Electronic Engineering

Incorporating ... ELECTRONICS, TELEVISION & SHORT WAVE WORLD

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Symbols

WITH the increasing use of electronic apparatus in industry and engineering, symbols which were originally only intelligible to the radio circuit designer are now appearing in all the technical journals, and power engineers find that their present-day knowledge has to include an ability to read the complexities of an electronic-circuit diagram.

This task is not made easier when the circuit diagram takes on a variety of forms, and contains an assortment of symbols which differ sometimes from page to page in a given publication. It is unfortunate that these symbols differ even between branches of the same profession. For example, the power engineer's transformer, sometimes represented by a pair of wavy lines, becomes the radio engineer's resistance. The non-inductive resistance in radio and electronic diagrams is commonly used for an ordinary resistance in power circuits.

To add to the difficulties of reading, some circuits are drawn in such a manner that only an expert, with a pencil laboriously tracing over the lines, can determine the function of each component. His work is made still harder if unfamiliar outlines are used to identify familiar components.

As L. H. Bainbridge-Bell said in a recent article "The object of a circuit diagram is the explanation of the operation of a given circuit, and any attempt to make the diagram fulfil the additional role of a wiring diagram usually results in obscuring the electrical operation of the circuit." This implies an insight into the underlying reasons for the positioning and interconnexion of components, and the drawing of a clear circuit diagram is an art compounded of draughtsmanship and basic knowledge.

The use of graphical symbols which are familiar to all and accepted as standard throughout the profession will obviously simplify the task of reading a complex circuit. Naturally a power engineer may be averse to seeing familiar symbols replaced by those introduced by a newer branch of engineering, but the introduction of universal electrical graphical and letter symbols is an important step towards that standardisation to which we all pay lip-service but seldom encourage.

The British Standards Institution has done good work in producing a new edition of "Standard Symbols for Telecommunications"* and a copy of this book should be the desk companion in every electrical drawing office. In addition to the cataloguing of accepted symbols for all types of circuit it gives suggestions for the production of clear circuit diagrams, which, if adopted, will go far towards raising the standard of British technical publications in the radio and electrical field.

* BS. 530, price 10s. 6d., from the British Standards Institution, 28 Victoria Street, S.W.1.

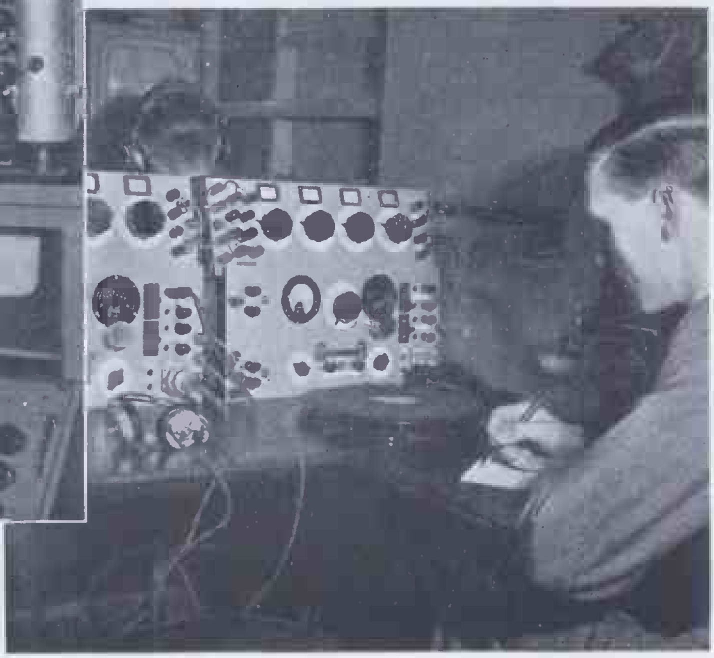
ENGELSK FJERNSYN:

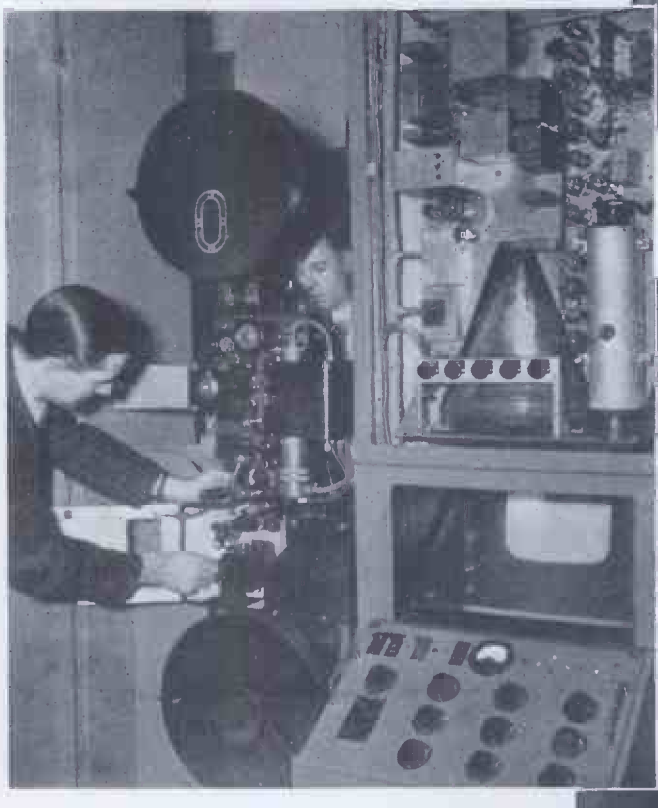
British Television at the Copenhagen Exhibition

Section of the crowd watching the television in the demonstration hall at the Nimb Restaurant, Tivoli Garden, Copenhagen

The Emiscope projector tube being fitted to the E.M.I. film scanner. The 9" tube has an optically flat screen and is operated at 15 KV.

Carrying out tests in the control van





Adjusting the projector of the E.M.I. film scanner which enabled ordinary films to be used in the television programmes

The Art of Exposition

By R. O. KAPP, B.Sc., M.I.E.E.*

The lectures on "The Presentation of Technical Information" which were delivered by Professor Kapp last year, aroused wide interest and have now been amplified and published in book form by Messrs. Constable & Co., Ltd.

This article, based on extracts from the book, is printed by kind permission of the publishers and author.

THE popular notion of the scientist as a recluse who makes great discoveries in the solitude of his laboratory was, in bygone days, sometimes true of the pure scientist. It is rarely so now. And it has never been true of the engineer. He can accomplish little except in co-operation with others. His day is crowded with talks, conferences, committees. His contacts with people are numerous and varied. In all of them mind addresses mind. It does so sometimes through the spoken, sometimes through the written word. Talk and paper are, in these days, among the engineer's most important tools. He must learn to handle them well. The executive engineer has a greater use for them than for the tools that are found in the carpenter's and fitter's shops. So why think that these alone are educative? Why train engineers in the use of tools that they may never have to touch again once they have been launched on their professional career and teach them nothing about the tools that they will have to use?

The bad expositor may, and often does, provide an impressive volume of published work. It may contain a valuable record of profound thinking. But yet it will fail to be very effective. With sublime conceit he thinks himself, perhaps, superior to the obligations of mere craftsmanship; or it has never occurred to him that rather hard work has to be done whenever thought is being transferred from mind to mind; or, if it has occurred to him, he is content to let the reader do the whole of this work, to put into the right order in his mind what is in the wrong order on the paper, to draw the conclusions he is meant to even when they are not stated, to jump without guidance to the significance of a statement, to bridge any gap the author's carelessness may have left in a line of reasoning. The books of such an author are like quarries rich in precious ore, but hard to work. "Let those who want the ore," the author seems to say, "dig for it." But will they? Need they?

Sometimes they have no choice. An author with unique and indispensable information has his readers at his mercy. The student who can find no well-written textbook must use a badly written one. He must quarry hard in it if he would pass his examinations. Every expert, again, who would know what his contemporaries are doing must spend many weary hours quarrying in atrociously composed contributions to learned societies. For well composed ones are all too rare. And the works manager who relies on his technical experts for guidance has often no choice but to take their reports home with him to read at leisure during long evenings. For he finds it useless to ask for verbal explanations; the spoken words of the experts prove no more illuminating than the written ones. So while he should be recuperating for the next day's task he must quarry instead; quarry among a disordered sequence of ideas, clumsy sentences, unfinished arguments, unexplained conclusions, undefined terms, ambiguous phrases. All of them, the undergraduate, the expert, the works manager, are turned into quarry slaves. The bad expositor is their master.

If he possesses knowledge that cannot be obtained elsewhere he remains their master. For knowledge is indeed power. But as soon as a better expositor comes along with the same knowledge, the slaves will turn to the new one and be free of their slavery. For it is to be remembered that, in these days, competition for attention is great. Every technical man encounters far more written work than he ever has time to read. He gives his attention only to those who know how to earn it and hold it.

Functional English

A person who expresses himself in good literary style may yet be a bad expositor. In some literary styles obscurity is no defect, but it is a grave defect in the presentation of technical information. So of all the available ones the learned Societies have one particular style in mind when they call for a higher standard of English. It will be convenient if this style has a name. So I will call it Functional English.

The purpose of Functional English can be stated in a few words. It is always to convey new information. The information may consist of all kind of facts, of inferences, arguments, ideas, lines of reasoning. Their essential feature is that they are new to the person addressed. It is chiefly the language of Science. The aim of a good functional style is to maintain receptivity in the person addressed.

A bad expositor may, by his bungling, do much to cause the reader to lose receptivity, while an expositor who has successfully solved the problems of Functional English will know how to ensure its maintenance, even when circumstances are not favourable.

The first "don't" that I would put to those who have technical information or reasoned argument to present is this: Don't allow anything that is irrelevant to intrude into your discourse. It seems an easy "don't," but it is really a very hard one. Testing for relevance raises some of the most difficult problems that an expositor ever has to solve. And it is important to

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remember with all humility that every one of us fails to solve them very often. The best we can do, I venture to suggest, is to be aware of our weakness, to be ever watchful, and to hope that in time we may improve.

There are few things more destructive of receptivity than to have to pause during one's reading and ask oneself: "What has this to do with it?"

Pace and Timing

In the theatre it is important for each character to appear on the stage and leave it at the moment when his entry and exit will be most effective, for each significant remark to be made at the most telling moment, for every situation to be prepared at the most appropriate pace; if it is too fast the audience will fail to notice something of importance; if it is too slow the audience will lose interest and receptivity. Similarly in a novel the plot must be developed at the rate that comes natural to a reader who would keep up with it. And with an orator whose pace is too rapid the attention of the audience tires, while it flags just as much with one whose pace is too slow.

Are pace and timing less important to the presentation of technical information? A little less important perhaps, but surely still of considerable importance. If a scientific fact or argument is presented at a moment when the person addressed is thinking about something else it will fail to reach its mark. And if something fails to reach its mark in a learned Society it certainly does not matter less than if something fails to do so in a music-hall. The attention of a person reading a scientific treatise is as liable to wander as the attention of a person reading a novel.

Lest it be thought that for a simple statement of fact such problems do not arise let me give an example. "The coal on arrival at the coal sheds is weighed and electrically tipped into a hopper and fed on to a conveyor, which carries it to the top of the boiler house, where it is tipped onto two drag conveyors, after magnetic extraction of any iron present, the coal being directed to any boiler at will."

The above sentence only slightly caricatures a style from which we have all suffered many times. But what is wrong with it? The grammar and syntax are perfectly correct. It does not contain any unnecessary words or involved phrases. The language is simple and concise. It contains no recondite mathematics, no elusive argument, nothing but straightforward statements. And yet it imposes a great strain on the attention. The reason is because the pace at which the information is presented is greater than the pace at which it can be absorbed.

The young scientist is sometimes told, a little pontifically, that he must be as concise as he can; that he must never, never use two words if one suffices to express his meaning. The above example shows that such advice may be very misleading. It arises from a confusion between what is needed to *express* a meaning and what is needed to *convey* it. Tell the young scientist by all means not to use more words than are needed to convey his meaning. But if he is restricted austerely to the bare number needed to express it he may omit the error of overcrowding, which is just as bad an error as that of verbosity.

The scientist who prides himself on his concise, laconic style is often a mere soliloquiser. He is too much interested in his own achievements, not enough in the reader whom he is addressing. To such a scientist technical information is something to be placed on record, not something to be conveyed from mind to mind.

Some Do's and Don'ts

So far I have mentioned only one or two of the methods available for making one's discourse easy to understand. Perhaps it will be useful if I add a few Do's and Don'ts on the same theme.

DO, during the development of a mathematical argument, occasionally point out the significance of terms and formulae encountered in the course of the argument.

When opportunity offers do so with such remarks as: "This term represents the potential energy in the system and this one the kinetic energy." "This expression disappears when the system just fails to oscillate." "It will be noticed that at the limit a equals b." "In this expression we recognise the Z-factor." Comments of this nature are more plentiful with good than with bad expositors. By their judicious use you can make your discourse both easier to understand and more fascinating.

DO make plentiful use of graphical methods of presentation. It is worth while to do so in the interest of good exposition. For graphical methods are of great help to those who cannot think in completely abstract terms.

DON'T, when using curves and diagrams, allow them to contain more detail than is needed for the purpose of your discourse. It is often difficult, especially when preparing drawings of mechanical systems, to put in all that is needed as an aid to the understanding and to leave out all the rest. But it is worth while to take a lot of trouble with this difficult problem.

DON'T place too many curves on the same figure, especially when they intersect at acute angles. And don't have too many scales on the co-ordinate axes.

DO label co-ordinate axes with the units that they represent and the scale. Do so even if you think that the reader ought to guess what the axes represent. He might guess wrong. Besides, he wants to receive technical information, not to engage in a guessing game.

DO, also, give informative titles to all illustrations. The title may be clear from the text and this may refer correctly to figure numbers. But the reader does not want to have to scan the text in order to know what the pictures mean.

DON'T, during a lecture, have a figure thrown on the screen to illustrate what you have just been saying while you proceed to the next section of your lecture. That causes the eyes of your audience to be concerned with one thing while their ears are concerned with another. Eyes and ears can do this, but brains cannot. The audience must either take notice of the slide and miss what you are telling them, or listen to you and ignore the screen.

DO, when preparing pictures, diagrams, graphs, tables, etc., for lantern slides, remember that the audience will not be seeing each for long. Limit, so far as possible, the information contained in each slide to what you want to convey during the lecture. Do not, for instance, expect the audience to appreciate the significance of all the numbers contained in five columns, or to disentangle a dozen intertwining curves.

