rooms in the ships of the U.S.A. These recordings are brought back to the classrooms on shore and reproduced, at a suitable volume-level, for the student engineers, thus enabling them to hear actual sounds of engines running normally and faultily. The instructors can then point out the significant noises for which to listen.

Educational FM

THE use of frequency modulation for educational broadcasting is extending rapidly in the United States. The seventh non-commercial educational FM station is to be erected by the Chicago Board of Education.

NEWS IN ENGLISH FROM ABROAD

REGULAR SHORT-WAVE TRANSMISSIONS

Country : Station	Mc/s	Metres	Daily Bulletins (BST)
America			
WNBI (Bound Brook)	15.130	19.83	2.15, 3.0‡, 4.0‡, 6.0†.
WRCA (Bound Brook)	17.780	16.87	2.15, 3.0‡, 4.0‡, 6.0†.
WGEO (Schenectady)	9.530	31.48	9.0†, 10.55§‡.
WGEA (Schenectady)	15.330	19.57	7.45§‡, 9.55§‡.
WBOS (Hull) ..	11.870	25.27	5.0, 9.0, 12.0 midt.
WCAB (Philadelphia)	6.060	49.50	12.30 a.m. (Mon.), 11.30‡.
WCBX (Wayne) ..	11.830	25.36	7.30‡, 8.15†, 8.45§‡, 11.30.
WCBX	15.270	19.65	2.0, 5.0§‡.
WRUL (Boston) ..	6.040	49.67	11.30§‡.
WRUL	11.730	25.58	11.30§‡.
WRUL	11.790	25.45	8.30*, 9.30§‡.
WRUL	15.350	19.54	4.0*, 6.7§‡, 8.30*, 9.30§‡.
WRUL	17.750	16.90	4.0*, 6.7§‡.
WLWO (Cincinnati) ..	15.250	19.67	5.0‡, 8.0†.
Australia			
VLR7 (Lyndhurst) ..	11.840	25.34	5.20.
Egypt			
SUX (Cairo)	7.865	38.14	6.50, 10.10.
French Equatorial Africa			
FZI (Brazzaville) ..	11.970	25.06	8.45.
India			
VUD3 (Delhi)	9.590	31.28	1.30, 4.50.
VUD4	11.830	25.36	9.0 a.m., 1.30, 4.50, 6.15.
VUD3	15.290	19.62	9.0 a.m.

Country : Station	Mc/s	Metres	Daily Bulletins (BST)
Japan			
JZI (Tokio)	9.535	31.46	8.0
JZJ	11.800	25.42	10.30.
JLG4	15.160	19.86	8.0.
Manchukuo			
MTCY (Hsinking) ..	11.775	25.48	8.0 a.m., 10.5.
Sweden			
SBO (Motala)	6.065	49.46	10.20.
Thailand			
HSP5 (Bangkok) ..	11.715	25.61	12.45.
HS6PJ	19.020	15.77	12.45.
Turkey			
TAP (Ankara) ..	9.465	31.70	7.15.
TAQ	15.195	19.74	12.15.
U.S.S.R. (Moscow)			
31-metre band ..	—	—	7.0, 8.0, 9.0, 10.15.
Vatican City			
HVJ	6.190	48.47	8.15.

MEDIUM-WAVE TRANSMISSIONS

	kc/s	Metres	
Ireland			
Radio-Eireann	565	531	1.40†, 6.45‡, 6.50†, 10.0.

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

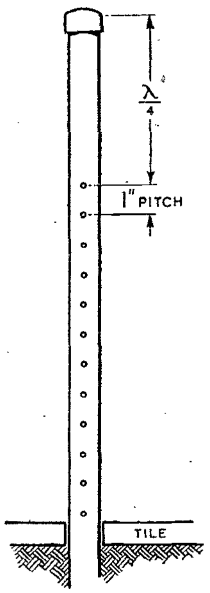
Acoustic Aerials

A New Technique for Predicting the Polar Characteristics of Complex Arrays

The calculation of the field patterns of multi-unit aerial arrays is extremely laborious, and for practical purposes polar diagrams can be obtained with the aid of acoustic models

THE use of models of complex directional aerial systems for checking the predicted performance has generally been based on ultra-high frequency technique, the frequency of excitation being increased so that the wavelength bears the correct relationship to the length of the radiating elements in the model. While good results have been obtained with this method, there are considerable difficulties in taking measurements without disturbing the field, and also in making allowance for the change of conductivity of the earth's surface with frequency.

Since most of the problems of multiple aerial design are based on wave interference, it seems probable that a study of acoustic interference patterns might provide a satisfactory solution, and investigations recently described in America[1] confirm this view. Not only can the scale of the acoustic model be reduced below that of high-frequency models, but with suitable microphones the disturbance of the field pattern is much less. Mathematical treatment produces similar equations for acoustic and electromagnetic radiation, the only correction when interpreting the results being a term resulting from the fact that radio waves are polarised, whereas sound waves in air are not.



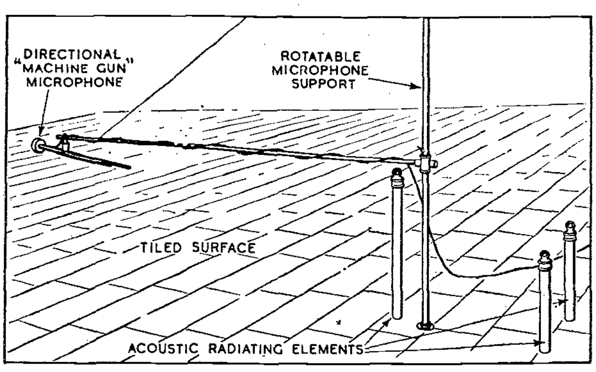
Acoustic model of a vertical half-wave aerial. Sound is radiated from the line of small holes and a closed pipe with a non-radiating top section is used to obtain the desired pressure distribution.

The design of the acoustic equivalent of the aerial is based on the assumption that the radiation emanates from a series of elemental doublets distributed along the aerial. Accordingly, the acoustic equivalent consists of a pipe with a series of fine holes drilled at short intervals, through which sound is emitted in strength and phase depending upon the standing wave in the pipe behind. In order that the pressure distribution shall simulate the current in the radio version, there should be an antinode at the end of the pipe, i.e., the pipe should be open. This would, of course, give rise to considerable unwanted sound radiation, and in practice the end of the pipe is closed to form a node, and the first hole (representing the tip of the aerial) is drilled a quarter wavelength down.

Experimental Details

In the experiments carried out by the authors, a frequency of 600 c/s was used with a wavelength of 22.6in. at 20 deg. C. A half-wave aerial would then consist of a series of holes rising 11.3in. above ground level and topped by 5.65in. of closed pipe to produce the anti-node at the highest hole.

A Western Electric 555W loud speaker unit was used as a source of sound energy in the practical work, and, after a series of experiments on relative pipe diameters, hole sizes and spacing, it was found that 1in. diameter pipe drilled at intervals of 1in. with holes 0.05in. in diameter gave the closest approximation to the current distributions found in radio aerials. That is to say, the energy lost by radiation from each hole resulted in the same progressive departure from sinusoidal distribution.



Layout of three-element acoustic aerial system and exploring microphone for investigating the high angle fields of the directional aerial at station WLW.

Field experiments were made first of all with an acoustic model of the simple vertical half-wave aerial, the characteristics of which are well known.

The model was arranged to project through a tiled surface laid on the ground. The hard tile acts as a good reflector, and if it is of reasonably large diameter compared with the wavelength, reflection from the change of conditions at the boundary is negligible. A diameter of 35ft. was used in these tests.

The microphone is suspended from a light derrick of small-diameter tube, designed to cause the least possible interference with the sound field. It is capable of rotation through 360 degrees for polar curves, and the arm may be raised or lowered to any required altitude angle. Both these operations are effected by lines actuated from the control point at a distance of about 50ft. from the aerial model.

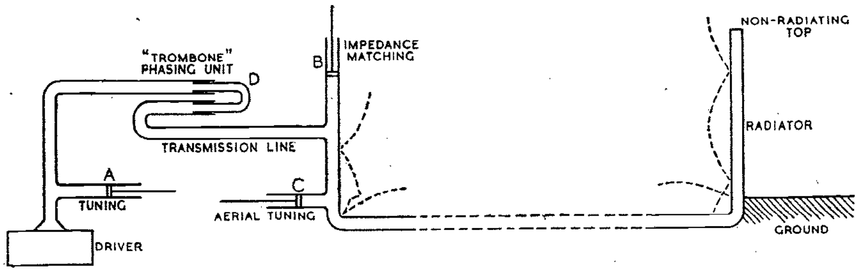
In the early stages trouble was experienced from standing waves reflected from buildings and other objects in the vicinity, and it was found necessary to use a directional microphone of the "machine-gun" type pointing directly at the sound source to minimise these effects. Trouble from extraneous noise was eliminated by using a selective circuit between microphone and amplifier tuned to 600 c/s. This also avoided complications which might have arisen from the presence of harmonics in the sound source.

Close agreement with calculation was found in all cases, and experimental curves of field patterns result-

[1] "Acoustic Models of Radio Antennas," by E. C. Jordon and W. L. Everitt. *Proc. I.R.E.*, April, 1941.

Acoustic Aerials—
ing from special current distributions could be closely duplicated acoustically by drilling holes of different sizes along the pipe.

It is pointed out that deviations

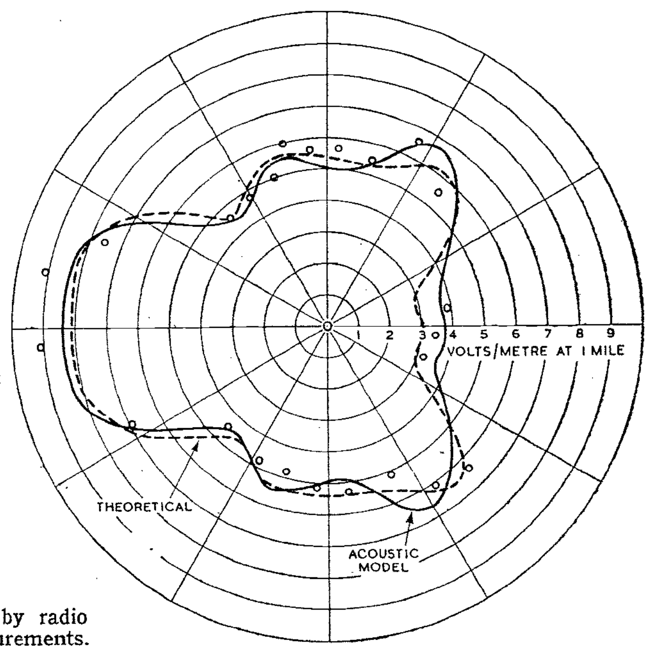


Acoustic matching unit for independent control of phase in each aerial unit.

from sinusoidal current distribution in the aerial have marked effects on the high-angle distribution of the field which are difficult to calculate and measure, and it is in this direction that the results given by the acoustic model are invaluable.