DO, when describing mechanical devices, use all your inventiveness in the search for common objects to which to compare the various bits and pieces that you have occasion to describe. If their significant features are three dimensional, even drawings do not solve the reader's difficulty. You can help him if your description makes plentiful use of terms like "diamond shaped," "lozenge shaped," "saucer shaped," "in the form of a circular rubber stamp," "dumb-bell shaped," "a truncated cone shaped like a lampshade."

DO, when describing a mechanical device or invention, consider very carefully whether first to describe the mechanical details and then to say what purpose they serve, or first to state the problem that the device is designed to solve and then to show, while describing the mechanical details, how the purpose is served by them. I do not think that one can make a rule and say that one of these methods is always better than the other. The choice should depend on the circumstances. First to enumerate and describe the levers and cams and grub screws and whatever else belongs to the device and then to say what they are for is perhaps the more straightforward procedure. But to state the problem first and then show how it has been solved is the stimulating one. It gets the reader trying to do some inventing for himself. It puts him in a state of expectancy, almost as though he were reading a mystery story. When he is told "the purpose of this device is to do so and so" he begins to wonder how it can possibly be done. This causes him to be very receptive to every word that tells how the problem is solved.

DON'T, lastly, think that an abundance of explicitness is appropriate only to the lower level on which cheap popularisers of science work. It is, admittedly, possible to overdo explanations and thereby become irritating. But over-explicitness is not a common fault and under-explicitness is. Besides, you can afford to be very explicit indeed without irritating if you contrive to be stimulating at the same time.

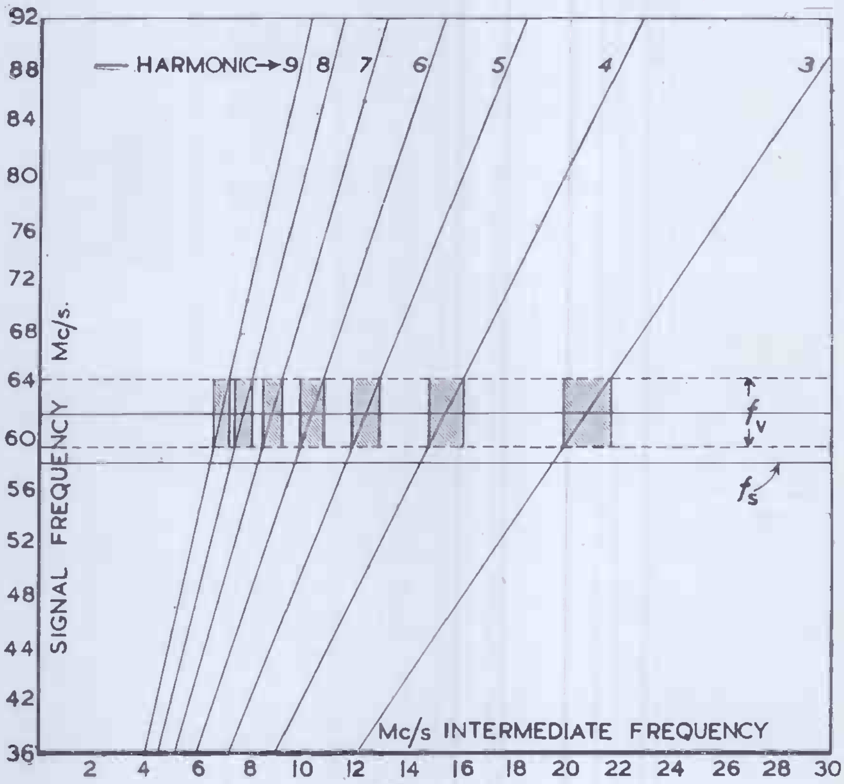
The Sutton Coldfield Television Station

I.F. Selection Chart

The B.B.C. have officially announced the frequencies of the Birmingham Television Station at Sutton Coldfield, which will be : Vision 61.75 Mc/s. Sound 58.25 Mc/s.

The upper sideband of the vision transmitter will be partially suppressed, and the sound channel will be amplitude modulated.

The following note describes a graphical method of determining the suitable intermediate frequencies for television receivers operating on this wavelength.



It is well known that one of the drawbacks of super-het. receivers is the liability to interference, which can arise through feedback from the detector output of harmonics which fall within the acceptance band of the circuits. To reduce this self-interference to a minimum, it is necessary to choose an intermediate frequency whose harmonics do not fall within the band.

A graphical method of determining the suitable frequency was demonstrated by L. H. Bedford before the Television Society in 1936,* and is reproduced here in a form suitable for the Birmingham station.

Referring to the chart, the horizontal scale represents useful values of I.F., and the vertical scale gives the signal frequency of the transmitter. A horizontal line f_v is drawn at the value of the vision frequency (61.75) and two other lines at the limits of the sidebands (2.5 Mc/s.). The partial suppression of the upper sideband has been neglected in this chart. The sound frequency, f_s, has also been inserted.

Diagonal lines radiating from the lower scale are drawn to correspond with the harmonics of the I.F. scale, *e.g.*, the third harmonic of 16 Mc/s. cuts the abscissae at 48 Mc/s.

Where these harmonic lines intersect the vision frequency band, the shaded areas indicate where interference can be expected. Thus, by reading upwards from the I.F. scale, the "safe" values of I.F. can be seen at a glance.

A. Folwell

* L. H. Bedford, *Jour. Tel. Soc.* Vol. 2., p. 227, 1936.

The Linear Accelerator

By G. R. NEWBERY, B.Sc., A.Inst.P.*

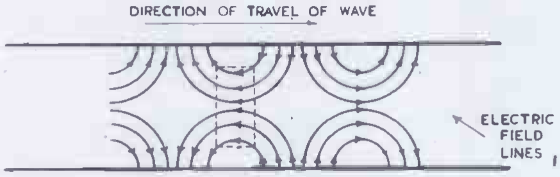


Fig. 1. Electric field in plain E_{01} guide

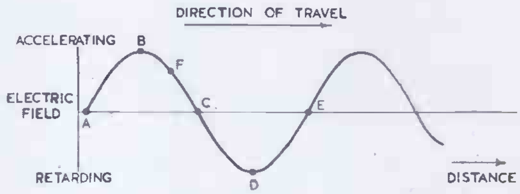


Fig. 2 (righ). Plot showing instantaneous relative positions of travelling wave and electron

THE most obvious method of accelerating a charged particle is to cause it to traverse a gap between two electrodes at a potential difference of V volts. A particle with unit charge, e.g., an electron, cannot be given an energy of more than V electron volts by this method. Thus the production of high energy particles is beset by all the difficulties which attend the generation of extremely high potential differences.

One way of surmounting this difficulty is to cause the charged particle to traverse a succession of gaps, the electrodes of which are connected to a source of high frequency alternating voltage. Then, if the times at which the particles are crossing a gap are synchronised to the alternating voltage, so that for example, at the time of traverse the voltage is always a maximum in the accelerating direction, the need for an intermediate rectifier is avoided and the particle gains an energy of V electron volts at each gap. This was the principle of the early linear accelerator developed by Lawrence and Sloan in 1931, which was the forerunner of the cyclotron. This differs in using a magnetic field to maintain the particle in a spiral orbit, so that it continually traverses the same electrode gap in synchronisation with the alternating voltage.

The linear type of accelerator is of interest because it avoids the necessity for the magnets which are used to produce the near-circular paths of the cyclotron and its allies. The possibilities of the so-called " linear accelerator " are now being extensively explored, using microwave techniques, in an endeavour to produce a compact source of high-energy electrons for the generation of deeply penetrative X-radiation. Such radiation is of interest both in the realm of nuclear physics and in the treatment of malignant disease.

* Research Physicist, Medical Research Council. At present working at the Research Laboratories of The General Electric Co. Ltd., Wembley.

Types of Accelerator

There are two main types of microwave linear accelerator, known as the travelling and standing wave types. The former accelerates the particle in a moving electric field by a method very similar to that by which a surf-rider derives his acceleration from a sea-wave. The latter accelerates the particle by making use of the interaction between the varying electric field of the standing wave pattern and the particle itself. Both these methods will now be described in detail.

In the travelling wave system, an electromagnetic wave is injected into a special waveguide system simultaneously with an axial beam of electrons. The waveguide system, which is of the E_{01} circular type with irises loading it at short intervals, has the property of propagating the wave with a phase velocity which can be adjusted to any desired value by altering the iris dimensions. Thus in a practical system, the waveguide is designed so that the wave enters and starts to travel with the same velocity as the injected beam of electrons. Now a further property of the E_{01} wave type is the existence of an axial electric field, shown in Fig. 1. The electron beam therefore experiences an axial force, which may be accelerating or retarding according to the relative phases of the wave and the electrons. Consider a single electron at the moment of injection; its position relative to the injected wave may be at any position along the curve A, B, C, D, E in Fig. 2. When it is at the positions A, C or E, it will not experience any force and will continue with its original velocity. If it is at the position B it will be accelerated, while in the position D it will be retarded. Particles which are retarded will later experience an accelerating force as they move to the region between C and B. Particles which are accelerated will later experience a retarding force as they move into the region between C and D. Thus the particles will be bunched about C and gain no energy.

If, however, the phase velocity of the wave is increased as the wave travels down the system, the accelerated particles will not move to the retarding region. Instead, a bunch of particles will result which will be centred around some point such as F and, provided the wave velocity is correctly adjusted, the bunch will remain in this position relative to the wave and will be continually accelerated, so that the particles will continually gain energy from the wave. In order to increase the phase velocity of the wave, as required, the iris dimensions will have to be progressively changed along the system. However, because of the dependence of the particle mass upon velocity, the increase in energy consists more of an increase in mass than of velocity. as the velocity approaches that of light. For example, at an energy of 100,000 electron volts, the velocity of an electron is 55% of that of light, while at 1 million and 10 million electron volts it is 94% and 99.8% respectively. Consequently, after an initial accelerating section, the dimensions of both guide and irises may be allowed to remain constant. Fig. 3 shows diagrammatically a section of a guide constructed for the acceleration of electrons.

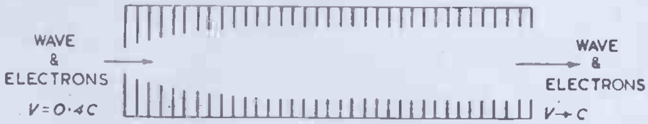


Fig. 3. Iris loaded E_{01} guide suitable for electron acceleration

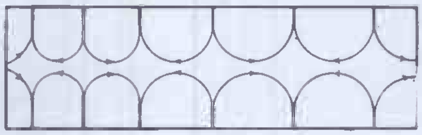


Fig. 5. E_{016} resonator suitable for electron acceleration

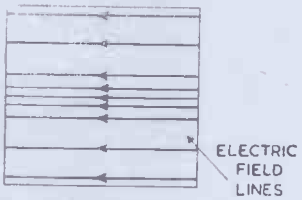


Fig. 4. E_{310} resonant cavity

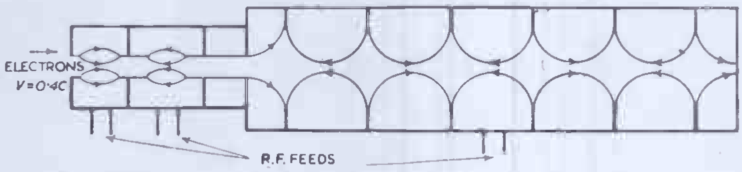


Fig. 6. Proposed form of resonant accelerator.

As the electrons and the wave travel along the guide together, the energy of the wave is transferred to the bunches of electrons. Both wave and electrons emerge together at the far end of the guide. If the length of the guide is below about one metre, and unless critical guide and iris dimensions are used, there will be an appreciable fraction of the input power remaining in the wave. It may then be worthwhile to close off the end of the guide by a reflector, leaving only a small aperture to allow the beam of accelerated electrons to emerge and to reduce the number of irises to two per wavelength. In this way a system of standing waves is set up in the guide, and this arrangement is called a standing-wave accelerator, to distinguish it from the former travelling-wave type. The standing-wave system can, of course, be analysed into forward and backward wave components, and it can be shown that the electrons are affected by the forward component but not by that in the reverse direction.

Standing Wave Accelerator

The standing wave accelerator can be regarded from a slightly different point of view. Consider first a simple resonant cavity (Fig. 4) accommodating an E_{010} pattern. An electron injected through a small axial hole or grid, when the field is about to become accelerating will meet a forward accelerating field for one half-period of the oscillation. If it remains in the cavity thereafter, the axial field changes sign, and the electron will be decelerated. The dimensions of the cavity must, therefore, be so chosen that the electron takes one half-period only to cross the cavity. The electron is then caused to enter a second cavity whose feed is so phased that its axial field is likewise about to become accelerating as the electron enters. Once again, dimensions are such that the electron takes a half-period to cross, but they will naturally be different from those of the first cavity, since the electron now has a higher velocity when it enters. These cavities may be joined together to form a continuous E_{01n} resonator loaded by irises, as considered above, and shown in Fig. 5.

The standing-wave accelerator is probably more practicable where overall length must be limited to give compactness, but meets problems which do not occur with the travelling-wave type. The fact that, to obtain the high powers needed, the magnetrons must be pulsed, leads to a serious problem which has to be faced in the standing-wave equipment: the finite time of build-up of the resonator field.

When the steady state of operation is reached, the resonator behaves as if it has a very low input impedance which is approximately transformed, by a matching system, to the characteristic impedance of the wave-guide feed. At the commencement of build-up of the resonator field, the resonator has, however, a much higher impedance. This, viewed through the matching transformer, presents a very high impedance across the guide. In consequence, the magnetron operating frequency is pulled away considerably from the desired value. To overcome this difficulty, a water-load is included in the feeding waveguide in such a position that the magnetron's load becomes always approximately resistive and roughly matched, and its frequency of operation is little changed during the build-up period. As build-up occurs, the resonator impedance decreases and becomes purely resistive and finally the power is shared by the resonator and the water-load appropriately to their resistances.

At the 1948 Physical Society Exhibition, the G.E.C. Research Laboratories and the Medical Research Council, in collaboration, demonstrated the results of preliminary investigations intended to establish the practicability of the standing-wave type of accelerator. In the projected complete arrangement to which these investigations are being directed, the accelerator will take the form sketched in Fig. 6. There will be two short separate E_{010} cavities for initial acceleration with grids or re-entrants to pass the electron beam, followed by a centre fed E_{01n} cavity for the main acceleration, in which the loading irises are all uniformly spaced.

With this arrangement, it is expected that electrons of 4 to 5 MeV energy can be produced in a system about 1 metre along. When completed, it will also allow a practical comparison with the travelling-wave accelerator which has been built by A.E.R.E.

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The CONNSONATA

A New Musical Instrument

By ALAN DOUGLAS

INSTRUMENTS for the production of sustained organesque tones fall into three general classes. Those which generate a series of sine waves, which are subsequently combined as required to synthesise a complex steady tone; those in which a complex musical tone is initially engraved or photographically produced so that it has merely to be keyed ready-made, either alone or with other similar complete waveforms; and those in which a waveform is generated for each note, such waveforms containing a large harmonic series from which those not required for any tone colour are removed by selective filter circuits.

For most acceptable tone colours, the fundamental is generally much more pronounced than the other necessary harmonics. This has made it difficult to generate a harmonically-rich waveform in which the whole harmonic spectrum is correctly related.

The Connsonata overcomes this difficulty by producing a sine wave and a harmonically-rich wave simultaneously in each generator, but entirely isolated from a circuit viewpoint.

Those who recall the series of valve organs built by Coupleux and Givelet from 1930 to 1939 will remember that a series of 85 oscillators was provided for each manual, each being of the type in which an anode winding was coupled to a grid winding on an iron core, the latter made adjustable for tuning purposes. Normal pipe organ couplers and other controls were employed to select the pitch ranges and the waveform, which was harmonically rich, was diverted through a series of formant circuits from which the different tone colours were derived. Many difficulties were encountered in securing sufficiently stable results; valves were not too good at that time, stabilised power supplies were not efficient, and the type of oscillator used was not perhaps the most satisfactory. The newer alloys for magnetic cores had not appeared, and the general bulk of each component made the organ very large by comparison with modern standards.

The Connsonata exemplifies the advances made in the intervening years in a striking manner. Basically it is similar to the Coupleux & Givelet organ in that it uses a series of 167 independently tuned oscillators. But with modern components and circuit methods the entire system is housed in a normal small two-manual console.

A schematic arrangement of the organ is shown in Fig. 1. The independent oscillators for each manual are selected as to pitch range by means of standard organ couplers. The outputs from the common key contacts are fed to mixing amplifiers, which incorporate selective filters. The loss in gain due to the filters is restored by means of a pre-amplifier and the combined

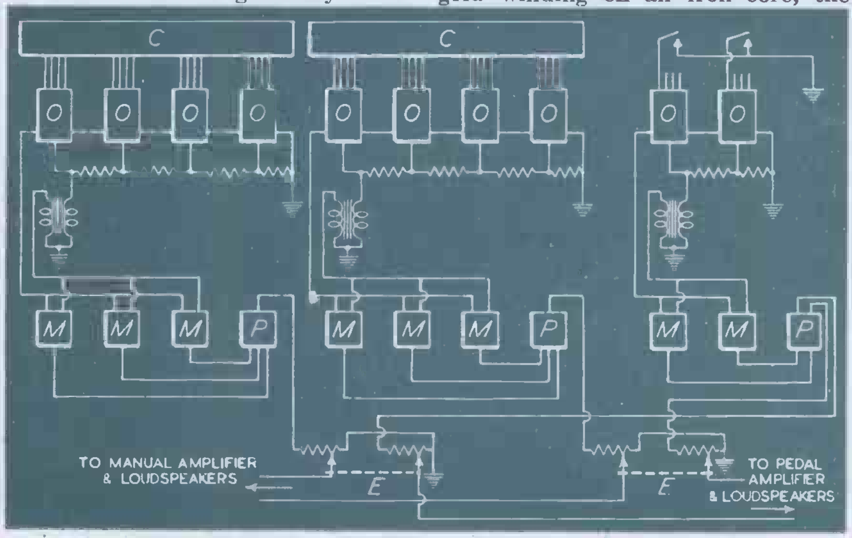


Fig. 1. Schematic diagram of the Connsonata organ

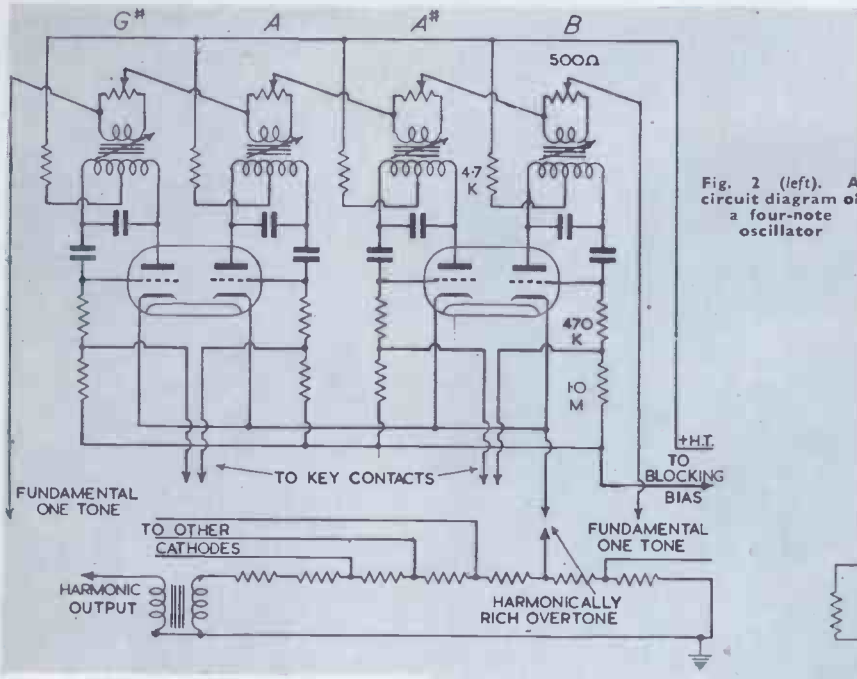


Fig. 2 (*left*). A circuit diagram of a four-note oscillator

outputs are fed, in parallel, to attenuators under the control of the player's feet before passing into the main amplifiers.

A four-note oscillator is shown in Fig. 2. The grids are normally biased beyond cut-off, but on connecting the key the 470 K resistor is earthed, thus restoring normal bias. The sinusoidal output is taken from the series resistor chain across the oscillator output windings, but the harmonically-rich cathode signal is passed into a voltage divider common to all the cathodes in parallel.

Each oscillator coil has an adjustable air gap in the magnetic circuit for exact tuning purposes, and each valve is one half of a double triode, making for economy in heater current. Both the heater and anode current supplies are stabilised.

The vibrato or tremulant is generated by a multi-vibrator oscillator with speed adjustment, and injects about 5 V into the keyed signal circuits.

Fig. 3 illustrates a typical mixer circuit. The grid circuit of any mixer not required is earthed to put the stop "off." A resonant circuit will be observed for one of the tone effects, the other one being essentially a low-pass filter. The output circuits of all the mixers for any one manual are paralleled.

Fig. 4 shows the relationship between the playing keys, tone sources and output. A manual to pedal coupler is also shown. There is one contact on each key which connects the output to any selected coupler, since the contact beneath "swell" and "great" is in the form of a bus bar which simultaneously connects all the points shown. But clearly no signal can flow unless one of the appropriate coupler bars is contacting the oscillator output. The couplers are moved by electromagnets following standard pipe organ practice, operated by stop keys which at the same time connect the required mixer units for the tone selected.

Fig. 5 shows the interior of an

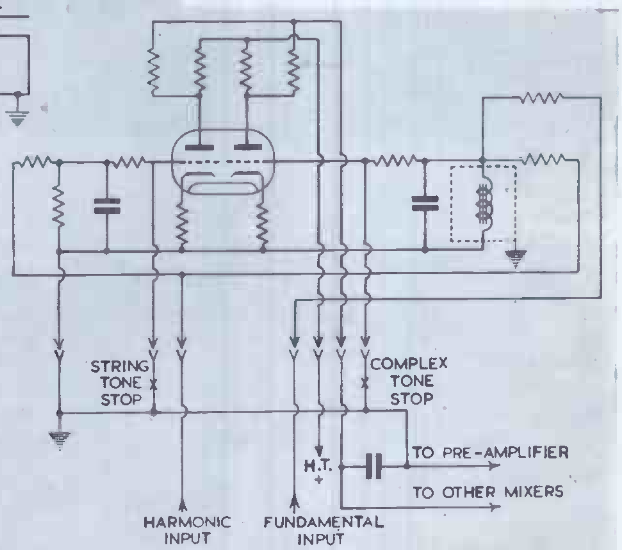


Fig. 3 (*right*). A typical mixer circuit showing one of the resonant circuits for tone effects

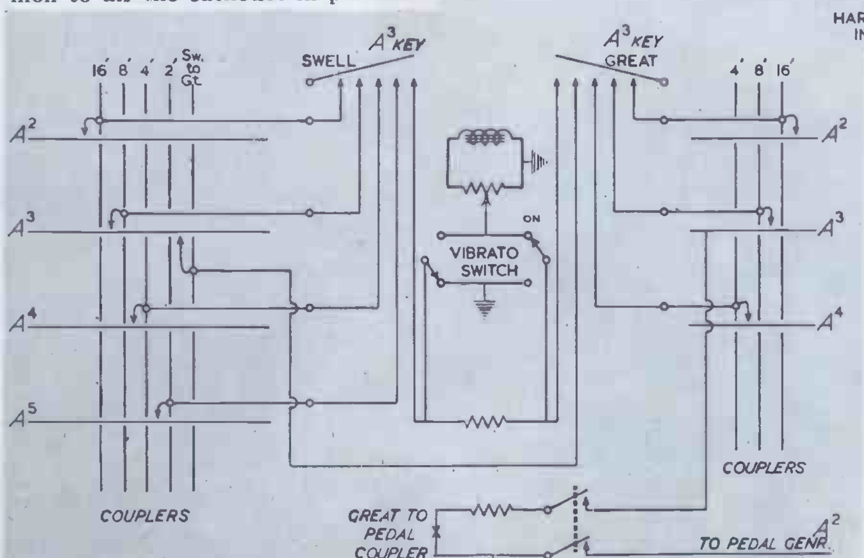


Fig. 4 (*left*). The relationship between the playing keys, tone sources and output

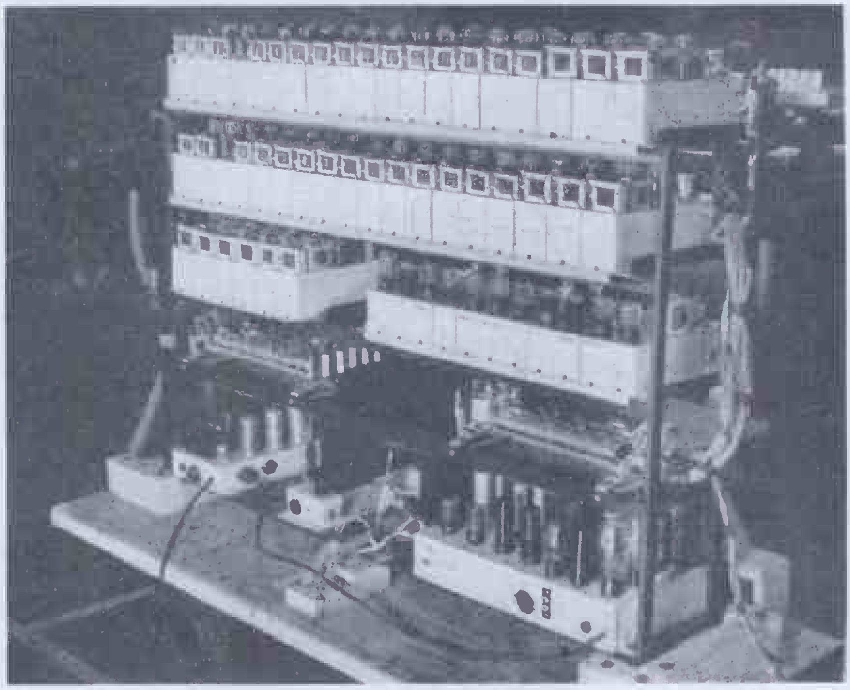


Fig. 5. Interior of the organ chassis

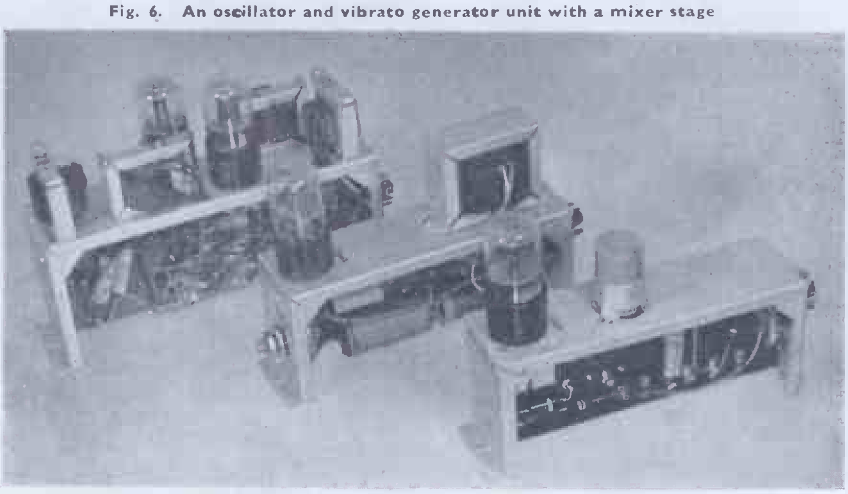
organ chassis, while Fig. 6 illustrates some of the main units individually; the upper one is a four-note oscillator, the centre unit is the vibrato generator, and the lower unit is a mixer stage. The complete organ is shown at the head of this article.

The makers employ an entirely separate amplifier and loudspeaking system for the pedal department. While in a room the volume may not be great, at high levels very severe intermodulation takes place owing to the great intensity of the lower notes (bottom C 16 ft. = 32.703 c/s.) if a common amplifier is used.

From an organist's point of view, the console conforms to normal controls and playing technique and the dimensions are in accordance with RCO standards. The softer pedal tones are under the control of the swell expression pedal, the louder ones being on the great pedal.

The frequency is stable within a few moments of switching on, and owing to the temperature-compensated components remains within the permissible limits for accurate tonal synthesis.