For some purposes an acoustic model consisting of two point sources, one at ground level and the other at the top of the aerial, may be used. This method is not accurate for high-angle measurements, but is useful at lower angles at short distances, and where only the vertical component of the field is required.

Mutual impedance measurements of two aerials can also be made by the acoustic method. The principle involves the measurement of the distribution of pressure and phase due to one aerial along an imaginary line corresponding to the position occupied by the second. This is done by using a two-point



Comparison of field strength of WLW directional aerial obtained (dotted) by calculation, (full line) from acoustic model and (single points) by radio field strength measurements.

source for the first aerial and exploring the line of the second with a probe microphone, both the pressure and phase being measured electrically by oscillographic comparison of the input and output circuits.

Models of directional aerial systems employing more than one radiating element have been built, and their field patterns are found to agree closely with their electrical counterpart as far as it is possible to measure the latter. In systems of this type the relative amplitude and phase in the various elements is of great importance. Relative amplitude in the acoustic model is easily arranged by using separate driving units, but the phase is not so easy. The simplest method is to use a "trombone-slide," but this cannot be used unless the pipe acting as the transmission line is terminated with its characteristic impedance to eliminate standing waves. If there is a perfect standing wave on the line, the phase of the pressure at the end does not change with the length, but the magnitude of the pressure varies and the phase stays constant until it reverses when the pressure passes through zero at certain critical lengths. To overcome this difficulty the transmission line must be properly terminated by a method similar to variation of tapping points on an electrical line. Since it is not feasible to move the tapping point along a pipe containing a standing wave, the same result is obtained by using two plungers to move the standing wave system past the stationary tapping point.

This method was used successfully in an acoustic model of the directional aerial system at station WLW, from which useful information about the high-angle radiation was obtained. As a matter of interest, the ground level polar curve is reproduced, showing the close agreement with theoretical and radio field strength curves.

The acoustic method of aerial design is not only of value in studying actual cases, but may be used to produce special polar curves for which methods of obtaining the required current distribution are not yet known. What these current distributions should be can be easily stated after measuring the pressure in the pipe by the stethoscope method. These can then be handed to the radio engineer as a guide to the line of development.

Identifying the Luftwaffe

SEVERAL new types of aircraft being used by the *Luftwaffe* are depicted on the revised edition of the *Flight* identification chart of German aircraft. The chart, which comprises 15 silhouettes of the leading types of German aircraft supplemented by 44 line drawings and measures 13½×20½in., can be ordered from the Flight Publishing Co., Ltd., Dorset House, Stamford Street, London, S.E.1, price 1s. 3d., plus 6d. postage on single copies, 7d. up to three copies, or 8d. up to six copies.

BOOK RECEIVED

Blueprint Reading Simplified. By A. C. Parkinson.—This book points out the great advantages to all engineering workers of being able to read machine drawings quickly and accurately, and takes the reader through what is virtually a concise course in engineering drawing. Wireless men know how great a handicap it is not to be able to read and understand a theoretical diagram, which may be described as the shorthand form of the cumbersome pictorial or practical wiring plan. To the mechanical engineer the machine drawing is analogous to the theoretical circuit diagram, and lack of ability to understand it at a glance forces him to rely on a pictorial representation. Pp. 91; 183 figures. Sir Isaac Pitman and Sons, Ltd., 39, Parker Street, Kingsway, London, W.C.2. Price 6s.

Salving Accumulators

Regeneration of Sulphated Cells

By A. HICKLING, M.Sc., Ph.D.

IT is a common and annoying experience that lead accumulators which are only intermittently in use for laboratory or experimental work gradually lose their capacity and their ability to hold a charge. This is due in nearly all cases to the sulphating of the negative plates which takes place if the cells are allowed to stand idle for lengthy periods. It does not seem to be generally realised, however, that there exists an extremely simple method by means of which even very badly sulphated accumulators can be restored to practically their original capacities. This method, which was originated by Bennett and Cole many years ago,[1] consists merely in replacing the sulphuric acid electrolyte by a solution of sodium sulphate, giving a long charge in the ordinary manner, and then washing out with distilled water and filling with fresh acid. The results of this treatment are remarkably good, as is shown by the following test carried out by the present author.

Eight 2-volt accumulators of a very well-known make were selected for testing out the method. They had given good service over a period of about six years, but owing to irregular charging they had eventually become badly sulphated and were almost useless. The cells, which were of the multi-plate celluloid-cased type, had originally a capacity of of 30 ampere-hours (Ah).

The accumulators were first charged in the ordinary way at 2 amps. for 25 hours. They were then put on continuous discharge at 0.5 amp., and their useful life was considered ended when the voltage (on discharge) fell to 1.80 volts. The capacities, measured in this way, were:—

Accumulator No.	1	2	3	4	5	6	7	8
Capacity (Ah)	4·5	4·5	5·5	6	5·5	5·5	5·5	5·5

It is seen that in most cases the capacities were only about a sixth of the original values. The cells were then emptied, washed out twice with distilled water, filled with a 20 per cent. solution of sodium sulphate (200 grams of crystalline salt $Na_2SO_4 \cdot 10H_2O$ per litre[2]), and charged at 2 amps. for 50 hours. They were then again emptied, washed out twice with distilled water, filled with sulphuric acid of specific gravity 1.25, and their capacities measured in exactly the same way as before. The new values were:—

Accumulator No.	1	2	3	4	5	6	7	8
Capacity (Ah)	29	29	29	29	28	29	29	29

It is seen from these results that a most remarkable improvement in the capacities of the accumulators had been brought about, the new values not being very different from the original rating. To test whether this improvement would be maintained on subsequent ordinary use, the discharged cells were now recharged at 2 amps. for 25 hours and the capacities again measured. The results given below show that the improvement is substantially maintained.

Accumulator No.	1	2	3	4	5	6	7	8
Capacity (Ah)	28	26	28	27	27	29	29	28

The treatment does not seem to affect the cells disadvantageously in any way, and there was no undue shedding of active material.

The mechanism of the regeneration appears to be roughly as follows: When a lead accumulator is allowed to stand for long periods in the discharged state, the fine particles of lead sulphate on the cathode tend to dissolve in the electrolyte and reprecipitate as larger and more insoluble crystals on the electrode. In this form the lead sulphate presents a relatively much smaller surface area, and is not readily reduced back to lead by cathodic hydrogen when the cell is recharged. The capacity of the accumulator is then very much lowered, and we have the phenomena associated with sulphating. On charging with a sodium sulphate electrolyte, however, the liquid in the vicinity of the cathode becomes alkaline owing to the discharge of hydrogen ions, and the lead sulphate dissolves, the lead being then subsequently deposited on the electrode in a finely divided form and the cell is restored to its original condition.

The merits of the regeneration treatment seem to be such that it should be widely known among electrical experimenters, as it is extremely simple (as opposed to various methods of chemical regeneration proposed from time to time), and it serves to restore to useful life many accumulators which would otherwise be discarded—probably a serious matter in these days of shortages.

[1] *Transactions of the American Electrochemical Society*, 1912, **21**, 303.

[2] The solution may be made by using commercial Glauber's salt at the rate of 4 oz. per pint of distilled water.

LETTERS to the EDITOR

The Editor Does Not Necessarily Endorse the Opinions of His Correspondents

Should Amateurs Know Morse?

THE letter signed "No-Remorse" in the November issue needs answering. No doubt "a very large proportion of our best radio engineers do not even pretend to know morse." Similarly, a very large proportion of our best radio amateurs do not pretend to be radio engineers.

As for the statement that "quite a lot of amateurs scrape through a morse test and then either buy a ready-made transmitter or a kit of parts . . ." isn't it time to publish some facts about this point? It would be interesting to get the R.S.G.B. to conduct a census, but as that may not be possible I have made a private "census" of local amateurs. Out of twenty-three local amateurs with radiating licences, only one was using a commercially built transmitter. There were *no* kit transmitters in use. The remainder, of powers up to ¼ kW, were home constructed. As for the receivers, there were eight American-built communications sets. The remainder were home-built straight sets. Nine of these stations used CW only; only two worked exclusively on telephony. These results show that, in this area at least, the amateur with no knowledge of morse would be unable to contact 40 per cent. of the locals at all, and would be unable to contact the majority for 50 per cent. of the time. Of course, these figures may not hold over the whole country, but it seems probable that these results *would* be confirmed by a country-wide survey.

If "No-Remorse" has no knowledge whatsoever of morse, and therefore cannot have first-hand knowledge of pre-war amateur CW operating, he is not qualified to criticise the necessity for morse, however learned his 20 years' radio technical experience may have made him.

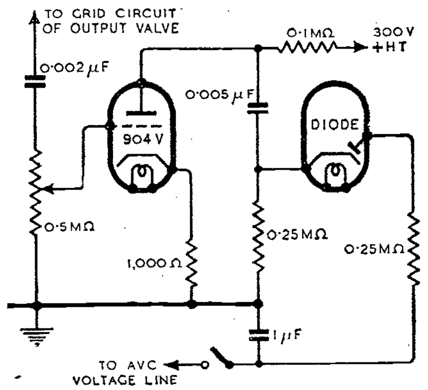
With regard to the proposal to divide amateur bands into separate phone or CW bands, there are one or two objections. It would inevitably lead to the need for a multiplicity of crystals, which many amateurs, especially the younger ones, are not in a position to afford. One of the chief joys of amateur work is constructing really good gear out of junk picked up for next to nothing. A new crystal may mean several weeks' pocket money for these young enthusiasts.

"SIGNALMAN."

Supplementary AVC

YOUR readers may be interested in a circuit, which I have devised and had in use for the past year or so, for minimising the effects of selective fading.

It is, in effect, a limiter whose threshold working point is determined by the normal AVC voltage. Thus, under normal reception conditions it does not operate, but operates when the carrier voltage drops. It then produces an "artificial" AVC voltage, which depends mainly on the higher pitched part of the sideband frequencies, i.e., the part that is most prominent during selective fades. Also AVC is "slowed down" due to the 1-mfd. condenser, which all goes to help the action during high-speed fading.



This device has the effect of stopping all extra loud bursts of sound and seems to reduce harmonic distortion, probably because it prevents overloading of the RF and IF stages.

London, S.W.19. R. G. YOUNG.

Post-war Wireless

SOME of your more politically minded readers may object to your reference to "immutable economic laws," for since economics is a function of man-made society, its laws which were made by man can be altered by other men. But what I believe you have in mind is that the wealth and labour devoted to radio will not exceed the proportion due to its potential services to mankind at the present state of organisation of a mechanised society.

Neither Mr. Rosen's article nor your Editorial gives serious consideration to the possible uses of radio. For example, is there not likely to be a great use of "blind-landing" equipment and other forms of specialised D.F. for civil aviation after the war, to say nothing of the radio altimeter? Then consider the American "Highway Radio" for giving instructions to motorists; this points to a further sphere of application of radio to assist transport. An entirely different sphere is the electric calculating machine; everyone knows that the Totalisator is worked electrically, but there are also machines for solving differential equations which cannot be solved by calculation, and there are numerous other applications of electrical technique to the assistance of other forms of science. Many of these are, of course, small-scale uses which would not absorb much manufacturing capacity; but I mention them to reinforce my main argument, which is that one cannot take it for granted that entertainment will retain first place in radio production after the war, but that we have yet to investigate what use could be made of radio technique in a world in which the economic law governing production was the benefit of the product to the community.

D. A. BELL.

London, N.21.

Training of Wireless Engineers

THE trouble about which Mr. Webb complains in the November *Wireless World* is tackled at its root in Mr. Edward E. Rosen's article, appearing in the same issue. The present war has given support to the view (which seems to be implicit in Mr. Rosen's article) that here, as in America, radio engineering should be acknowledged as a distinct and separate profession.

Every support should be given to Mr. Rosen's suggestion that British universities should establish degrees in which radio and allied engineering may be taken as a main subject. A National Certificate in Radio Engineering, also sponsored by Mr. Rosen, has been advocated by this Institution in correspondence with the Board of Education since 1935. The proposal was turned down by the Board on the grounds that the requirements of the embryo radio engineer were met by the curriculum of the National Certificate in Electrical Engineering!

The Professional Purposes Committee of this Institution recommends not only that a National Certificate in radio be established, but that, like all other National Certificates, it should provide for specialisation. This affords a safeguard against the danger of certain branches of radio engineering (e.g., television) coming to be erroneously regarded as separate arts or vocations, and not as applications of radio engineering.

It is sincerely hoped that this Institution's renewed request, made through Lord Hankey, for the establishment of a National Certificate in Radio Engineering will be granted without undue delay.

G. D. CLIFFORD,
General Secretary,
The British Institution of Radio Engineers.
London, S.W.1.

Broadcast News Presentation

I WAS keenly interested in the Editorial in your June issue entitled "Presentation of Broadcast News," particularly your observation that the make-up and style of broadcast bulletins has undergone little fundamental change since 1939, or, for that matter, since 1922, and that broadcasting is still too much like the newspapers and the newspapers are too much like broadcasting. In support of this contention you point out that the morning newspapers often contain long items in the same words as the radio bulletins of the previous night. Another interesting observation in your article was that what might be termed "geography lessons" in news bulletins annoy well-informed listeners. You argue that there should be a well-defined line between real news on the one hand and commentary, exposition or speculation on the other, and that news proper might be broadcast in "telegraphese" to ensure the utmost economy in words.

I cannot pretend to have any first-hand knowledge of the contents of news bulletins in the Home Service of the B.B.C., but I have listened carefully to the Empire bulletins[1], and, in common fairness to the men who write them, I must say that many of them bear evidence of careful sub-editing. They are not written in "telegraphese" and they do contain, at times, information which might be regarded as "geography lessons," but, so far from annoying even well-informed listeners, this information seems to please them. In my experience, not many people are so well informed to-day that they can call to mind at a moment's notice the information required to give them a clear understanding of any and every news item broadcast. I agree that the inclusion of information can be overdone, but I think there is a happy medium in which sufficient explanatory matter is added to give the uninformed listener a clear picture of the happening, without at the same time annoying the informed listener.

In my opinion, the difference between newspaper and radio treatment of news lies not so much in the choice of material as the way in which it is presented. I believe that radio should tell its story in broad, bold outlines. All unnecessary detail should be excluded, and so should every word which does not play a vital part in the story. It is not easy to do this and at the same time preserve euphony of language and continuity of thought. Radio news writing must be euphonious, otherwise even the best announcer cannot read it smoothly.

A successful radio news writer must first of all be a clear thinker. Once he has absorbed the facts of a story he should be able to pick out the points that really matter and express them in clear, simple language. A really good man can tell a big story in 150 words. I have frequently seen fairly big stories told in 100 words. Obviously, much detail had to be omitted, but listeners got a good picture of the things that really mattered. In my experience, that is all they ask for and that is what I think they should get. Australian listeners, at any rate, would soon protest if they thought we were keeping back part of a story because it was difficult to tell over the air; they would also resent any withholding of details in the interests of the newspapers.

Finally, I think every radio news writer will agree that good "copy" isn't turned out by accident. At the risk of being redundant, I repeat that clear thinking must precede clear writing. The man who cannot think clearly will never make a good radio news writer. Lest it be thought that I am reflecting on journalistic standards, I hasten to add that he will never make a good newspaper man either.

M. F. DIXON,
Federal News Editor,
Australian Broadcasting Commission.
Sydney.

[1]The bulletins are hardly comparable to those of the Home Service, to which our original criticism referred. In our view, most of the oversea transmissions, which are constantly improving and are now much better than when our correspondent's letter was written, are vastly superior in presentation. A widely held opinion is that they are more "grown-up."—ED.

Random Radiations

By "DIALLIST"

A Mild Brain Teaser

RECENTLY I had to take an exam, the first I'd sat for for many, many years. One of the questions looked a gift at first sight, but a little thought showed that it wasn't such money for jam as it seemed. Here it is in case you care to have a go at it. A potentiometer whose windings have a resistance of 60,000 ohms is connected across a 240-volt source of DC. The slider is connected to the anode of a pentode and is adjusted to make the anode voltage 180. The valve passes a steady current of 6 mA at all anode voltages above 60. What is the resistance of the windings between the slider and the negative end? "Easy," you cry. "Two-forty volts through 60,000 ohms means a steady current of 4 milliamps. So between the slider and the positive end the current is 6 *plus* 4, equals 10 milliamps; resistance 6,000 ohms. Answer: 60,000 *minus* 6,000, equals 54,000 ohms." But what about the fixed resistance represented by the valve, which is in parallel with the windings between the slider and the negative end? The true answer is obtainable only by simultaneous equations and a quadratic. Have a shot! Our old friend Kirchoff's second law is the key.

Common Sense

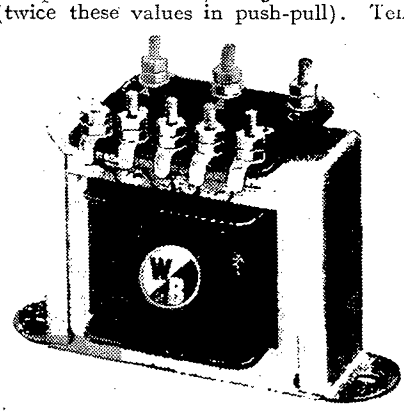
Anyhow, it's what I call a silly question. Your practical man, if he wanted to know the answer accurately, would never have bothered about quadratics. He'd have stuck a milliammeter between the negative end of the potentiometer windings and the earth line. Knowing the current through the part of the windings between the slider and the earth line, the simplest of calculations would have given him the answer. Personally, had I been marking the paper, I'd have given about 3 out of 10 to those who indulged in intricate calculations and got the right answer, and full marks to those who got the rough answer of 45,000 ohms and added that they'd use the milliammeter method to obtain absolute accuracy. Exams are apt to expect far too academic an attitude in answering questions, whereas amidst the brass tacks of actual working it's the essentially practical approach to a problem that is of the first importance.

Those Voltages

IN the course of the present war I've been stationed in a variety of places and had a queer assortment of quarters, ranging from wooden huts (they have been my chief abiding places) to requisitioned houses, generally slightly bent by bombs or land mines, and even, during one blissful month, to a luxury hotel. Wherever I go I take with me a small wireless set and a reading lamp, hoping that even the wooden huts and the semi-wrecked houses may have electric supplies of a kind. Generally they have, though during the winter of 1939 it was a case of oil lamps and a battery set—*when* I could get HTBs. But the voltages have been a bit of a nightmare. The set can cope with anything from 200-240 DC and has a rather bigger range on AC so long as the frequency is 50 cycles. Only twice has it been stymied—once by 100-volt DC and once by 25-cycle AC. But I've had to collect a fine varied assortment of bulbs for the reading lamp! Let's hope that one of the benefits of post-war reconstruction will be the standardisation of voltages and frequencies in the supply mains of this funny old country of ours.

W.B. Senior Output Transformer

DESIGNED to match the majority of loudspeakers to any type of high-resistance output, this new output transformer is suitable for heavy duty and will pass currents up to 50 or 60 mA. (twice these values in push-pull). Ten



ratios ranging from 10:1 to 75:1 are available, and four of these may be used with push-pull circuits. The makers are Whiteley Electrical Radio Co., Ltd., Victoria Street, Mansfield, Notts.

The Fan Problem

YOU may remember that I wrote a month or two ago of difficulties experienced with some of the cheaper American-made electric fans. The big snag is that the windings of the induction motor haven't sufficient reactance to 50-cycle AC to reduce the current to an amount that they can safely carry. Hence they are apt to burn out, especially if the spindle is not running freely through lack of lubrication. And when you tackle the job of rewinding you find that you can't make bigger coils because there's no room in the casing. An idea worth trying out struck me, and it proved to give the answer. A 1-microfarad condenser has a reactance of about 3,000 ohms at 50 cycles. That was obviously too much, so one of 2 microfarads was tried in series with the windings. This gave a fair speed. Three microfarads gave a speed rather on the high side. Though the windings didn't heat up, the bearings did after a longish run. The solution eventually found was to use two small 500-volt test condensers of 1 and 2 microfarads respectively and to fit a switch so that either 2 or 3 microfarads could be used.