Fig. 6. An oscillator and vibrato generator unit with a mixer stage



A Note on the Ignition of Ignitrons

By S. M. BRAMSON

THE Ignitron is very popular in half-cycle welding and is usually ignited by a thyratron in a circuit such as that of Fig. 1. It

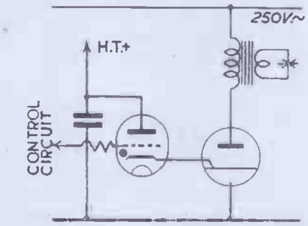
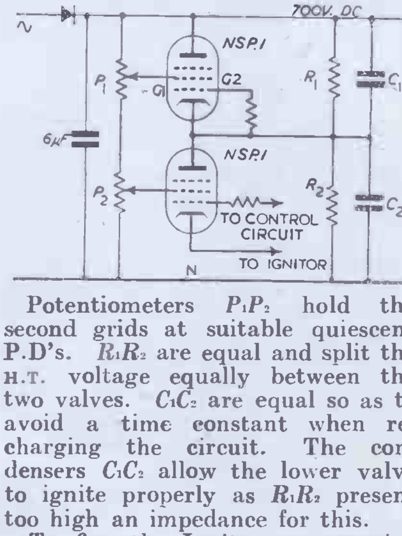


Fig. 1.

is possible to ignite Ignitrons by using cold-cathode flash tubes such as the N.S.P.1 in place of a thyratron, and ½-cycle timers built on this principle have proved very satisfactory.

A suitable circuit is shown below, using two N.S.P.1's in series to provide a higher voltage impulse.



Potentiometers P_1P_2 hold the second grids at suitable quiescent P.D's. R_1R_2 are equal and split the H.T. voltage equally between the two valves. C_1C_2 are equal so as to avoid a time constant when recharging the circuit. The condensers C_1C_2 allow the lower valve to ignite properly as R_1R_2 present too high an impedance for this.

To fire the Ignitron a negative pulse of 30 V at about 50 μA is applied to the first grid of the lower valve. As soon as this valve ignites its anode falls in voltage, producing a firing potential between G_1 and G_2 of the upper valve. Both valves are now conducting and discharge the 6 μF capacitor through the ignitor of the Ignitron.

Any standard peaking and phase-changing circuit may be incorporated.* In practice it is advisable to connect the negative terminal *N* to the neutral of the supply.

* Germeshausen, K. J. *Review of Scientific Instruments—February*, 1937.

Magnetic Materials

By G. FitzGerald-Lee, F.R.S.A.

UNTIL the year 1900 the only useful magnetic material known was pure iron, which has an initial permeability (i.p.) of 275 and a maximum permeability (m.p.) of 4,500, and is still used for pole pieces and relays. All other magnetic materials, with initial permeabilities ranging up to 100,000, have been discovered and developed during the last 47 years.

Low-carbon steel, with 250 i.p. and 2,500 m.p., is used for the fields and frames of D.C. and synchronous machines; annealed cast steel (i.p.: 175; m.p.: 1,500) for frames and solid poles; and annealed cast iron (i.p.: 125; m.p.: 500) for frames. Early in the century Sir Robert Hadfield evolved silicon-iron, which is an iron or low-carbon steel to which up to 4 per cent. silicon has been added; it has low magnetic hysteresis, and one type, with 4 per cent. silicon, 0.05 carbon, 0.8 manganese and 0.02 each of phosphorus and sulphur, is commonly used in sheets for transformer cores.

For stampings in transformers and high-efficiency rotating machines low-loss silicon steels have been evolved, such as Lohys and Stalloy. Fig. 1 shows the B-H curve of Lohys (B = lines per square centimetre; H = 1.256 × ampere turns per centimetre) and several other metals mentioned here. Hipernik, a 50 per cent. nickel steel (i.p.: 6,000; m.p.: 90,000), is used in audio-frequency and instrument transformers.

The principal requirements of steels for permanent magnets is that they shall have high remanence (retentivity) and coercive force; they often contain up to 35 per cent. cobalt or 10 tungsten. Nifal (ni-f(e)-al) and Alnico (al-ni-co) are examples of modern permanent magnet alloys. Nifal has enabled great improvements to be made in aircraft instruments and reduction in the size of magnetos and cycle dynamos. Cast Alnico, with 54 per cent. of iron, 18 nickel, 12 cobalt, 10 aluminium and 6 copper, is used in magnetic chucks for turning and grinding; it gives 30 per cent. more energy per unit volume than cobalt steel. One of the earliest magnet steels contained simply 0.9 per cent. carbon with 8 cobalt. This was improved on by one containing 0.6 carbon, 35 cobalt, 8 tungsten and 2.5 chromium. Later still a further improvement was made by reducing the cobalt content to 25 per cent. and adding 20 nickel and 15 titanium. This last steel is very similar to the Japanese Honda steel, which has 7 per cent. less nickel. Honda was a development of two other Japanese magnet steels, Mishima A and B, both with about 26 per cent. nickel and 12 aluminium, but the B having 8 cobalt as well.

Nickel containing 21.5 per cent. iron is unusually susceptible to magnetism of low intensity, and when it was embodied in the transatlantic cable the time of transmission was five times quicker than it had been previously.

The most highly magnetic material known for many years, eventually superseded by Nifal, was a steel containing 0.9 per cent. carbon, 35 cobalt, 5 tungsten and 2 chromium. "Permalloy," originally a trade name, now appears to be a generic term for high-nickel iron alloys having high magnetic permeability and low hysteresis loss, and which contain other elements such as copper, molybdenum, chromium, cobalt and manganese. It usually has about 78 per cent. nickel, and is widely used in telephone equipment (i.p.: 9,000; m.p.: 100,000).

Mu-metal, of the permalloy type, contains copper and manganese.

A new magnetic material is known as "Supermalloy"; this has about 79 per cent. of nickel, 15 iron, 5 molybdenum and 0.5 manganese, impurities such as carbon, silicon and sulphur are much lower than in most commercial alloys. The initial permeability of Supermalloy, which was discovered in 1943 and fully developed this year, is over 100,000. In the form of 0.001 in. insulated tape the i.p. is about 90,000 as compared with about 15,000 for molybdenum-permalloy. The use of Supermalloy in communication transformers has been found to allow a threefold increase in the range of frequencies transmitted, and a pulse duration three times that previously obtainable. The melting of Supermalloy is effected in vacuo in an induction furnace and the alloys are poured in helium or nitrogen, at atmospheric pressure.

The physical reasons for the success of Supermalloy are not yet definitely known. It is believed that the presence of certain impurities or combination of impurities, such as are usually found in commercial alloys, prevents the attainment of high permeability; and that a definite *cooling rate* must be used, below the temperature at which atomic ordering begins, or the specimen should be held for a definite time at a temperature of about 450° C. It appears that when a critical amount of ordering is present, the magnetostriction and the magnetic crystal anisotropy both tend to disappear at the same time in the alloy of proper composition, and that high permeability then occurs in the polycrystalline material.

The latest materials for permanent magnets are *sintered* Alnico, Alcomax and Hycomax.* Cast Alnico magnets, which have already been mentioned, have to be ground to size after heat treatment, as the alloy is too hard to be rolled or machined by normal methods; and, further, it is often impossible to provide for small holes and accurate bores in such castings. These difficulties have now been overcome by producing the magnets by the powder metallurgy process of sintering, whereby the constituents of the alloy are first reduced to powder and then mixed and moulded together under heat and pressure to the exact shape and size required. The resultant alloy is chemically and physically identical with the cast product except that it has very much greater mechanical strength. The interesting differences between the magnetic properties of cast and sintered Alnico, Alcomax and Hycomax are shown in Table 3, and Fig. 3 shows sintered Alnico compared with various magnetic steels, each mass of alloy having the same magnetic strength as the others.

A recent British Patent Specification (No. 583,411) relates to a pro-

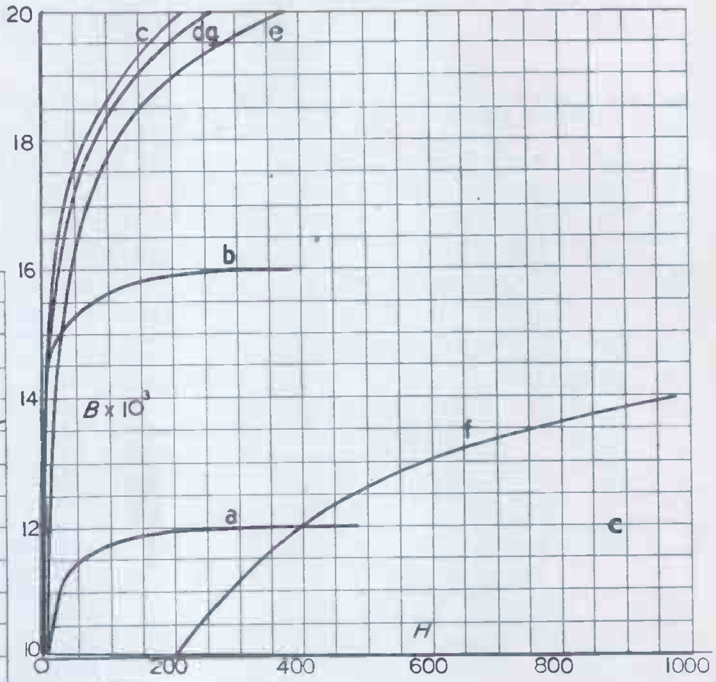
* The last two materials, which are anisotropic, are manufactured on a commercial scale only in Britain by Murex Ltd., Rainham, Essex.

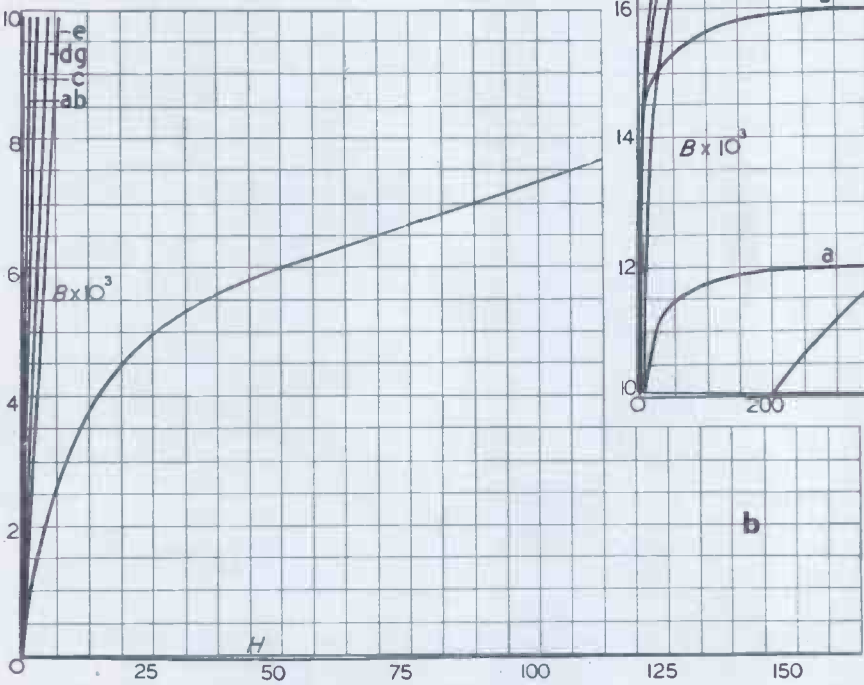
Fig. 1. B-H Curves for various magnetic materials

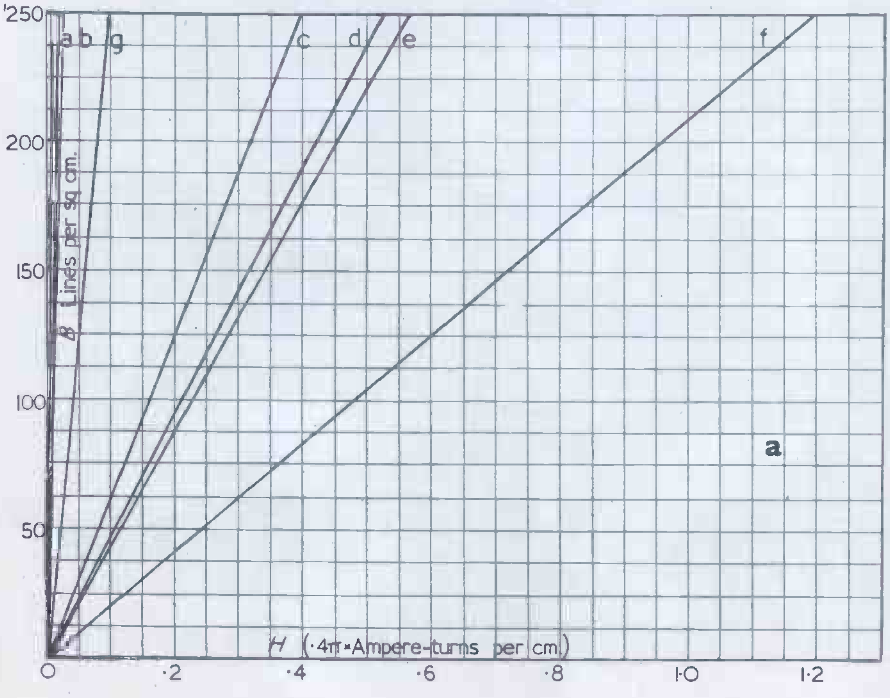
(a) From H = 0-1.2, B = 0—250
(b) From H = 1.2—160, B = 250—9,000
(c) From H = 160—1,000, B = 9,000—20,000

Reference

a. Permalloy b. Hipernik c. Pure Iron d. Low Carbon annealed steel e. Cast steel, annealed f. Cast iron, annealed g. Lohys.







cess of making an anisotropic permanent magnet in which an iron-base alloy containing about 9 per cent. aluminium, 25 nickel and 21 cobalt is subjected to the action of a magnetic field while cooling from a solution temperature of 1,240° C. down to 650° C., and a precipitation or ageing heat-treatment is applied to the alloy before it is finally magnetised. The alloy may contain up to 5 per cent. of copper, titanium or silicon, or up to 1 per cent. zirconium, or any two or more of these elements up to 10 per cent. The cooling in the magnetic field is effected at an average rate of 0.5-15° C. per second, the maximum cooling rate of the quarternary alloy of iron, aluminium, nickel and cobalt being 10° per second with 21 per cent. nickel and 15° with 30 nickel. If silicon is present the cooling rate is less than 10° per second, and is slower still as the silicon content is increased; with zirconium present the cooling rate should not exceed 1° per second.

Table 1 shows the coefficients of magnetic permeability and susceptibility of certain materials, those in the first column being established by dividing the magnetic induction produced by the magnetising force; and in the second column by dividing the magnetic intensity by the magnetising force.

Table 2 gives the hysteretic contants, or Steinmetz coefficients, for various materials.

TABLE I.—COEFFICIENTS OF MAGNETIC PROPERTIES

Material	Perm.	Susc.
Annealed very soft iron wire	—	280
Annealed soft iron wire ...	3,080	245
Moderately soft iron wire	2,590	200
Annealed steel wire ...	—	37
Hard-drawn steel wire ...	—	25
Glass hard piano wire ...	—	10
Annealed Norway iron ...	—	439
Nickel	280	18
Cobalt	170	11
Hadfield manganese steel	1.4	—

Fig. 2 graphically recapitulates the development of magnetic materials from iron to Supermalloy; in Neumann's "1040" alloy the beneficial effect of purification of the material with respect to non-metallic substances such as carbon and oxygen was used to considerable advantage. It will be interesting during the next few years to see whether this progress can be maintained.

TABLE II.—HYSTERETIC CONSTANTS

Material	Hys. Con.
Very soft iron wire	0.002
Very thin soft sheet iron	0.0024
Thin good sheet iron	0.003
Thick sheet iron	0.0033
Ordinary sheet iron	0.004
Transformer cores	0.005
Soft annealed cast steel	0.008
Soft machine steel	0.0094
Cast steel	0.012
Cast iron	0.016
Hardened cast steel	0.025

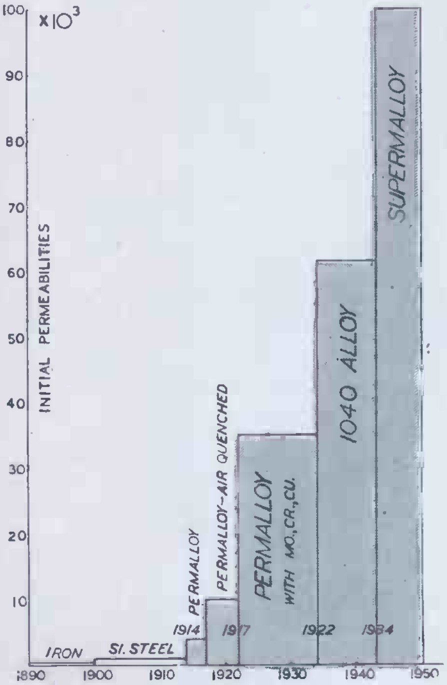


Fig. 2. Sixty years' development in magnetic permeability.

TABLE III.—COMPARATIVE MAGNETIC PROPERTIES

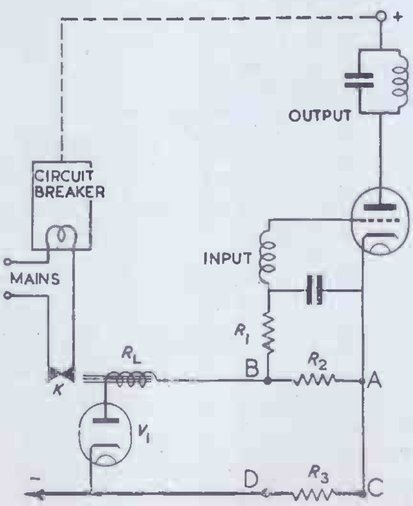
Alloy		Remanence Br. in gauss	Coercivity Hc, in oersteds	Energy product BH max.
Standard "Alnico"	C	7100-7900	580-480	$1.4\text{-}1.8 \times 10^6$
	S	6400-7700	550-450	$1.4\text{-}1.66 \times 10^6$
High Coercive "Alnico"	C	6300-7200	660-550	$1.4\text{-}1.8 \times 10^6$
	S	5800-6400	640-590	$1.4\text{-}1.66 \times 10^6$
High Remanence "Alnico"	C	8000-8800	420-320	$1.3\text{-}1.7 \times 10^6$
	S	7300-8000	450-350	$1.25\text{-}1.45 \times 10^6$
"Alcomax II"	C	12700	570	4.3×10^6
	S	11200	560	3.3×10^6
"Hycomax"	C	8500	790	2.7×10^6
	S	7600-8200	820-760	$2.4\text{-}2.8 \times 10^6$

C = Cast S = Sintered

Power Valve Protective Circuit

It is common practice to protect the grid or anode circuits of power valves with relays, whereby a change in current in either of these circuits causes the anode supply to be cut off. This method, however, has the disadvantage that the relay may operate during the adjustment of the valve load or when transients are caused by switching in an associated part of the circuit.

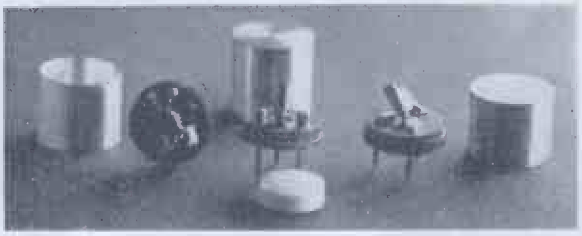
The accompanying diagram shows a simple and efficient safety circuit that does not suffer from the usual disadvantage outlined above, as it operates only when the ratio of grid current to anode current falls below a predetermined safe operating value. A triode power valve obtains its bias by means of the grid current flowing in the grid resistor R1, and a resistor, R2, is placed in series with it so that the grid current places point B at a negative potential with respect to A. A resistor R3 is arranged in the cathode circuit of the valve so that it carries the anode current but not the grid current, the current flowing in such a direction that the potential of D is below that of the point C. The values of R3 and R2 are in the same ratio as the maximum permissible ratio between the grid and anode currents. Thus, during normal operation the potential of B is not above that of D, but if the grid current falls or if the anode current rises then B becomes less negative than D, then the diode V1 conducts, allowing relay R_L to open the key K. The circuit breaker comes into operation and removes the anode supply from the valve, thus preventing damage.



When the load is being adjusted, or when transients occur, the grid and anode currents rise together, and the circuit continues to operate normally.

—*Communicated from the E.M.I. Laboratories.*

Amplifying Crystal Units



Following the preliminary report which was given in the September issue of this journal, articles have appeared in *Audio Engineering*,* describing the design and assembly of experimental germanium crystal units.

The following summary and illustrations are reproduced with acknowledgments to the author, **Mr. S. Young White**, and the publishers of *Audio Engineering*.

GERMANIUM crystals for rectifiers are obtained from ingots formed *in vacuo* and slowly cooled to give the required internal structure. The centre section of the ingot shows large size grain detail and is most suitable for working.

Two processes are required for developing "high back-voltage" crystals—lapping and etching. Lapping introduces large flow forces which probably change the surface layer. The action of the etch is not fully understood, but it improves the back voltage. Fig. 1 shows a complete curve of back current and voltage. In the high back-voltage crystal which has been adjusted for rectification, the current up to 30-70 V is negligible (point A on the curve). The current increases exponentially, being under control in the region A-B, but becoming unstable as C is approached, possibly due to local heating. From C-D the current becomes increasingly unstable and will slowly or rapidly approach D by itself. At this point the characteristic shows negative resistance and the current may rise to 300 mA or more. The point C gives greater "control grid" action, but the high g_m obtained is transitory, and B is the stable operating point for amplification.

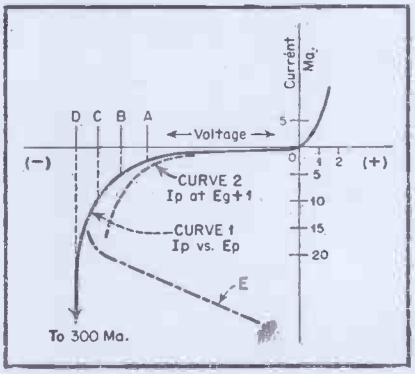


Fig. 1. Characteristics of germanium crystal

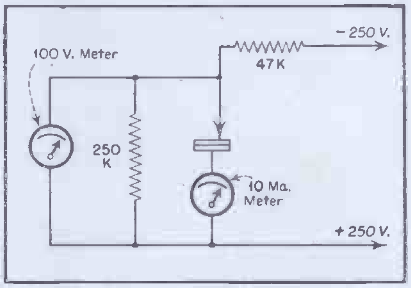


Fig. 2. Circuit for testing sensitive spots

All stable points that have little variation of current through them tend to stabilise, taking perhaps 10 minutes to do so. By keying pulses at approximately 30 V through them, the points also tend to become uniform. Tapping can also be tried and while a widely varying contact will not respond, it is often possible to stabilise a contact varying by 5 per cent. in current.

Mounting

There is an advantage in using a miniature tube base mount with a base of ⅛ in. Bakelite about ½ in. diameter. A rim can be turned for a Dural cover if required (*see* photographs). The catswhiskers can be mounted in slots at the top of the copper base pins, using a dummy crystal of .073 in. diameter brass to align the tips of the wires. After they have been correctly aligned at the required angle and height the slots are closed over and soldered.

The two mounts shown on the centre and right of the photograph are made with two pieces of tungsten sheet held down by brass heads on the pins. The pieces are adjusted to a gap of 0.003 in. by a feeler gauge and the crystal presented to them so that it bears on the gap with its edge. This is mechanically easy to adjust as the crystal assembly is swung past the gap, but there are several disadvantages, notably the difficulty of drilling tungsten and the requirement that the edge of the crystal must be lapped. However, the mount makes a useful double diode and tends to give good uniformity of the contacts.

In the right-hand photograph the crystal has been turned so that its top lies on one side of the gap and the side on the other, the side of the crystal being the grid.

To turn the line contact into a point, the tungsten is given a slight radius. Despite the uneven geometry of the edge of the 1N34 crystal, it is comparatively easy to find an operating point on the rim.

With this type of construction, the anode must have a high back voltage and must consequently be a polished and etched surface. The grid, however, needs no such surface. The tungsten must be polished and the burrs removed. It is well to reverse-plate it in sodium hydroxide for a few minutes with a nail for the other electrode, using a single dry cell, and with the tungsten positive. The plating is stopped when the tungsten is grey over all the immersed portion.

In mounting the tungsten, the copper pins are bent at more than 90° and forced into the bakelite base. The pressure of the pins on the sheets will anchor them firmly, while allowing the tungsten to be moved to locate the gap under the crystal. The crystal should be spring mounted.

Fig. 2 shows a circuit for testing for sensitive spots. A high voltage (250 V.) is used with a bleeder of 47,000 ohms and 0.25 megohms in series, the crystal being connected to the junction through a 10 mA meter, and a valve voltmeter across it.

The H.T. supply should be turned off each time to prevent shocking the crystal. The maximum applied voltage should not exceed 70 V, with a minimum of 15 V. To obtain a desirable figure of about 5 mA at 40 volts for a number of crystals, the point B on the curve must be held so that a number of crystals will work on a single battery supply. It has been found that present production of 1N34 crystals show wide variations in current at −40 V, since they are primarily intended for rectification and not amplification.

* Page 26, September, 1948.

German Radio Capacitors

By S. J. BORGARS,
B.Sc. Eng., D.I.C., A.M.I.E.E.

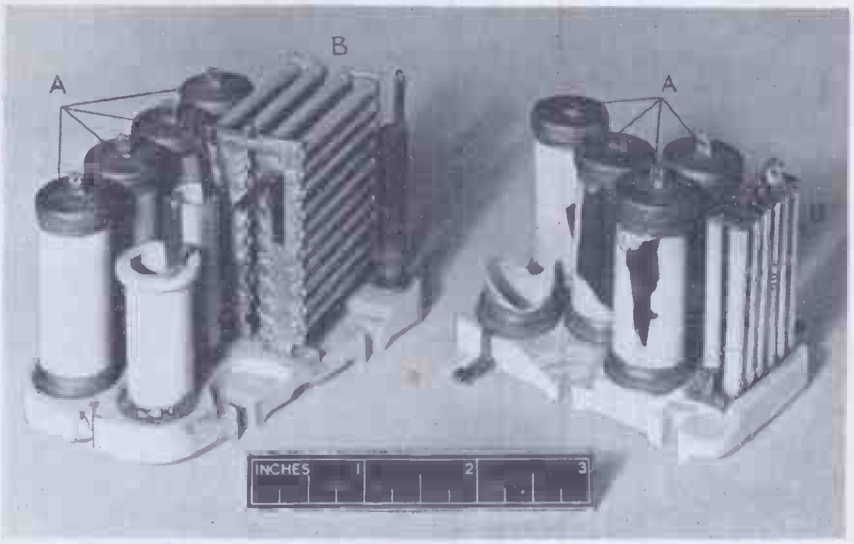


Fig. 1. Groups of ceramic tubular capacitors mounted on glazed ceramic baseplates
A—Sealed in glazed ceramic tube closed by metal end caps
B—Bank of paralleled units

A STUDY of the characteristics and construction of capacitors used in German radio equipment reveals several features of interest, and an attempt is made in this article to survey those capacitors which represent the latest advances in German technique and to emphasise points of interest to the radio engineer.

Capacitors were broadly divided into three grades, the first grade being generally designed for use at temperatures between −40 and +70° C., and in saturated atmospheres. Second grade types were for operation from −20 to +70° C., and third grade from 0 to +60° C., in atmospheres of 85 and 75 per cent. relative humidity respectively.

Paper Dielectric Capacitors

Foil Types

The capacitor unit generally consisted of a winding of aluminium foil, about 6 to 8 microns thick, interleaved with high grade Kraft tissue. The number of tissues employed and the thickness of each tissue varied according to the rated working voltage of the capacitor, according to the following representative table:

Working Voltage	Number of Tissues	Thickness of each tissue in Microns
100	2	8
200	2	10
300	2	13
500	3	10
1000	4	12
1500	5	12

Tabs of tin or copper, about 20 microns thick, were inserted in the winding to make electrical connexion to the foil.

After winding, the capacitor roll was vacuum impregnated. Petroleum jelly was probably the most widely used impregnant as it is satisfactory over a wide temperature range and will withstand fairly high voltage gradients. The comparatively high dielectric constant of chlorinated naphthalene, known in Germany as "nibren," had made its use attractive and it was widely employed as an impregnant. It was used without any stabilisers or other additives and was claimed to be very satisfactory.

After vacuum impregnation the capacitor roll was housed in either a cylindrical or rectangular case.

One type was housed in a cylinder of glazed ceramic closed at each end with a metal cap, the ceramic being metallised at each end for soldering to the caps. Alternatively the cylinder was of brass or steel sealed with ceramic or glass.

First grade rectangular metal cased capacitors were sealed by ceramic plates, by ceramic terminal bushings, or by glass seals. The ceramic was appropriately metallised for soldering to the case and to the capacitor leads. The glass seals were fused to flanges of iron alloy which were soldered to the case.