Caution Needed

The fan can then be run for, say, an hour, with 3 microfarads in series; then, if its motor case becomes hot the switch is turned over to the 2-mfd. setting and it is run like that till it cools down. I don't know the inductance value of the motor windings, but the speed when 3 microfarads are used with my fan leads me to believe that not so very much more capacity would produce something getting on towards resonance. And that would, of course, mean fireworks, for in such an acceptor circuit capacitive and inductive reactance then cancel out, and there's nothing but the ohmic resistance left to oppose AC. If, therefore, you have rewound a small fan or want to curb the exuberance of one that hasn't yet burnt out, be careful in your experiments with series capacities.

Servicing Difficulties

THE other day I was talking to a first-rate serviceman, one who really does know the job and can always be relied upon for good work. He was remarkably cheerful, considering the difficulties of the times. Having a wide circle of customers, he employed three or four assistants in peacetime; now every man Jack of them has been roped into the Navy, the Army or the R.A.F., and he is left to do the work entirely off his own bat. How he manages I don't know, for things are not so simple or straightforward as they once were. In the gay days of peace, when a certain component in a certain set broke down beyond repair, all that had to be done was to remove it and put in a replacement. Nowadays, especially if the set is an oldish one (and almost certainly if it is of American make), the replacement component may be unobtainable. The easy way out of the difficulty is, of course, to tell the customer that nothing can be done about it. But the good serviceman doesn't work on those lines. He thinks out ways of substituting a component that is available, even though its characteristics are somewhat different.

Ways and Means

This may entail—it often does—making quite considerable alterations in the set under repair. But if the serviceman knows his job the result is a receiver that functions once more, though some of its circuits may be very different from what they were when it left its maker's factory. The serviceman of whom I'm writing told me of one ingenious tip of his own and asked me to make it known for the benefit of any of his brothers of the craft who may run up against this particular snag. Here it is. Some of the American midgets use the 50L6 output valve. These *can* be obtained, but as the price has soared to £2 10s. or so a substitute at a more reasonable figure is much to be desired. There is a substitute, the 25L6, which is not too hard to find or too highly priced. I don't know these valves, but I believe that 50L6 has a 0.15-amp. heater and the 25L6 a 0.3-amp. heater. The solution is to load up the filaments of the other valves (including the rectifier, probably a Z4) to 0.3 amp. I'm told that the line-cord resistance doesn't get unduly hot—if it does it can be rewound with heavier wire. Anyhow, some of the "doctored" midgets have been working well for 7 or 8 months, so the eating seems to prove that pudding satisfactory.

Abstracts and References

EACH year a subject index to the Abstracts and References section of *The Wireless Engineer* has been published as part of the December issue. This, however, will be discontinued this year, and instead it will be published, together with an index to authors, separately early in 1942. A charge of 2s. 6d., plus 3d. postage, will be made for the index, and, as supplies will be limited, it will be necessary to order copies from the publishers, at Dorset House, Stamford Street, London, S.E.1, before the end of the year.

The November issue of *The Wireless Engineer*, which was on sale on the first of the month, contains more than 250 abstracts from, and references to, recently published articles on wireless and allied subjects in the technical journals of the world. Issues are obtainable to order through newsagents or direct from the publishers at 2s. 8d., including postage.

RECENT INVENTIONS

A Selection of the More Interesting Radio Developments

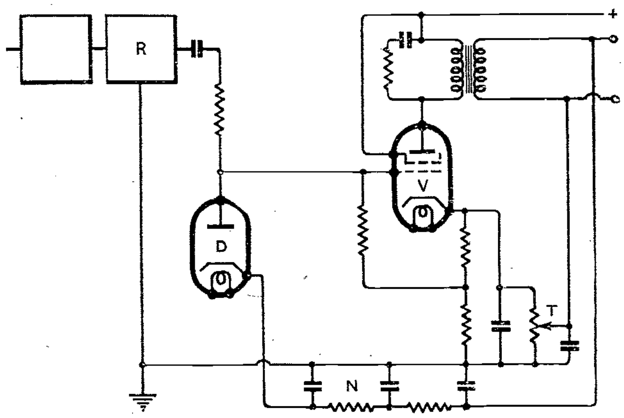
RADIO GUIDEWAYS

A NAVIGATIONAL course for a ship or aeroplane can be formed by transmitting two radio beams so that they overlap slightly. The overlapping part then produces a "lane" or guideway, which is identified by the navigator by the merging together of two complementary morse signals, such as A and N, or T and E, into a continuous note, when the two signals are transmitted separately one on each of the beams.

The width of the "lane" so formed depends on a number of factors, such as the rate at which signals fall off, and the spread of each of the beams. The ideal course would be a line, but this is not possible in practice.

The object of the invention is to produce a narrower lane than that normally available, so that a vessel following it can keep to a straighter course. For this purpose the directivity of each of the two beams is periodically oscillated or "wobbled" through an angle less than that over which a continuous note would normally be received if the beams were kept stationary. In this way the equisignal indication is reduced to the narrow sector in which both oscillating beams overlap simultaneously.

Marconi's Wireless Telegraph Co., Ltd., and S. B. Smith. Application date October 14th, 1939. No. 533185.



Suppression circuit for interference.

FILAMENT CONTROL

WHEN using a high-powered cathode-ray tube, say, for projecting television pictures on to a large screen, it is necessary to heat the cathode to a very high temperature in order to produce the desired emission. Usually the filament current is kept at a constant value by means of rheostat control, but this has the disadvantage that as the filament "evaporates" its resistance increases so that a constant-current drive means an increasing power-input and an unnecessary shortening of the last period of the filament's life. Incidentally, this method of control also gives a greater emission than is necessary in the final period of operation. If, on the other hand, the filament is worked on constant voltage, the emission will fall below that required for satisfactory results.

According to the invention, a rheostat control is used to maintain the emission at a constant level from beginning to end of the filament's life. For this purpose a small auxiliary filament of identical make-up is run in parallel with the main filament, preferably mounted in a separate miniature control tube. An ammeter inserted in the anode circuit indicates the effective emission, and a rheostat in the common supply circuit to both filaments is varied so as to keep the ammeter reading at a constant value.

Baird Television, Ltd., and C. S. Szegho. Application date August 17th, 1939. No. 533650.

SUPPRESSING INTERFERENCE

ONE method of reducing the effect of impulsive interference, such as that caused by the ignition systems of motor cars, is to limit the maximum output of the set both for signals and interference alike, thus preventing the former from being swamped by the latter. In addition, it is possible to insert a shunt circuit across the input, so as to by-pass any disturbances of steep wave-front without appreciably affecting the acceptance of the required signal.

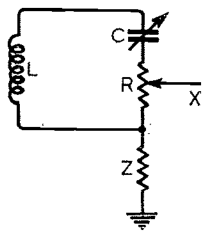
According to the invention, an independently limiting bias replaces the more usual automatic one, and is made to include an audio-frequency component which renders a diode (included in the shunt circuit) non-conducting except when an impulsive disturbance is present, in which case the diode is made conductive and so by-passes the unwanted impulse.

In its simplest form, a diode D is shunted across the input of the AF amplifier V. The signals from a detector are applied to the anode of the diode and also the grid of the amplifier. A tapping T from the output of the latter feeds back to the cathode of the diode a biasing voltage which includes (1) a DC component sufficient to keep the diode on the threshold of being conductive, and (2) an audio-frequency signal voltage which is slightly delayed by a retarding network N. So long as only the required signals are present the diode cannot act as a shunt, but the impact of a sharp impulse automatically unbalances the diode, which thereupon by-passes it away from the amplifying valve V.

Murphy Radio, Ltd., and H. A. Fairhurst. Application date June 23rd, 1939. No. 532521.

ELIMINATING UNDESIRED SIGNALS

THE circuit shown herewith comprises an inductance L, a condenser C, and a resistance R, the latter being earthed through an impedance Z, which may be either an inductance, a capacity or a resistance. If signals are injected into such a circuit by any form of coupling (not shown), then any desired frequency can be excluded from the output taken from the point X by varying that tapping point in such a manner that the potential developed (by the undesired frequency) across the resistance R is equal and opposite to the potential it develops across the impedance Z. The potentials must, of course, be matched in phase as well as being equal in amplitude, and this is ensured by first tuning the main L, C circuit to resonance and then making a fine readjustment of either the inductance or capacity on either side of the resonant point.



Cutting out unwanted signals.

The principle can be used to cut out an interfering signal, particularly where the inductance L is a frame aerial and the voltage developed across Z is, at least in part, that due to the well-known vertical effect.

G. Hodges. Application date August 28th, 1939. No. 533453.

RADIO-ALTIMETERS

IT is well known that the height or clearance of a craft above a reflecting surface, such as the sea or ground, can be measured by transmitting radio energy of varying wavelength, and heterodyning the wave returned after reflection with the wave then being radiated. The resulting beat-frequency will depend upon the time taken by the reflected wave to complete the double journey, and so gives a measure of the craft's altitude.

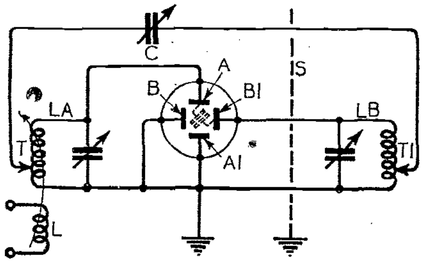
In practice, however, it is found that the desired beat frequency is largely masked by harmonic frequencies, which appear to be due to irregularities in the contour of the terrain or to variations in its conductivity; these auxiliary frequencies also vary, to some extent, with the height at which the observations are taken and the speed at which the craft is moving.

The invention is concerned with a method whereby the demodulation products of the reflected and outgoing waves are analysed, and attenuation circuits, combined with negative reaction and automatic gain control, are utilised to get rid of the undesired harmonic frequencies, or at least so to reduce their effects that the fundamental beat frequency dominates the indicator and so gives a clear-cut indication of the altitude required under given conditions of operation.

Electrical Research Products, Inc. Convention date (U.S.A.) November 16th, 1938. No. 533538.

CATHODE RAY INDICATORS

WHEN measuring, say, the output of a short-wave oscillator, it is usual to apply to the two pairs of deflecting plates of a cathode ray tube, two voltages which are displaced 90 deg. in phase. The simplest method of securing the desired phase-shift is to connect a resistance in series with a condenser across the supply to one pair of plates, the values of the resistance and capacity being determined by the formula $R=\frac{1}{\omega C}$. But for very high frequencies this method breaks down owing to the very low input impedance that will then exist across the plates.



Method of obtaining phase-shift.

The figure shows how the difficulty can be overcome. The plates A, A1 are connected across a circuit LA and the plates B, B1 across a circuit LB, both circuits being tuned to the common output frequency L, and being screened from each other at S. At this frequency they will accordingly behave as pure resistances.

For very high resistances the interplate capacity (shown in dotted lines) may be sufficient to introduce the required phase-difference of 90 deg. Otherwise, they are coupled together from tapping points T, T1 through a condenser C, the tappings being such that the effective resistance in series with C satisfies the formula already given.

E. J. Alway. Application date September 28th, 1939. No. 532984.

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

UNBIASED

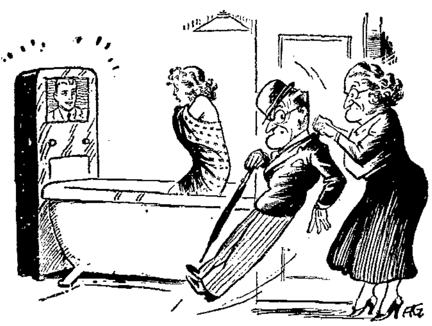
By FREE GRID

Recollections of Long Ago

I WONDER if any of you noticed in your papers recently the report of a case in New York in which a lady secured a divorce from her husband on the grounds of mental cruelty because he had put a television set in the bathroom and it made her feel all hot and bothered to see the announcer's face smiling at her from the foot of the bath when she was sitting in it.

Reading about it carried my mind back to the dim and distant past when we had television in this country, a bygone memory about which I often talk to my grandchildren and tell them that, with luck, they may live to see the day when it returns. In those far-off days I followed my previous practice in the realm of sound broadcasting and equipped each room of the house, including the bathroom, with an extension cathode-ray tube, carrying all feed wires including high- and low-tension supply in a special low-capacity multi-core cable of high insulation.

I well recollect the first time I put this system into operation. We happened to have staying with us on a visit a young niece of Mrs. Free Grid's, a comely damsel of some eighteen summers—I mean the girl, of course, and not Mrs. Free Grid.



"Covered with confusion."

She happened to be in the bath when I switched on, and the ears of Mrs. Free Grid and myself were assailed by piercing shrieks for assistance, coupled with disjointed exclamations about there being a strange man in the bathroom. Not knowing exactly what had happened, Mrs. Free Grid and I raced upstairs together and, flinging her aside, I put my weight against the locked door and broke my way in, ready to do battle with the intruder.

For the moment I stood gaping foolishly until Mrs. Free Grid angrily pulled me out, for there was nothing to be seen but the girl, standing in the bath wrapped in a towel, and gazing horror-stricken at the smiling and debonair features of the Alexandra Palace announcer on the screen. It was perhaps unfortunate that at that moment the announcer was talking about the glorious view before him, but as it turned out afterwards, there was an outside broadcast on and he was giving his impressions of the scenery.

It took quite a lot of arguing on my part to convince the girl and Mrs. Free Grid that television was not a duplex affair and that, although they could see the announcer, he could not see them. In fact, Mrs. Free Grid was never quite convinced, as she fitted a dainty pair of "black-out" curtains in front of the screen which the occupant of the bath could draw or not as circumstances dictated. I noticed, however, that she did not forget to cut a tiny peep-hole in the curtain so that she could see the programme without herself being seen when in the bath.

Electrosurgery

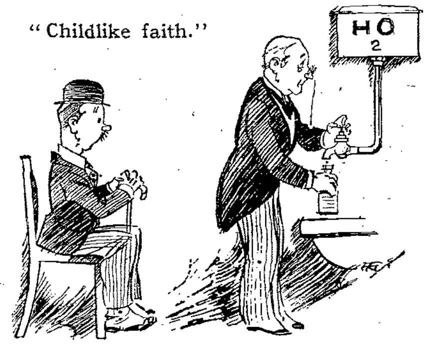
I WAS particularly interested in the article published in *The Wireless World* on radio surgery, as it all seems so absurdly simple. Not that I have any particular desire to try my 'prentice hand as a surgeon, as I still have bitter memories of what happened years ago, soon after I was first married, when Mrs. Free Grid was suffering from a boil on the back of the neck. In a foolish moment of youthful enthusiasm I volunteered to operate on it for her. Whether my hand was unduly shaky, or whether my hacksaw had one or two jagged teeth, I cannot say, but the ensuing yell she set up brought a strongly worded protest about taking the bread out of his mouth from a dentist living next door.

No, the point of the article which interested me was the one in which it was stated that radio surgery was being increasingly used for the "face renewal" operations practised in modern beauty parlours. It so happened that I had been reading the article just before blundering unexpectedly into one of Mrs. Free Grid's "at homes" one afternoon. One glance at the guests which Mrs. Free Grid had invited to make free with my bread and margarine immediately convinced me what tremendous scope there was for this sort of thing, and I immediately saw in it a means whereby I could not only rebuild my depleted fortunes, but could at the same time help my country as a super-tax payer.

Unfortunately, my country did not show itself as willing to help me as I was to help it, for I was unable to obtain the necessary permit to buy the valves which were, of course, in the transmitting class.

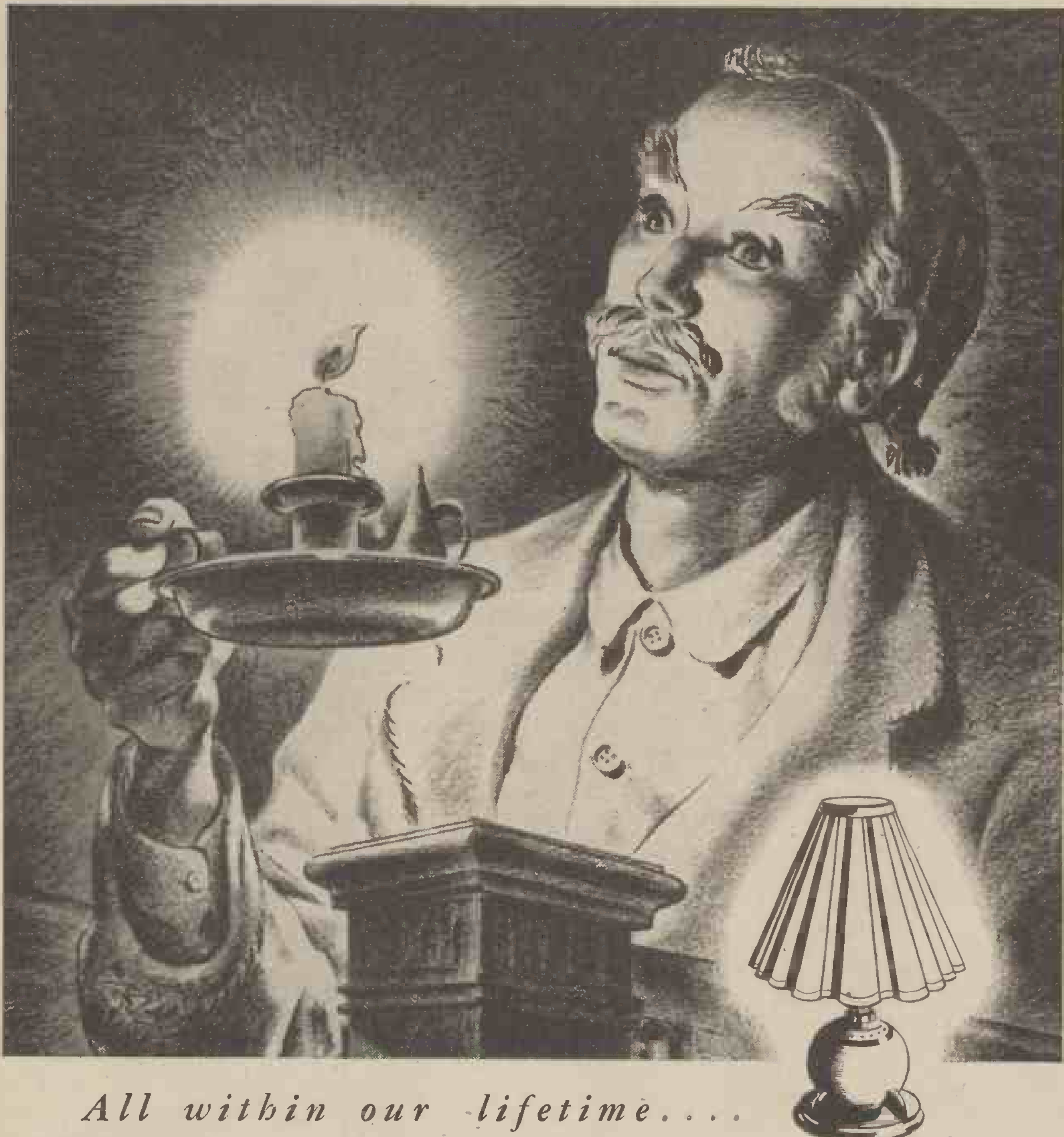
Fortunately, one does not have to depend upon valves entirely, and *The Wireless World* had published a circuit diagram of an alternative

"Childlike faith."



spark generator, and it was a simple matter to construct an induction coil. At length I had everything completed, and at Mrs. Free Grid's next reception I called for volunteers to take their seat in the operating chair. Nor did I lack patients, for it is a curious fact that while men have a childlike faith in doctors, women are equally trusting where beauty specialists are concerned, and, moreover, by a curious kink in the feminine mental make-up, whereas the most *passé* of women never believes that she is beyond repair, yet on the other hand the most young and beautiful of them always imagines that nature can be improved upon.

My first patient was also my last, and I had to spend an anxious half-hour in applying artificial respiration with a stirrup pump. The whole snag was, as I found out afterwards, that I had been working on too low a frequency, this being due to my miscalculating the LC constants of the circuit, owing to my foolishly following "Diallist's" advice in the September issue of this journal and attempting to juggle with his new-fangled "all-in" logarithm tables instead of sticking to the old and trusted long-hand mathematics to which I had been accustomed all my life.



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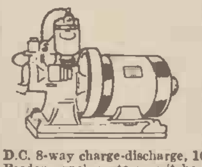

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WANTED, T.P. 2620, 402P., X.30, P.E.N.26, V.M.S.4, K.T.63, 2 of each, must be new valves.—Pablo Scarfi, Maindee Sq., Newport, Mon. [9743

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ROTARY Converters, 230 v. D.C. in, 230 v. 50 cycles out, 1,000 watts, £25; Crypto ditto, 440 watts, £15; Siemens ditto, 400 watts, 60 cycles, £12/10; several others smaller, all voltages, in and out.—Harris, Strouds, Bradfield, Berks. [9784

COMPONENTS—SECONDHAND, SURPLUS, ETC.