Metallised Paper Type

In this class of capacitor the electrodes consisted of zinc metallising deposited on a high quality Kraft tissue, the thinnest tissue used being about 8 microns thick. Before metallising, the tissue was given a coating of a cellulose nitrate lacquer about 0.5 micron thick, followed by an extremely thin coating of silver. Metallising was achieved by passing the tissue over molten zinc under reduced atmospheric pressure. Zinc vapour condensed to a depth of about 0.1 micron over the whole of the surface with the exception of a longitudinal strip at the edge of the tissue. This strip was previously given a very thin coating of oil which inhibited the deposition of the zinc.

The capacitor unit was wound so that the unmetallised strips of adjacent tissues were at opposite ends of the roll, thus producing an extended foil winding of low inductance. The metallised edge of each tissue was lapped over during the winding to facilitate subsequent connexion to the metallising. The unit was pressed flat so as to be suitable for insertion in a rectangular case and a layer of zinc about 0.6 mm. thick was sprayed on to each end of the capacitor roll. The capacitor leads were spot welded to these layers.

The unit was vacuum impregnated with a hydrocarbon wax mixed with paraffin wax, and then sealed into a rectangular metal case fitted with glazed ceramic terminal bushings. An interesting method of sealing the containers without soldering had been evolved as a result of an anticipated shortage of tin. Each container was pressed to the required shape and the seams spot-welded at one or two points. Scrap copper was placed in the container and the copper melted in a reducing atmosphere. The molten copper flowed along all the seams and on cooling formed a perfectly satisfactory hermetic joint.

The specification value of insulation resistance for first grade metallised paper capacitors of working voltage up to 250 was 200 ohm-farads, and for higher voltages was 1,000 ohm-farads. The power factor was stated to be about 0.007.

Ceramic Dielectric Capacitors

Fixed Type

Various types of fixed ceramic capacitors were produced. The electrodes were usually of silver fixed on to the ceramic, and adjustment of capacitance to bring the value within the required tolerances was done by grinding the metallising.

The capacitor leads were soldered to the metallising, and the unit was given a coat of lacquer. This lacquer was inadequate as a protectant against severe climatic conditions and special protection had been afforded the tubular type capacitors for use under these circumstances by housing them in glazed ceramic tubes as shown in Fig. 1A.

Tubular capacitors were produced with temperature coefficients ranging from −750 to +150 parts per million per °C. and parallel units were used for temperature compensation purposes. (Fig. 1B).

Trimmer Type

Considerable quantities of the small rotary type trimmer capacitor familiar in this country were made.

Larger types suitable for use in radio transmitters were also produced, Fig. 2. These capacitors consisted of a rotor, stator, and baseplate all of ceramic. The electrodes were of silvering in recesses on the upper side of the rotor and the under side of the stator, thus there was no silvering on the contacting surfaces of rotor and stator. These surfaces were ground to give smooth operation.

Another type of ceramic trimmer consisted of a ceramic tube with the stator electrode metallised on the external surface of the tube, the moveable electrode being metallising on an internal ceramic plunger operated axially by a lead screw. A variation of this type was a ceramic tube with two stator electrodes metallised on to the external surface, the capacitance between them being varied by an internal metal plunger, after the manner of a split stator capacitor.

Mica Dielectric Capacitors

A comparatively small amount of development had taken place on mica capacitors probably due to a shortage of mica, which, it is understood, occurred about 1943.

One type of interest was hermetically sealed into a rectangular ceramic case. The case was closed at one end except for a small internally metallised hole, and a rectangular lid metallised round its edges was soldered to corresponding metallising around the open end of the case. The lid also had an internally metallised hole and on assembly the capacitor lugs projected through the holes in the lid and case and were soldered to the metallising.

One of the most interesting result of the mica shortage was the attempt to make synthetic mica which the Germans claim to have done successfully on a laboratory scale. Quartz, alumina, magnesia, potassium, and cryolite were used as basic materials. These were mixed, melted, and cooled under carefully controlled conditions. A temperature gradient across the melt, together with the application of a magnetic field, caused molecular alignment during cooling in such a manner as to produce a laminated structure similar to that of natural mica. It was claimed that the product could be split like natural mica, would withstand higher temperatures than natural mica, and the quality was very consistent as impurities were negligible.

Fig. 2. Large ceramic trimmer capacitors

Plastic Dielectric Capacitors

A capacitor with a polystyrene dielectric had been developed primarily to replace the mica type for telecommunication purposes. The polystyrene was produced as a film by extrusion. During extrusion it was stretched in two direction at right angles. The film was wound interleaved with aluminium foil and the roll baked at about 90° C. This was said to release the tension inherent in the film as a result of the stretching, thus shrinkage was caused giving a roll of stable characteristics. The roll was hermetically sealed by methods described above for paper capacitors.

It is understood that film 10 microns thick could be produced, but normally two 20 micron films were used for a capacitor having a working voltage of 200. The temperature coefficient was stated to be about $-100/10^6/°$ C. and the power factor 0.0003.

Electrolytic Capacitors

Electrolytic capacitors were produced in various capacitance values and working voltages, the highest operating voltage being about 500. Certain types were claimed to be satisfactory for operation from −40 to +70° C. They were housed either in tubular or rectangular metal cans, and either bakelite, synthetic rubber, or glass used as the sealing medium.

The anode foil was of aluminium of not less than 99.8 per cent. purity and about 100 microns thick, both plain and etched foils were used, the etch ratio being about 4 or 5 to 1.

The composition of the electrolyte varied according to the maximum working voltage and range of operating temperatures, but standard ingredients were generally used, viz., boric acid, ammonium borate, and ethylene glycol.

Formation of the film was generally done by a continuous process.

Winding was usually carried out with spacers of sulphate cellulose tissue. This operation may be done wet, or the unit may be wound dry and subsequently impregnated.

Air Dielectric Capacitors

Variable Type

Fig. 3 shows a four-gang variable air capacitor which is of interesting construction. The main metal parts of the capacitor were die cast in a magnesium alloy. The stator vanes and screens were cast integrally with the main frame. Screens were cast in the cover which, on assembly, aligned with the screens in the main frame, thus each capacitor section was completely screened from its neighbour. Each rotor section was die cast and was mounted on a ceramic spindle which traversed the length of the capacitor. An interesting point was the provision of an annular peripheral groove in the rotor vanes of three sections for trimming purposes.

Various types of variable air capacitors were made for specialised purposes. One type was designed primarily to have a low value of temperature coefficient. The rotors were mounted on a ceramic spindle and the stators on ceramic rods. The ceramic members were anchored at one end of the capacitor, but at the other end they were mounted in such a manner as to permit freedom of movement in a direction parallel to the spindle axis.

The idea of the construction is that a temperature rise of the capacitor will cause equal axial displacements of the rotors and stators and thus the capacitance change will be negligible.

Another type was designed for incremental control by a relay mechanism. The electrodes were in the form of interleaving concentric cylinders. One set of cylinders was fixed and the other set was mounted on a ceramic rod.

Each operation of the relay caused a small axial movement of the ceramic rod and thus produced a small change of capacitance.

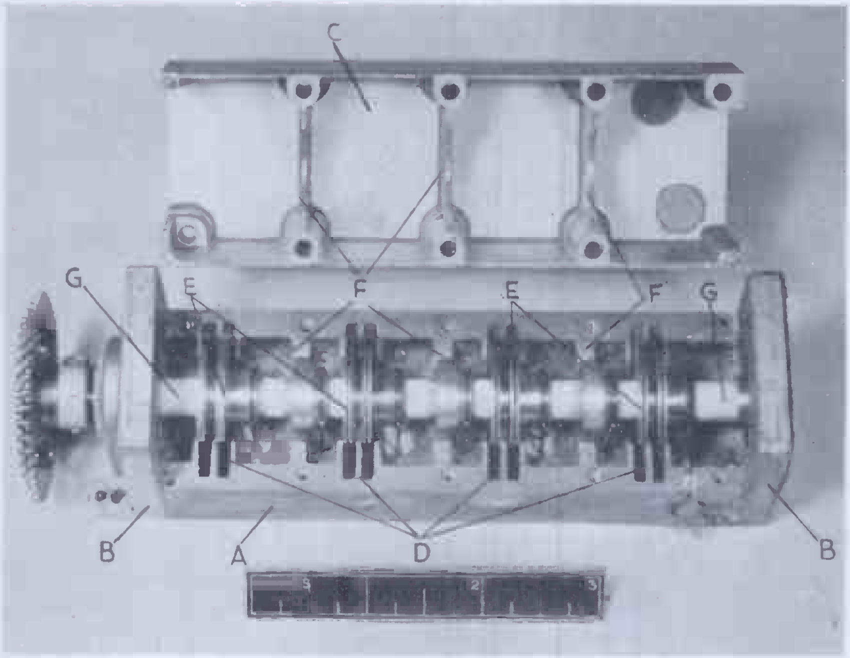


Fig. 3. Four-gang variable air capacitor. Metal parts are die cast of magnesium alloy

A—Main frame
B—End plates
C—Cover
D—Stator vanes
E—Rotor vanes, note peripheral groove in three of the rotor sections
F—Screens
G—Ceramic spindle

Trimmer Type

The electrodes of pre-set or trimmer air dielectric capacitors were usually either concentric cylinders or parallel plates mounted in a ceramic frame.

Fig. 4 is a sketch of an experimental trimmer which was constructed mainly of ceramic. The assembly is reminiscent of the rotary disk ceramic trimmer type capacitor but the stator has a raised part with a contour parallel to the edge of the rotor disk, and spaced from it by about 1 mm. The rotor electrode was metallised on the edge of the rotor disk and the stator electrode on the parallel stator face. Five types were made with values of maximum capacitance from 1.6 to 5.4 pF.

Conclusions

The trend of German radio capacitor development during the last few years was in general to develop and improve existing techniques. Very little had been produced that was new or novel fundamentally, but considerable progress had been made in the development of manufacturing processes and in the application of certain materials to improve the performance of the finished product. The chief points of interest are the extensive use of ceramic in the construction of various types of capacitor, the use of glass for terminal seals, the application in certain instances of die casting in light alloy, and the development of certain impregnants.

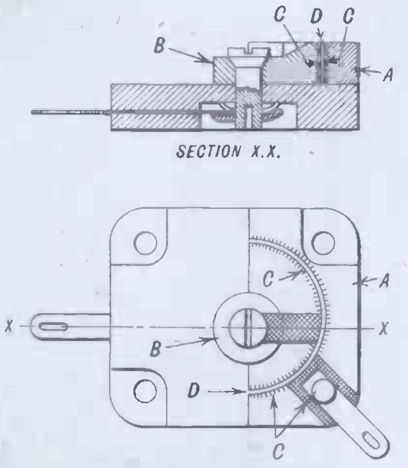


Fig. 4. Experimental air dielectric trimmer capacitor

A—Ceramic stator
B—Ceramic rotor
C—Metallising
D—Air gap

Acknowledgments

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Potentiometers for Computing Circuits

By R. WILSON WILLIAMS, Ph.D., A.Inst.P.*

AT the present time, interest in electrical analogue computing is widespread and the basic operations of electro-mechanical and electronic analogue computing have been surveyed in these columns by Mynall[1]: war-time developments of electrical computing as applied to anti-aircraft predictors are alluded to by Douch.[2] Resistance potentiometers are used extensively in electrical computing and it is the purpose of this article to indicate some design considerations which must be kept in mind when potentiometers are employed in computing circuits.

The main features of a resistance potentiometer are familiar enough—the card or strip of insulating material, wound with resistance wire whose properties are sensibly uniform along its length, and bent round to lie along the circumference of a circle, with a slider pivoting about the centre of the circle and making contact with a track bared along the edge of the card. The resistance card may be of uniform width—in which case the voltage from the potentiometer slider varies linearly with its angular position—or its width may vary along its length so that the output voltage follows a pre-determined law of (non-linear) variation with the angular position of the slider. Potentiometers of this kind are available commercially† and are capable of giving results of high accuracy. Various features may be included in the mechanical design of the potentiometer to reduce errors found in it after assembly. Thus Colvern Ltd. employ "cam-correction": here the slider is permitted a certain amount of angular motion, in addition to, and independent of the motion of the main shaft, this motion being communicated to it by means of an arm which bears down on a track concentric with the potentiometer card. The profile of the track is controlled by screws arranged at regular intervals round its circumference and is adjusted so that the output voltage of the potentiometer, as observed at several test settings of the shaft, attains the desired value at each setting.

* University of Liverpool

The Loading of Potentiometers

Consider a resistance potentiometer of total resistance R_o connected to a voltage source of negligible internal impedance, giving E.M.F. E volts. The potentiometer slider (Fig. 1) is positioned at a fraction x up the length of the potentiometer track (*i.e.*, $x = 1$ when the slider is at the top of the potentiometer) and feeds a resistive load R_L ohms. The total load on the source E is

$$R_o(1-x) + \frac{1}{\frac{1}{R_L} + \frac{1}{R_o x}} = R_o(1-x) + \frac{R_o R_L x}{R_L + R_o x}$$

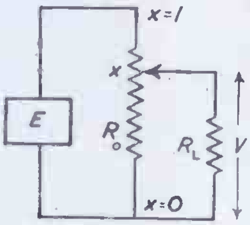


Fig. 1.

and therefore the voltage V developed across the load is

$$E\,\frac{\dfrac{R_o R_L x}{R_L + R_o x}}{R_o(1-x) + \dfrac{R_o R_L x}{R_L + R_o x}}$$

i.e.,

$$\frac{V}{E} = \frac{R_o R_L x}{R_o R_L x + R_o(1-x)(R_L + R_o x)}$$

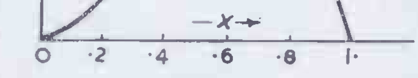


Fig. 2. Curve of v. x, showing maximum value at 0.66

If R_L is infinitely great, we know that $\frac{V}{E} = x$ and therefore the error resulting from the loading effect of R_L on R_o is given by $\Delta =$

$$x\left\{1 - \frac{R_o R_L}{R_o R_L x + R_o(1-x)(R_L + R_o x)}\right\}$$

$$= \frac{x^2(1-x)(R_o/R_L)}{x + (1-x)(1 + R_o/R_L x)}$$

When $\frac{R_o}{R_L}$ is small, Δ approximates to $\frac{R_o}{R_L}\,x^2(1-x)$. It is readily demonstrated that the function $x^2(1-x)$ has a maximum value at $x = 2/3$ (*see* Fig. 2) and therefore it can be stated that the maximum error due to the load R_L on the potentiometer occurs when the potentiometer slider is set so that 2/3 of the potentiometer resistance R_o lies below it, the value of the maximum error being $\frac{4}{27}\cdot\frac{R_o}{R_L}$ (expressed as a fraction of the voltage E applied to the potentiometer). It is clear that values of R_o and R_L should be selected so that the ratio of R_o to R_L is as small as possible in order to minimise the loading error. Alternatively, the potentiometer card can be graded to allow for the loading effect of a known load R_L. If it is not desired to resort to grading, the following considerations act as a guide in selecting values of R_o and R_L. If a summing amplifier is used to deal with the computing voltages, the resistors used in the resistance chain (which constitute the loads on the potentiometers whose outputs are being summed) may be of as high a value as is feasible from the point of view of stability, that is, stability of resistor value with time. However the value of R_L may be decided by some other consideration, *e.g.*, R_L may be another potentiometer. Assuming that R_L has been fixed and that the maximum loading error which is tolerable has been laid down, the relation $\Delta_{max} = \frac{4}{27}\,\frac{R_o}{R_L}$ decides a value of R_o. It is important that R_o should not be of too low a value. The voltage scale used in the computing circuits being known, the

† The firms of P. X. Fox, Ltd., Colvern Ltd., and Painton & Co., may be mentioned in this connexion.