SOUTHERN RADIO'S Wireless Bargains:—

5/- Parcel.—Assorted components, including valve holders, volume controls, wire, resistances, condensers, circuits, etc.; 5/-.

25/-—Small trader's parcel of components, 100 saleable items; 25/-.

ORMOND Loud Speaker Units, balanced armature type, 6/6; smaller bakelite type, 3/6; unshrouded type, 2/6; wireless crystals, 6d. each, 5/- per dozen tins; Ace P.O. microphones, complete ready for use with any set, 6/6 each; Westectors W2, 2/6; mica condensers, assorted sizes, 3/- dozen; assorted terminals, plugs and tag ends, 6/9 gross; Telsen radio magazines, complete with 4 blue prints, 6d. post free; Mainsbridge condensers, 1 mfd. 1/-, 2 mfd. 1/9, 4 mfd. 2/9 each; valve holders, assorted 9-, 7-, 5-, 4-pin, 3/- dozen; permanent magnet speaker, W.B., 10in., with transformer, 25/-; thousands of bargains for callers; all goods guaranteed; please add postage to amount of order, approximate postage 7d. on 5/-, to 1/1 on 25/-.

SOUTHERN RADIO SUPPLY Co., 46, Lisle St., London, W.C.2. Gerrard 6653. [9808

MR. F. H. WILSON (late Manager of Radio Clearance, Ltd.) will shortly be opening a new business.

WATCH
THIS
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NEXT
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FOR a
VARIED
SELECTION of
GOOD Quality
RADIO Components.
F. H. WILSON.
[9807

COULPHONE RADIO, New Longton, near Preston. —Latest type PM Speakers, with transformers, 8in. Goodmans, 20/-; 10in. Rola and Goodmans, 25/-; Electrolytics, 500 v, 8 mfd., 3/6, 8+8 mfd. 5/9, 16+8 mfd. 7/3, 50 mfd. 50 v 3/3; Cosmocord Crystal Pickups, 30/-; Erie 1 watt Resistors, all values, 7/6 doz.; Vol. Controls with Switch, 4/9; Tubulars, Valve Holders, etc. S.A.E. for list. [9788

GALPINS

ELECTRICAL STORES

21, WILLIAM ST., SLOUGH, BUCKS.

'Phone: SLOUGH 20855 *TERMS: Cash with Order*

ELECTRIC LIGHT CHECK METERS, small, late type, well-known makers, first-class condition, electrically guaranteed, for A.C. Mains 200/250 volts 50 cy. 1 phase 5 amp. load, 10/- each; 10 amp. load, 12/6; 20 amp. load, 15/-; all carriage paid.

D.C. ELECTRIC LIGHT CHECK METERS, 200/250 volts, 5 and 10 amps., in new condition and electrically perfect; 7/6, post free.

AUTO. CHARGING CUT-OUT AND VOLTAGE REGULATOR, ex-R.A.F., suit any dynamo up to 20v. at 15 amps., fully adjustable, with wiring instructions, complete in metal case, 3/6, post 9d.

SOLID BRASS LAMPS fitted small B.C. double contact holder and 12 volt bulb, price 3/- post free.

110 VOLT D.C. MOTOR, totally enclosed, rated at 8 amps., ball bearing, in new condition, make good slow-speed dynamo, weight approx. 75 lbs., price 45/- carriage forward.

AUTO TRANSFORMER, 1,000 watts, tappings 0—110—200—220 and 240 volts for step up or step down. Price 65/-, carriage paid.

MOTOR-DRIVEN ALTERNATOR, direct coupled, motor, 110 or 220 v. D.C. input, complete with starter; alternator output 220 volts, 50 cycle, single phase, 176 watts, fitted governor; mounted on teak beams and fitted handles for carrying, condition as new, wear nil, size overall 40in. by 9in. by 11in. Price £16, carriage forward.

DYNAMO, 110 volts, 60 amps., shunt wound, interpole, ball bearing, speed 1,750 r.p.m. continuous rating. Price £15, carriage forward.

SPOTLIGHT, case size 9in. by 11in. by 12in., supporting bracket and screw (no stand), complete with margin mirror, condenser and two 500-watt 230 v. bulbs, bunch coils, one lamp, new one used 50 hours. Price £5 carriage paid.

110 V. BULBS 150 C.P., Ediswan screw fitting, half watt gas-filled, 2/6 each, post free, or 22/6 per doz., post free.

ZENITH VITREOUS RESISTANCES, all useful sizes, in perfect working order, price per doz. assorted 10/-, post free.

FRACTIONAL H.P. D.C. MOTORS, for 110 volt and 220 volt D.C. mains, only from 1/20th to ⅛ h.p., state size and voltage required, price 10/- each, carriage 1/-.

TELEPHONE MAGNETOS, or hand calling generators, 3 and 4 magnet type, unboxed, in good working order; Price 7/6, post free.

HIGH-FREQUENCY TRANSFORMERS, 100 v. A.C. input; output 5,000 volts, 500 watts, 500 cycles. 50/- each, carriage forward.

TONG TESTER, 0–50 amps., 1⅞in. gap, in perfect order £3, post free.

EX G.P.O. MORSE INKER AND TAPE RECORDER, complete with actuating relay and tape reel, mounted on mahogany base, clockwork model, in good clean condition and perfect working order. Price £15, carriage paid.

CAR DYNAMOS, small round type, output 6 volts at 10 amps., in perfect working order. Price 17/6, carr. paid.

SHEET EBONITE, size 12in. by 11in. by 1/32in., best quality. Price 4/- per doz., post free.

FIXED RESISTANCE, wire wound on slate, protected, 40 ohms to carry 1½ amps., new and unused. Price 6/-, post 9d.

LARGE TRANSFORMERS for rewinding, rating unknown, size 1 kW. auto. Price 17/6, carriage paid.

LARGE TRANSFORMERS for rewinding, size 2 kW. auto., rating unknown. Price 30/-, carriage forward.

WOUND RESISTANCES, mounted on enamelled iron, overall size 12in. by 1½in., resistance 6 ohms, wound with 18 gauge chrome nickel wire, new and unused. Price 2/6 each, post free, or 25/- per doz.

HIGH-VOLTAGE CONDENSERS, size 4in. by 4in. by 10in. 1 mf. 4,000 v. working. Price 15/-, carriage paid.

ROTARY CONVERTOR by "Electro Dynamic," complete in case with smoothing, 220 v. D.C. input; output 230 v. A.C. 50 cycle, single phase, 170 watts. Price £7/10/-, carriage paid.

DIMMIER RESISTANCE, slider type, protected, for 230 volt Mains, 500 watt size, graduated wire. Price 35/-, carriage 1/6.

VOLTMETER by "Crompton," switchboard type, 6in. dia. for A.C. or D.C., reading 0 to 1,200 volts, first reading 400 volts. Price £2/10/-, carriage paid.

LARGE A.C. MOTOR for rewinding, size 2 to 3 h.p., induction type, in good mechanical condition, ring oiler bearings. Price 50/-, carriage forward.

LARGE HOT-AIR ENGINE, 5¼in. dia. piston, in good mechanical condition. Price £4, carriage forward.

Lockwood CABINETS

ACOUSTICALLY DESIGNED

The only Standard Radio Cabinets with acoustic lining.

Our Model AD500 has been designed for Quality Reproduction. An idea of its efficiency and freedom from "box resonance" can be obtained from the weight which is approximately ¾ cwt. Although supplies of raw materials are very limited we are still able to manufacture a few of these famous cabinets and also our consoles, from time to time.

For full details of this and other standard models send 2½d. stamp.

Special designs to your requirements—FREE on request.

LOCKWOOD & CO.

65, LOWLANDS RD., HARROW, MIDDX.

'Phone: BYRon 1813

FOR THE RADIO SERVICE MAN, DEALER AND OWNER

The man who enrolls for an I. C. S. Radio Course learns radio thoroughly, completely, practically. When he earns his diploma, he will KNOW radio. We are not content merely to teach the principles of radio, we want to show our students how to apply that training in practical, every-day, radio service work. We train them to be successful!

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Please explain fully about your Instruction in the subject marked X.

Complete Radio Engineering
Radio Service Engineers
Elementary Radio **Television**

If you wish to pass a Radio examination, indicate it below.

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P.M.G. Certificate for Wireless Operators
Provisional Certificate in Radio Telephony and Telegraphy for Aircraft
City and Guilds Telecommunications

Name.. Age......

Address ....

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(Use penny stamp on unsealed envelope)

G. A. RYALL, "Arnehurst," Marsh Lane, Taplow, Bucks (late Ryall's Radio, London), offers radio components. Post free. Please give alternatives where possible.

T.C.C. Wet Can Upright 8 mfd. Electrolytics, 440v., soiled or slightly dented, working order, 12/9 per dozen, 6/9 for six. G.E.C. electrolytic blocks (as used), inverted type, slightly soiled, 14×14×7×3×3× 20×20 mfd., at 450-450-350-450-35-35v., two common leads, 4/9 per block. T.C.C. Midget cardboards, 25 mfd. at 25v., plus 10 mfd. 150v., 1/3 each. Hunts 4 mfd. 350v., slightly soiled, O.K., 9/6 dozen, few only; 10 mfd. 50v., 9/6 dozen.

PLESSEY Tuning Coils, in oval cans, oddments only, aerial, B.P., etc., no sets, two for 1/3. Ferranti screened coils, pairs, Aerial and H.F. transformers with reaction, 2/6 pair, with coil connections.

CELESTION Loud-speakers, energised type, with and without transformers, m.c., mostly 8in. (a few 6in.) fields, 600, 920, 1,200, 2,000, 6,500, 7,000, mostly been damp, out centre, at 12/6 per box five, 17/6 per five, and 22/6 per five, according to condition. Please give alternative if best not available; assorted boxes if required. Please give full details of requirements, and alternatives. All carriage paid.

CELESTION M.c. Oval Loudspeakers less transformers, speech coils, 30 ohms, handle 8 watts, fields 750 ohms, 70-100 m.a., been damp, slightly out centre, cones, etc., perfect; 3/9 each, 6/9 pair, 30/- per box ten, carr. paid.

RESISTANCES, well known make; ¼-watt, 1 meg., 1/3 dozen, 9/- gross; ditto, ½-watt, 800 ohms, 1/3 dozen, 10/- gross; 400 ohm ½-watt, 1/3 dozen, 10/- gross.