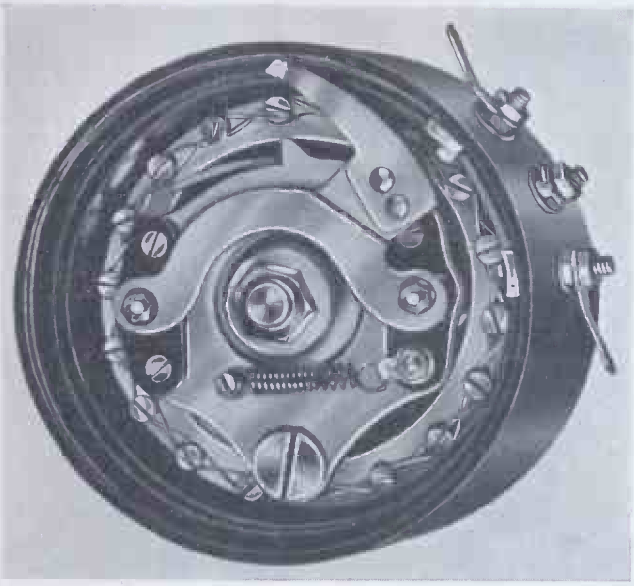


Fig. 3. *Left :* **Potentiometer with special "cam correction" device**

By courtesy of Messrs. Colvern Ltd.

Above : **Potentiometer with graded winding to give non-linear variation with position of slider**

By courtesy of Messrs. Painton Ltd.

voltage applied to R_0 is calculable and care must be taken to see that the dissipation in watts, at which the potentiometer is rated, is not exceeded. Even if the potentiometer is not over-loaded, an excessive amount of power should not be required for its operation: if it is energised from a transformer winding the value of R_0 in turn decides the copper resistance of the winding (for reasons which will be gone into later), and it is generally desirable to keep the transformer down to a reasonable size. Then again, it may be that a summing amplifier is used to energise R_0 and the power output of this amplifier will have a finite limit.

Numerical Example

As a numerical example, the case of a potentiometer used to yield a voltage (of mains frequency) representing range or distance may be considered. The potentiometer shaft has been assigned a rotational value of 36,000 yards, let us say, and the voltage scale prevailing in the instrument of which this potentiometer is a component is 1 volt R.M.S. per 1,000 yards. The resistance card of the potentiometer occupies an angular length of 300°, *i.e.*, 30,000 yards and so the voltage across it is to be 30 V. The rating of the type of potentiometer selected for this role in the circuit (the selection being governed by consideration of accuracy obtainable, mechanical design, reliability, etc.) is known to be 10 watts. However, the potentiometer is to be fed from a source of high internal impedance, which provides a voltage whose time-phase (with reference to the mains supply) is taken as the standard of phase in the computing circuits, and whose amplitude is similarly taken as a standard, defining the voltage scale used. This source cannot be loaded directly by the potentiometer and so a power reinforcing amplifier using negative feedback is employed to feed the potentiometer. The output valve of this amplifier cannot supply more than 5 watts and therefore, since there is to be 30 V across the potentiometer its resistance must be greater than $\frac{30 \times 30}{5}\ \Omega$. Also it is known that the load on the potentiometer will be a resistor in a summing chain of value 100 KΩ, this value being fixed from considerations of stability. If it is laid down that the maximum loading error tolerable is 25 yards, we have

$$\frac{4}{27} \cdot \frac{R_0}{100{,}000} = \frac{25}{30{,}000} \quad i.e.,$$

$R_0 = 562.5\ \Omega$. It can therefore be stated that $180 < R_0 < 562.5$. Taking for convenience a value of 500 Ω, the maximum error due to loading comes out at 22 yards and the power required from the output stage of the reinforcing amplifier is 1.8 watts, which is well within the capability of the stage.

Temperature Effects

Potentiometers are usually wound with wire of low temperature-coefficient of resistance and are fed from transformer windings of copper wire: the voltage drop in the winding will be a function of temperature and we now consider the error likely to arise due to this. Let the E.M.F. of the winding be E, its resistance r_0 at a reference temperature t_0°C and its co-efficient of resistance α ohms per degree C per ohm. The resistance of the potentiometer is R. The voltage across the potentiometer is therefore $\frac{ER}{R + r_0}$ which alters to

$$\frac{ER}{R + r_0(1 + \alpha\Delta t)}$$

when the temperature of the winding increases by Δt° C. The change in voltage is therefore

$$ER\left\{\frac{1}{R + r_0} - \frac{1}{R + r_0(1 + \alpha\Delta t)}\right\}$$

which approximates to $(E/R)r_0\alpha\Delta t$. for $R >> r_0$. Expressed as a fraction of E, the change is $(r_0/R)\alpha\Delta t$. If a maximum change of 1 part in 10^3 can be tolerated, then

$$\alpha\Delta t\frac{r_0}{R} = 10^3$$

or $\frac{r_0}{R} = \frac{1}{4\Delta t}$ for copper. Thus for $\Delta t = 25$°C r_0 would have to be 1% of the value of R in order to meet the accuracy requirement.

With several potentiometers fed from as many secondary windings, r_0/R should have the same value for each, if the various voltages across the potentiometers are to bear the same ratios to each other independently of temperature fluctuations.

The Grading of Potentiometers

Consider a potentiometer constructed with a card of varying width. The width y is a function, $f(x)$, of the length x along the card (Fig. 5). Let the wire used for winding the card be of resistance r_o per unit length: the number of turns per unit length along the card is n_o. Then the resistance between the points A and B on the card, whose distance apart is the small quantity δx, will be $2r_of(x)n_o\delta x$ and the resistance between the bottom end of the card ($x=0$) and the point A will be $2r_on_o\int_{x=0}^{x} f(x)dx$.

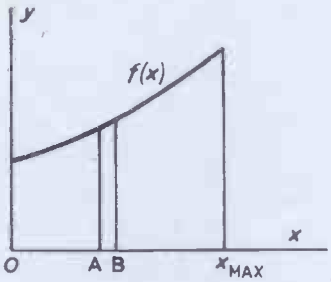


Fig. 5.

The total resistance of the card will be $2r_on_o\int_{x=0}^{x_{max}} f(x)dx = R$, say.

With a voltage E applied to the potentiometer, the voltage between the slider and the bottom end is given by

$$V = 2\frac{E}{R}\,r_on_o\int_{x=0}^{x} f(x)dx.$$

If it is desired for this voltage to vary with x according to the law $V = \phi(x)$, then

$$\int_{x=0}^{x} f(x)dx = \frac{R\phi(x)}{2Er_on_o}$$

and by differentiation, it follows that

$$f(x)dx = \text{a constant} \times \frac{d}{dx}\phi(x).$$

Hence if it is required to obtain a voltage output from the potentiometer following a law $\phi(x)$, the shape of the potentiometer card should be that of the derivative of $\phi(x)$.

An interesting problem arises when the derivative of $\phi(x)$ takes on a very high value for some value of x, as the required shape of card is not then a practical proposition. An

Fig. 4. Exploded view showing construction of special toroidal potentiometer. The wound ring fits over a moulded baseplate in which are four symmetrically placed contact springs to give tappings at 90°. The current is fed to the winding by the rotating arm (*top*) in which two silver pins make contact with the winding and two concentric sliprings. The main shaft is not shown in the photograph.

By courtesy of Messrs. P. X. Fox Ltd.

example of this is afforded by the function $\sqrt{x}$. The derivative is $\frac{1}{2\sqrt{x}}$ which becomes infinite at $x = 0$. (Fig. 6). The solution adopted is to make a card A.B.C.D. in which the end A.D corresponds to a value $\frac{1}{2\sqrt{x_o}}$ of the slope of the function $\sqrt{x}$, *i.e.*, the card extends from x_o to x_{max}, instead of from $x = 0$ to x_{max}. Below x_o the card is continued in the form of a strip or ramp made of material of negligible resistance, over which the potentiometer slider travels in the interval from $x = 0$ to $x = x_o$. Now if the exciting voltage E were applied across the potentiometer directly, the output voltage V would be in error, being zero at the end A, where its value should be $\sqrt{x_o}$. The error is eliminated by including in series with the potentiometer a fixed resistance of value

$$\frac{\int_{o}^{x_o}\frac{dx}{\sqrt{x}}}{\int_{x_o}^{x_{max}}\frac{dx}{\sqrt{x}}}\,.\,R = \frac{\sqrt{x_o}}{\sqrt{x_{max}} - \sqrt{x_o}}\,.\,R$$

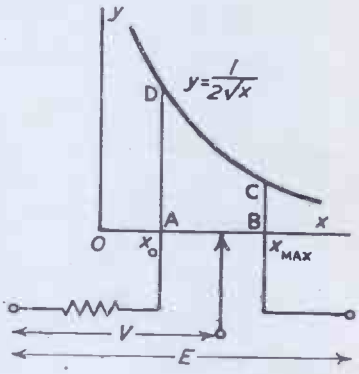


Fig. 6.

where R is the total resistance of the potentiometer. The exciting voltage is now applied across the series combination of potentiometer and fixed resistance, and the slider of the former then gives the correct output voltage, conforming to the law $\sqrt{x}$. The obvious limitation is that the output voltage is in error when x is less than x_o. In practice, it is quite feasible to wind a card where the ratio of maximum width to minimum width is as much as 4 or 5 to 1. In Fig. 6, taking $AD/BC=5$, we have therefore that $\frac{x_{max}}{x_o} = 25$, so that by adopting this solution only the first 4% of the total variation of x would be unusable.

[1] D. J. Mynall, *Electronic Engineering*, June, 1947.
[2] E. J. Douch, "The Use of Servos in the Army during the past war," paper read at the *I.E.E. Servo Convention*, May, 1947. *J.I.E.E.* Vol. 44, Pt. IIa, 177

Sync. Separator and Hard Valve Double Time Base for Television

By C. H. BANTHORPE*

SOON after the resumption of B.B.C. television transmissions the writer carried out an investigation into the problem of non-interlacing, and as part of the investigations it was decided that a sync. separator and double time base should be constructed which could be fairly complicated but must give the desired result, *i.e.*, excellent interlacing.

It is known that some of the causes of bad interlace are:

(a) Kick-back from the time bases, either from the electrode into which the sync. is applied, by supply leads, by the scanning coils and transformers, or by the correcting networks from output to input.

(b) Imperfect sync. separation.

(c) Variation of sync. pulse amplitude, and

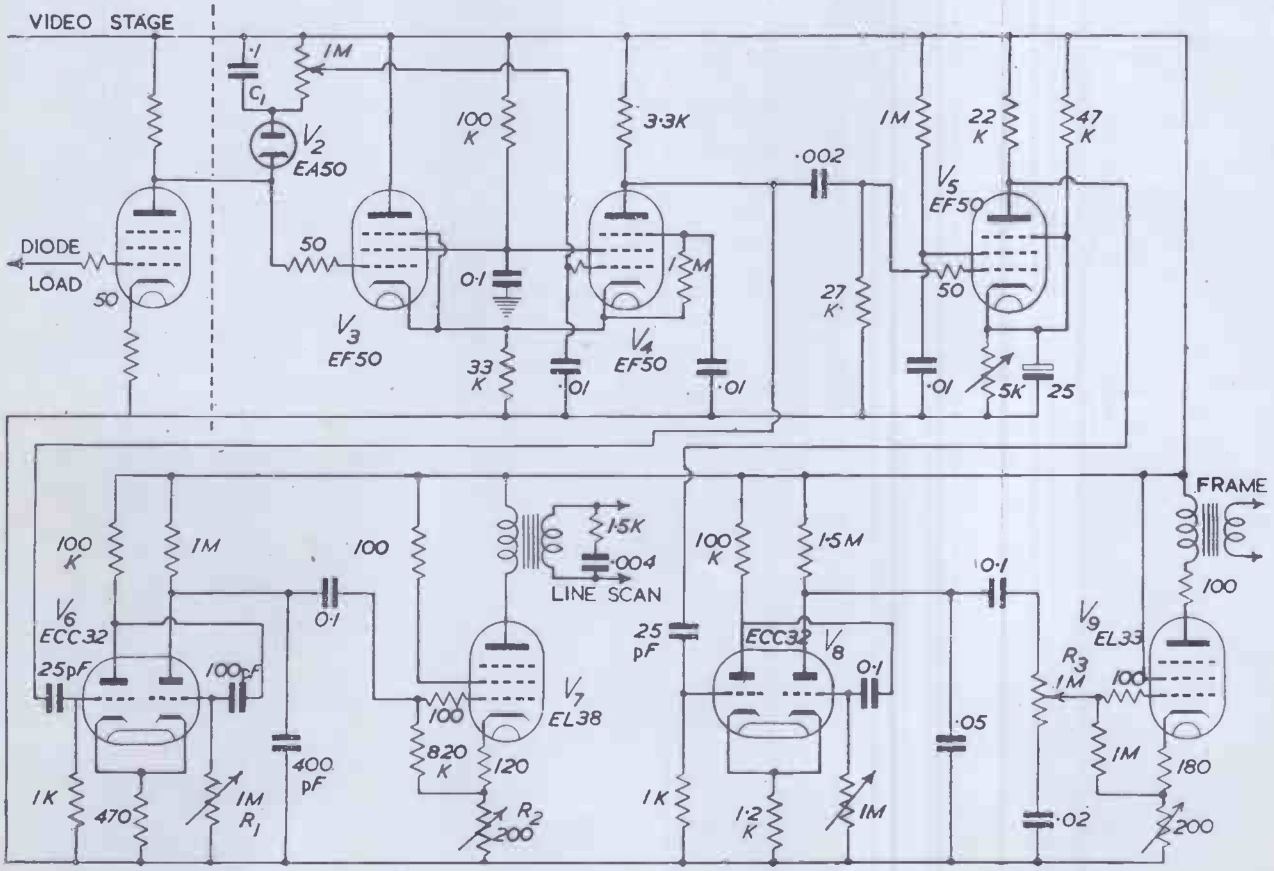
(d) Sloping sync. pulses.