CLIX Chassis Valve Holders, 5-pin oblong, 7-pin lemon and round, 4-pin round, all 2/3 dozen. American, 7-pin and Octal, chassis, British make, 4/- dozen. Insulating tape, 2oz. reels, 1/3 lb.

VOLUME Controls, U.S.A. make, 60,000 ohm, broad base, medium brass slotted spindle, less switch, 1/6 each; Sator midget 1 meg. and 400,000 ohm and 100,000, 1/3 each; British make broad base 1 meg. and 0.4, at 1/6 each, slightly soiled.

G.E.C. "Tuneon" Tuning Indicators, as used in the "AVC Five" neon type, 1/3 each; slow motion (epicyclic) drives, fit ¼in. shafts, long ¼in. spindles, well made in brass, with ball bearings, ratio 8-1, 1/3 each.

PAXOLIN Strip, 2½in. wide, as used for group boards, etc., three 12in. lengths for 1/6; group boards, with tags, 12-way, two for 1/3; or drilled, less tags, four for 1/3.

AMERICAN 2v. Battery Valves, sets three, American bases, 1A4VM/HFP, 1B4HFP, 2101 ½-watt output pentode; 6/6 set three; suit Philco sets.

ERIE Resistors, ½-watt type, actual values, as used in many well known sets, 140, 150, 200, 220, 270, 3,300, 6,000, 7,500, 18,000, 25,000, 27,000, 33,000, 150,000, 330,000, 390,000, 1½ meg., 3/- dozen, new goods; Erie resistors, 2 watt type, 800, 1,000, 1,500, 7,500, 8,000, 8,200, 12,000, 12,500, 30,000, 40,000, 56,000, three for 1/6, new goods; Erie resistors, 3-watt (note, many sizes in 2w. and 3w. are offered with a view to being used in parallel), 150, 300, 330, 390, 400, 680, 700, 1,500, 2,200, 3,300, 4,700, 6,800, 7,000, 12,000, two for 1/6, new goods; T.C.C. 0.1 mfd. tubular non-inductance condensers, 350v. wkg., 5/6 dozen, new goods.

KNOBS.—Small brown Ultra pattern, 1/3 dozen; large black mottled, 2in., three 1/3; Cossor light brown "Volume" round, dark brown octagular, "Radiogram" with arrow, "Wave change," 2/3 dozen, all with brass insets.

CLIX Input Strips, A. and E. P.U. loudspeaker, etc., 2-, 3-, 4-, 5-way, 2/3 dozen; plugs, 1/3 dozen; plug and socket, 3-position, as used for mains input adjustment, three, 1/3.

LARGE Goldtone H.F. Mains Chokes, heavy duty, two for 1/6, may be slightly soiled; Ferranti wire wound resistors, nickel end caps, 4,000, 6,000, 8,000, 35,000, 4 for 1/3.

CLYDON Type Trimmers on Ceramic Bases, 70 mm., 2/6 dozen; double trimmers on Paxolin, ex G.E.C., not joined, 2/6 dozen; single ditto, 1/6 dozen; ditto, not mounted, 1/2 dozen.

REX Type Switches, 4-bank, 2-pole, 4-way, 5 with shorting plates, 2/6 each; Rex type switch wafers, 3-way, 2-, 3-, 4-pole, 4 for 1/3.

VALVES.—Europa AC/L 4v. 1 amp., makes good detector or L.F. amplifier, 3/3 each; Europa AC/HP 5-pin base, 3/3 each (metallising of the AC/HP may be rather soiled but all O.K.).

WELL-KNOWN Make Mica Condensers, 0.0028 and 0.003, 1/3 dozen; silver mica Saor, 0,00015, 0.00045, 0.0005, 2/3 dozen; wave traps, ex K.B., iron core, 1/3; switches for band pass H.F. and dial lights, Wearite type, 1/3.

BATTERY Leads, 4-way with plugs, two for 1/6; cable, 4-way single strand in one cover, 4 yards, 1/3; single connecting wire, white, 18 yards, 1/3.

U.S.A. Make 1 watt Resistances, approx. sizes 17,000, 60,000, 70,000, 80,000, 90,000, 24 for 1/6.

PLESSEY 2-gang Screened Variable Condensers, with trimmers, straight type, 3/-; 2-gang, unscreened, with ceramic insulation, 3/-, less trimmers; 3-gang, screened with one trimmer only, 3/-; all straight, no superhet. types. Condenser drives, with 2-band scale, less escutcheon, similar Polar VP, 1/9.

(This advertisement continued on next page.)

All Power Transformers

It would be difficult to enumerate the various types of winding and components which we produce.

Sufficient to say — We specialise in the manufacture of Mains Transformers and Chokes of every type and size. Supplied in quantities or singly; We are willing also, to co-operate in the production of any proposition put to us, within our scope, to execute, with care and promptitude.

Write us for particulars:

ALL POWER TRANSFORMERS LTD.,
8a, Gladstone Road, Wimbledon, S.W.19

'Phone: LIBerty 3303

RELAYS for A.C. and D.C.

SILENT & RELIABLE

2 VA coil consumption, from 2-600 volts, tested to 2,000 volts. Unmounted and in cast iron casing. Also Time Lag Relays. High Sensitive Relays, complete control plants.

Midget Relay type ML *(for D.C. only)*

Apply for leaflet SPN/WW

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Electrical Remote Control Engineers and Manufacturers

Anerley Works, 207, Anerley Road, London, S.E.20
Tele.: SYDENHAM 6258/6259.

WARD

WE MANUFACTURE:

ROTARY CONVERTERS DC/AC for operating P.A. amplifiers, Radio Receivers, etc.

DC/DC ROTARY TRANSFORMERS, SMALL ALTERNATORS, SMALL DC MOTORS, H.T. GENERATORS, MAINS TRANSFORMERS up to 10 k.v.a. **PETROL ELECTRIC** generator sets up to 50 k.v.a. **BATTERY CHARGERS** for private and industrial use.

Full details of any of the above upon request.

CHAS. F. WARD

Office and Works:

37, White Post Lane, Hackney Wick, E.9

Tel.: Amherst 1393.

(This advertisement continued from previous page.)

BULGIN Single Toggles, less fixing nuts, three for 1/3. Items forming R.C.C. unit T.C.C., 0.01 mica, 120,000 Erie 1-watt, 300,000 ½-watt, two for 1/3. Group boards with Erie 10,000 3w., 4,700 2w., 1,200 1w., 500 1w., 1,200 ½w., 100,000 ½w., 1/8 each. Few only.

INVERTED Type Mansbridge Condensers, 2×1 mfd., 400v., wkg., 1/3 each; large capacity Mansbridge low-voltage for cathode by-pass, pair in one block, 1/6; Mansbridge 8 mfd., 400v. wkg., no fixing, 2/6 each. Small blocks, 0.5×0.5×0.25×0.25, two 1/3.

SPECIAL Note.—We now confine our business to Mail order, prompt attention, in rotation, from a quiet situation. Our customers should note that when the present stocks are disposed of there is no likelihood of our being able to offer further surplus goods.—G. A. Ryall, "Arnehurst," Marsh Lane, Taplow, Bucks. [9792

LONDON CENTRAL RADIO STORES Offer Finest Bargains in Radio and Electrical Gear.

PHILIPS Speech Transformers for Pentode Output; 3/6 each.

MORSE Keys. Don't confuse these with inferior junk; it's a super job; 8/6 each.

VALVES are in Short Supply; stock of Mullard T.S.P. 4's and H.V.R. 2's to be cleared at 15/- each; first come, first served.

CONDENSERS.—Special offer of metal cased paper condensers, 300v. working, all brand new and unused, 0.2 mfd., 1/9; 1 mfd.×1 mfd., 1/9; 1 mfd., 1/-; 0.5, 0.25, and 0.1 mfd., 8d.

RESISTORS, 10 watt, 100 ohm vitreous enamelled mains resistors, 1/3 each.

EX-BAIRD, wax impregnated cardboard panels, 10½in.×6in., 1/3 doz., short-wave coil, 7.23 metres mounted on ceramic trimmer, 1/- each; a big range of volume controls, 1 ohm, 200 ohm, 600 ohm, 1,000 ohm, all values 2/6 each.

FLEXIBLE Drives, well made, shielded cable-drives for remote control, ideal for radiogramophones, approx. 2ft. long; to clear, 4/- each.

ELECTRO-MAGNETIC Counters, resistance 500 ohms, from 1-12,999, size 4½in.×2in.×1¾in., ex-G.P.O., invaluable for countless purposes, 9/6 each; a smaller type, 1-1,999, size 4¼in.×1½in.×1½in., 5/6.

VALVE Holders.—Belling-Lee special H.F. 5-pin, chassis mounting in black bakelite; 1/- each, 10/6 doz.

PLESSEY Small Block Type Condensers, two tappings, 0.0005 and 0.1 mfd., 350v. test; 1/- each, 10/6 doz.

VARIABLE Condensers, well made heavy 3-gang superhet condensers, die cast frames in first class condition; 2/6 each.

SMALL Reversible A.C. Motors (as used for motor tuning), 25-30 volts A.C., built-in reduction gear spindle, speed about 60 r.p.m.; 8/6.

AUDAK Cutting Heads, heavy duty type, 3-5 ohm coil, a really high-class instrument; 17/6.

YAXLEY Type Switches, 2-way, 1/-; 2 bank 3-way, 2/-; 4-way, 4/-.

SCREENING Shields in Aluminium, 6½in.×5in.×5¼in., brand new and unused; 2/6 pair.

OUTPUT Transformers, primary 300 ohms D.C., secondary 0.5 ohm D.C., brand new, manufacturer's type, 4/6; also new chokes, 30 henry, 150 ohms; 3/- each.

RESISTANCES, assorted values and makes, Erie, T.C.C., American, etc.; low price of 1/6 doz.

B.I. Condensers, block type oil filled in metal cases with terminals, high quality components, 0.1 mfd., 1,000v. D.C. test, 2/6 each; and 0.25 mfd. 1,000v. D.C. test, 2/6 each; also 0.0003 mfd. 400 volt working D.C., 6/- per doz.

RELAYS.—Small relays for operation on 2v. D.C. with 6-way make and break switches, brand new; 5/- each.

TRIMMERS.—Twin trimmers on ceramic base, brand new; to clear, 6d. each, 5/- doz.

WEGO Condensers, tubular type, 0.1 mfd., 5,000v. working; 5/6 each.

COIL Formers, cardboard and paxolin, assorted sizes, useful for experimenters; 1/6 doz.

CONDENSERS, metal cased, non-inductive, 0.5 mfd., 1/6; 1 mfd., 1/9; 1 mfd.×1 mfd., 2/-; 2 mfd. 2/-.

METAL Rectifiers, by Standard Telephones, brand new, 12v. 3 amp.; 12/6 each.

VALVE Holders, American 4-pin chassis mounting type; to clear at 1/6 doz.

ACCUMULATORS.—Ediswan 2v. 60 amp., brand new, in ebonite cases, size 8in.×4¼in.×2½in.; callers only; 17/6 each.

CHARGERS.—Small trickle chargers, metal rectification, input 200-220v. A.C., output 2v. ½ amp., shockproof, 17/6; ditto, in metal case for mounting, 19/6.

SPEAKER Mesh, 10½in.×9¾, 1/6; also chromium escutcheons without dial, 7½in.×5¼in., 1/- each.

TUBULAR Wire-end Condensers, brand new, first quality components, 0.0003 mfd., 8d.; 0.005 mfd., 9d.; 0.01 mfd., 10d.; 0.1 mfd., 1/- each.

SEE Also Display Advt. Page 10. Postage must be included. No C.O.D. orders.

LONDON CENTRAL RADIO STORES, 23, Lisle St., London, W.C.2. 'Phone: Gerrard 2969. [9800

ACCUMULATOR Chargers, well known make, in green finished steel case, 2v., 4v., 6v., at 1 amp., 31/6; 2v., 6v., 12v., at 1 amp., 39/6, a really good charger at a modest price. Crystal Mikes, high sensitivity type, famous maker, 52/6; Instrument Rectifiers for Meters, 8/6, post 4d.; L.T. Metal Rectifiers, 2v., ½ amp., 4/3, 12v., 1 amp., 5/9, post 4d.; Transformers, specially wound for 12v. 1 amp. on 30 watt core, 13/9, post 8d.; kit of parts for trickle charger, 2v. ½ amp, 11/9.—Champion, 42, Howitt Rd., London, N.W.3. [9811

L.R.S

PROMPT DELIVERY

'Stuart' Centrifugal Electric

SHELTER PUMP

Quickly clears water from shelters. Ideal for many other A.R.P. uses. A sound job built for continuous running. Fan-cooled ball bearing motor, A.C. or D.C., any voltage. Low current consumption. Connections for rubber hose. All parts non-rusting. Please state exact mains voltage required.

These pumps (as supplied to Railway Co.s, County Councils, etc.) may also be used for garden fountains.

FOUNTAIN JETS for above .... 4/- extra.

No. 10.	100 *gals. per hour*	Carr. 2/- extra ...	£5 2 6
No. 11.	280 *gals. per hour*	,, 3/- ,, ...	£6 6 0
No. 12.	560 *gals. per hour*	,, 3/- ,, ...	£7 14 0

Prices include foot valve and strainer. Pump is ready for immediate use.

A few BARGAINS. All in perfect order

2 FERRANTI 0-150 m.a. Meters (Panel flush type), (used) .... 35/- each
1 HUNT 0-1 amp. Meter (used) 7/6
2 Heavy Switchboard 0-5 amp. Meters, new 37/6 each
2 Heavy Switchboard 150 Voltmeters, new 37/6 each
1 GARRARD Clockwork Gramomotor (used), (pre-war price £5/-/-) £3/-/-
DAVENSET Charger, up to 12 volts at 5-6 amps. (used but perfect), pre-war price £10/-/- £7/-/-
McCLURE Feeder Unit, model ACF-5 (new, less valves) £7/10/-

VALVES (used for testing only)

COSSOR: 210PG 15/-, 220PA 6/-, 220SG 9/-, 220DD 5/6. **MULLARD**: DO24 20/-, PM4DX 5/6, PM202 9/6, PM2 7/-. **OSRAM**: P215 6/-, U50 9/-, MS4B 10/6. **MAZDA**: L21DD 7/6, UU2 11/6. **TRIAD**: 6K7G 8/6, 686G 8/6, 6A7 8/6. **HIVAC**: PX230 6/6, L2103/6.

2 REMINGTON Electric Shavers (reconditioned) £3/17/6 each
1 Mary Ann Upright Vacuum Cleaner, AC/DC 230/250 volt (used) £7/7/-
3 Acme "Lion" Wringers, 16in. new, 49/6 each, plus 2/- carriage.

We also have a few Morphy Richards Electric Auto Irons and Electric Fires (new) which are offered tax free.

Send 2½d. stamp for illustrated price lists.

LONDON RADIO SUPPLY CO.
(Props.: The L.R. Supply Co. Ltd.) Estd. 1925.
"WINDEN," ARDINGLY RD., BALCOMBE, SUSSEX.

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TRIX SOUND EQUIPMENT

RELIABLE AMPLIFICATION
The TRIX ELECTRICAL COMPANY LTD.
65, Bolsover St., London, W.1. Euston 5471

Wanted

WANTED, Ferrocart G1.2.3.; Varley BP112 and BP113 coils.—C. F. Gibbs, 93, Pennygate, Spalding. [9812

HARTLEY TURNER RF.41 Radio Feeder Unit, with or without valves.—Fudge, 51, Fairway, Stafford. [9789

WE Buy New or Used Radios, amplifiers, meters, converters, radio and electrical accessories, etc.—'Phone: Ger. 4447. [9603

REPAIRS AND SERVICE

EPOCH. Epoch.—New diaphragms for all models. —"R.E.C.S.," Crown St., Reading. 'Phone: 2796. [9796

TRANSFORMERS, chokes, pick-ups, motor and armature rewinds, repairs of all descriptions to the wireless trade.—F. H. Marshall, 137, Windmill Lane, Nottingham. [9813

MAINS Transformer Service, repairs, rewinds, or construction to specification of any type, competitive prices and prompt service.—Sturdy Electric Co., Ltd., Dipton, Newcastle-on-Tyne. [9651

SITUATIONS VACANT

WIRELESS Technical Instructors Required in Army Units.

EMOLUMENTS.—Pay 8/9 per day (7 days a week); clothing, rations and accommodation, or if this cannot be provided allowances at authorised rates; if married and otherwise eligible, family allowance payable in respect of wife and children, subject to allotment from pay.

CANDIDATES Should Preferably be under 35 and over 24, and

(A) Hold one of the following qualifications:—

Graduateship of the Institution of Electrical Engineers.
Final (Grade III) Certificate of City and Guilds of London Institute Examination in Radio Communication.
Higher National Certificate in Electrical Engineering.
Certificate of City and Guilds of London Institute in Radio service work.
Or

(B) Be able to pass an examination on the following syllabus:—

Simple algebra, including quadratic equations; simple trigonometrical ratios and identities; vectors.
Properties of electrical currents; heating of conductors; magnetic fields; unit of current; Ohm's Law; resistance in series and parallel; potentiometers.
Magnetic effect of current fields due to parallel wires; field due to a solenoid; electro-magnets. Meters.
Induction; effect of rotating a coil in a magnetic field.
Mutual and self induction and inductance; effect of inductance on growth and delay of current.
Capacity; charging storage and discharge of condensers; through resistance and inductance.
Alternating currents; vector diagrams; effect of resistance variation; effects of L and C in A.C. circuit; phase difference of currents; resonance in a series circuit; parallel circuit of L and C; Q factor.
Elementary knowledge of valves; simple theory of amplifiers, oscillators and detectors; general principles of radio practice.

SUITABLE Candidates will be Interviewed at Local Centres, and, if successful, will be enlisted and appointed Acting Sergeant Tradesman. For those who are on the Schedule of Reserved Occupations, special arrangements will be made to enable them to be enlisted. In the event of any applicant found to be reserved under Schedule of Reserved Occupations special application will be made for relaxation of the Schedule. No guarantee can be given that this application will be successful.

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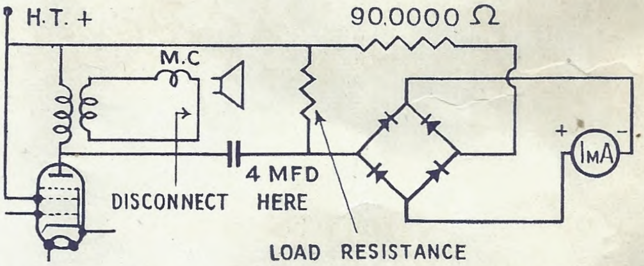

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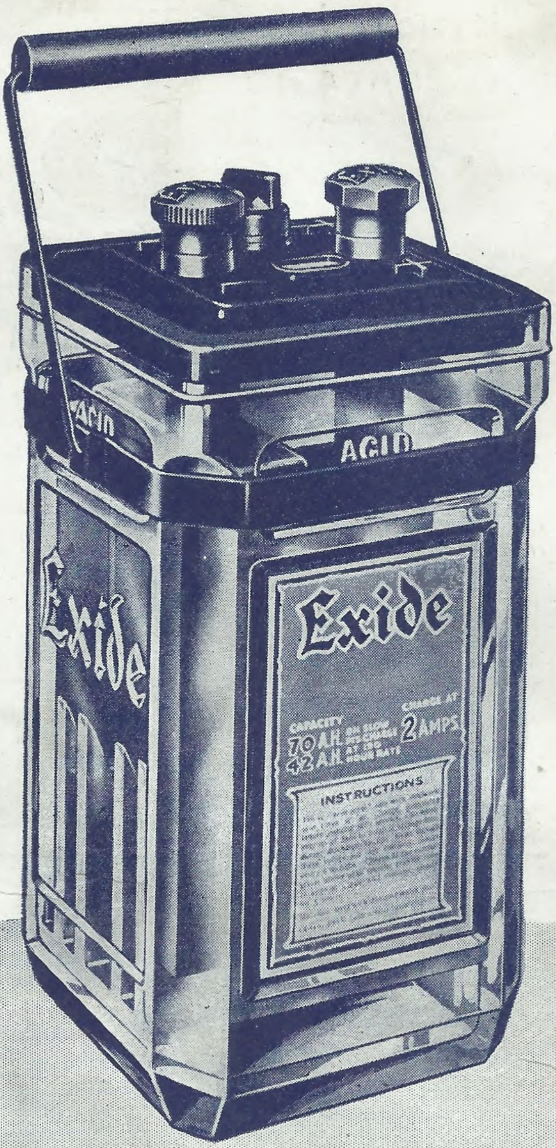
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