A circuit was devised, therefore (*see* diagram) to avoid these troubles. Although requiring several valves, it proved to be very useful during the investigation, has done considerable service since, and gives satisfactory results. The sync. separator will be seen to consist of a "long tailed pair," directly connected to the anode of the video stage, and a diode. Two E.F.50's are shown as the L.T.P., but a triode hexode has been used in that position. The anode potential of the video stage goes more positive on picture and drops during the sync. period. During this period the diode conducts sufficiently to keep the capacitor C_1 charged to a potential approximately equal to the maximum downward sweep of the video anode, which is the "blacker than black" level. This voltage is smoothed and a percentage of it applied to the control grid of V_4. During the picture time the control grid of V_3 will go positive, the cathode will follow it, as will the cathode of V_4, and as the control grid of V_4 is low with respect to its cathode, V_4 will be shut off, and its anode will be at H.T. potential. During the sync. period V_3 will be shut off, V_4 will take current and its anode potential fall. Negative-going sync. pulses, free from picture, therefore appear at the anode of V_4.

As V_3 does, in fact, get biased off before the anode of V_1 falls to its lowest level, the sync. pulses are effectively clipped and "noise" eliminated. The pulses at the anode of V_4 are, therefore, clean, sharp and of constant amplitude.

G_1, G_2 and G_3 of V_4 are decoupled

* Central Equipment, Ltd.



to earth and picture break-through via the capacity between cathode and anode is therefore very small indeed.

V_2 can be replaced by a potentiometer across the H.T. supply, but the valve is more satisfactory. The negative-going sync. pulses are differentiated and applied to the line time base. They are also applied to the grid of V_5 through a longer time constant circuit of 54 μS, which partially differentiates them. On the line sync. pulse a small overshoot occurs at the end of the pulse, but on the longer frame pulse a much larger one occurs and reverse half-line pulses build up. The use of a critical time constant in this way was first described by K. S. Davies.*

These positive half-line pulses are amplitude-clipped by V_5 to eliminate line pulses, and sharp negative-going frame pulses appear at its anode. These are then differentiated and applied to the frame time base.

The line time base consists of a cathode-coupled multivibrator, followed by a pentode amplifier. The speed is adjusted by R_1, and the amplitude by R_2. The frame time base is similar, but has an additional control R_3 to adjust linearity. These hard valve time bases are very pleasant devices and are extremely stable in use. The grids to which the sync. pulses are applied are "free" and there is, therefore, practically no kick-back when the time bases fire. With the values shown the amplitude is more than sufficient to scan a 12-in. tube with 6 KV E.H.T. and the flyback time is short enough. It is possible to make the flyback time shorter if desired, but there seems no point in so doing. Time bases of this kind have been used before and no claim is made for originality, but they seem to have been overlooked by television engineers in this country, possibly because no suitable British valve was available until recent times. Even in the U.S. there does not seem to be a television receiver using the circuit for line and frame purposes. It is as satisfactory as, and slightly cheaper than, the squegging type, and as mentioned above, has a free grid into which sync. pulses may be fed. It is possible that a very good interlaced raster can be attained by means of a circuit using less valves, but the above is offered as a tested circuit which gives the desired result.

* *Jour. Tel. Socy.*, Dec. 1937, p. 19.

The International Television

By Our Special

THE largest and most representative gathering of television engineers and scientists from more than 12 countries assembled in Zurich last month for the International Television Convention held during the week September 5-10. This Convention had been sponsored by the Swiss National Television Committee and the Swiss Federal Institute of Technology, with Professor Sanger as President of the Organising Committee, which included such distinguished names as Professor Tank (President of the Swiss National Television Committee) and Professor Baumann, Director of A.F.I.F. (Department of Industrial Research).

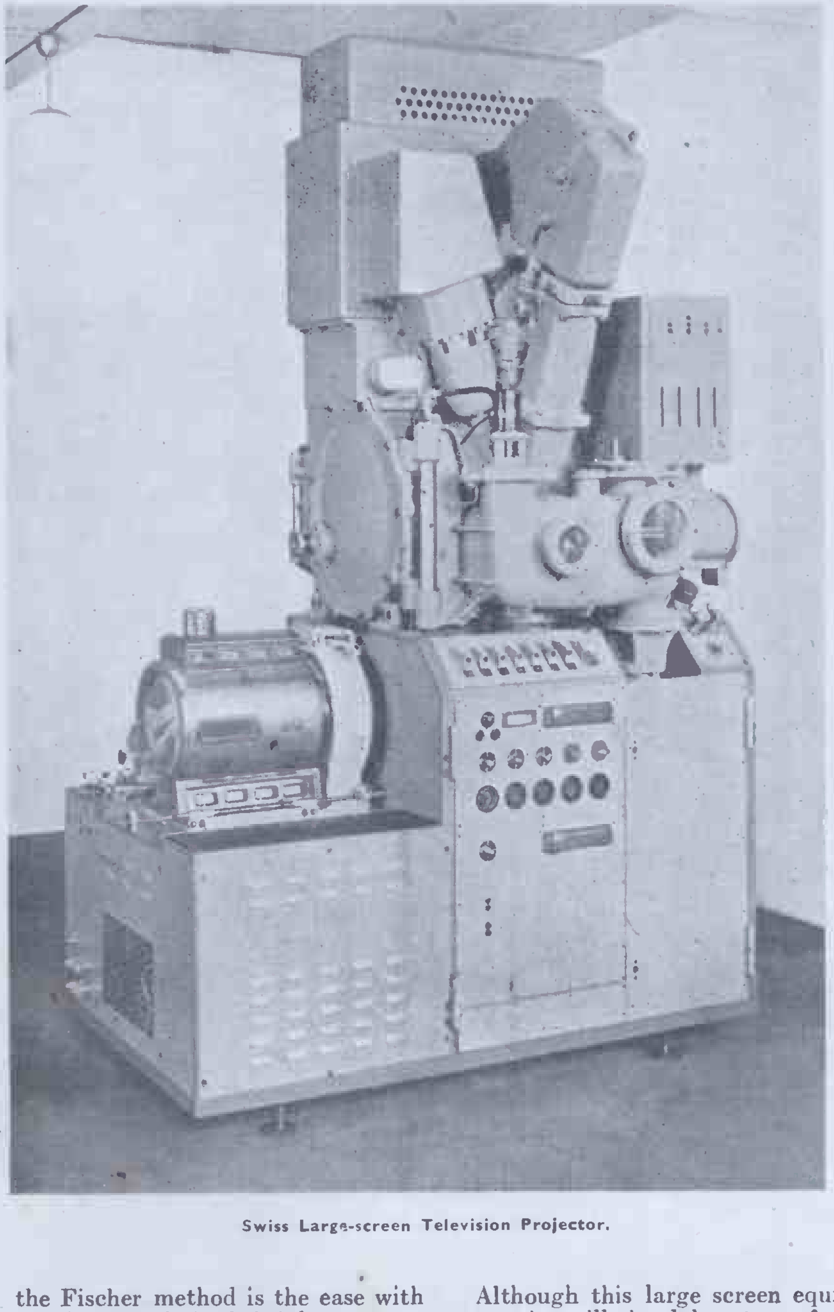
The Convention, which met in the physics lecture theatre of the Federal Institute of Technology, was inaugurated by the President of the Swiss Confederation, Dr. Enrico Celio, who stressed the significance of the problems to be discussed and the spirit of international co-operation for the advancement of knowledge which the Convention illustrated. The development of television, he said, could not be limited by political frontiers. The first goal must be the international exchange of programmes with the implied need for agreement on transmitting standards. The Swiss public, he continued, was impatient for a television service, though their unique problems, in the form of plurality of languages and geographical extremes, were bound to delay its introduction. The president then spoke of the late Professor Fritz Fischer, one of the first Swiss pioneers of television and a founder of the Television Committee, whose recent death at the height of his career was so widely lamented and whose work was now being continued by Professor Baumann.

Following the president, speeches of introduction and welcome were also delivered by Professors Tank and Sanger, after which the business of the Convention began with an address by Mr. T. H. Bridgewater (of the British Broadcasting Corporation) whose subject, "Television Studio and Outside Broadcast Practice in Great Britain," comprised a review of the latest trends in Television technique with particular reference to pick-up tubes, cameras, lighting, studio design and similar aspects closely associated with the actual formation of television pictures. Mr. Bridgewater revealed some of the ways in which British television practice is keeping up to date and gave details of the latest equipment and lighting intensities used for the recent Olympic Games.

During the succeeding four days, more than a dozen main lectures were given as well as more than 20 short lectures on subjects embracing every facet of television from pick-up tubes to international distributing networks, television recording and large screen projection. Particular mention must be made of the masterly paper by Dr. H. Thiemann, who has himself been so prominently associated with the project, on the development of the "A.F.I.F." large screen based on the original patent and principles proposed by the late Dr. Fritz Fischer. Readers of this journal may recall the basic principle of the invention whereby the effect of a true light valve is obtained by the variation of the angle of refraction of light directed on to the surface of a thin oil film. A modulated electron beam is made to impinge on the film and trace a complete raster, which results in the surface becoming distorted in proportion to the charge deposited. It is this surface distortion which bends the angle of refraction and so makes it possible, by a system of optical gratings interposed in the path of the beam before and after refraction, to allow more or less light, according to the modulation, to be transmitted through the system and projected on to a cinema-size screen. The demonstration consisted of "live" scenes, picked up direct by a French "Eriscope" camera, both out of doors and from a studio, as well as film projected through a "tele-cine" apparatus, the number of lines used being 729. In both cases the results were of the highest class and received enthusiastic praise from all those privileged to witness the demonstration. The pictures were exceptionally bright, easily equal to cinema standard—indeed, one of the advantages of

Convention at Zurich

Correspondent



Swiss Large-screen Television Projector.

the Fischer method is the ease with which any desired brightness can be achieved—and the definition appeared to be adequate, in fact any limitations in this respect could be traced to the sending rather than the receiving equipment.

Although this large screen equipment is still in laboratory form and requires further research and development before it could be offered for commercial exploitation, the present performance is so remarkable that one hopes, and believes, that Prof. Baumann, Dr. Thiemann and their assistants will be encouraged to pursue their task to its ultimate conclusion.

Among many other interesting papers, special mention should be made of outstanding contributions by Dr. Espley and Capt. West (Gt. Britain), Dr. Zworykin (R.C.A.), Messrs. Barthelmy and Delbord (France) and Mr. Vecchiacchi (Italy). Hardly any aspect of television was left unmentioned, but there was perhaps most emphasis, both by these authors as well as many others, on the wide subject of television distribution by national and international networks. Included under this heading is the indirect method of distribution by the medium of recordings on film, and this is by no means the least important for international exchanges of programmes while the present want of agreed standards continues. Indeed the deplorable situation now existing whereby even contiguous nations such as Britain and France could not directly exchange their own programmes was a topic for considerable discussion in the lobby, as well as in the Conference Room. Possibly one of the most valuable features of a convention of this kind is the informal meetings between television men from many nations. Problems such as this one of international standards do at least assume their proper weight and proportions when argued face to face by those immediately affected and we came away from the Convention convinced of the benefits which television will gain by such gatherings of representatives of the nations in an atmosphere of goodwill.

Any account of the convention would be incomplete without a mention of the excellent arrangements made by our Swiss hosts for the comfort and well-being of the visitors. No efforts had been spared to ensure an effective presentation of the papers, as well as other opportunities, less formal, for the most profitable intercourse between delegates. In addition, an agreeable excursion on the Lake of Zurich was provided by the courtesy of the Ministry of Posts, Telephone and Telegraph, while the week's proceedings were terminated in convivial manner by a banquet at which our hosts were jointly the Cantonal Government of Zurich and the Municipality of Zurich.

* See *Electronic Engineering*, Dec. 1944, p. 294.

Automatic Gain Control For Vision Receivers

By D. McMULLAN, M.A.

ALTHOUGH automatic gain control (A.G.C.) is incorporated in nearly all sound receivers and in many radar sets, so far little attention has been paid to its application to vision receivers in this country. Fading is not so common at the frequencies used for television, as at lower frequencies, but can still be serious especially at places remote from the transmitter. At television frequencies the two main causes of fading are variations in the atmospheric conditions and reflexions from moving objects (generally aircraft). Fading due to the former is only experienced at some distance from the transmitter and is usually slow. Reflexions from moving objects are troublesome at all ranges and the resulting fades occur at rates varying from one in several seconds up to about 15 per second and are often of sufficient amplitude to cause the brightness of the picture to vary from black to peak white.

Fading due to both the above causes was so troublesome on a set situated 45 miles from Alexandra Palace that it led the writer to develop a circuit for applying A.G.C. to the vision receiver. The circuit was required to compensate for variations in signal of at least 20 db. and it was desirable that it should respond as rapidly as possible.

General Considerations

The gain of a vision receiver may be varied by applying a negative voltage to the control grids and/or suppressor grids of the R.F. amplifying valves (or I.F. amplifiers if a superhet). In order to obtain A.G.C. it is necessary that this negative voltage shall be proportional to the strength of the received transmission. In the case of sound receivers the control voltage may be derived from a diode with a load resistance and reservoir capacitor connected across the last tuned circuit of the I.F. amplifier. The voltage across the capacitor is proportional to the strength of the carrier and does not vary with modulation of the carrier, the mean carrier power being constant.

This is not the case, however, with a carrier which is modulated by a

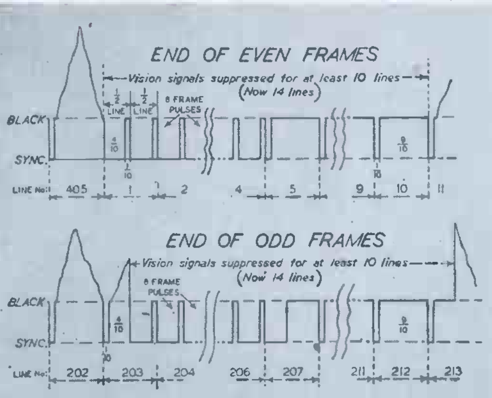


Fig. 1. Part of the B.B.C. television waveform, showing the synchronising pulses at the end of the even frames

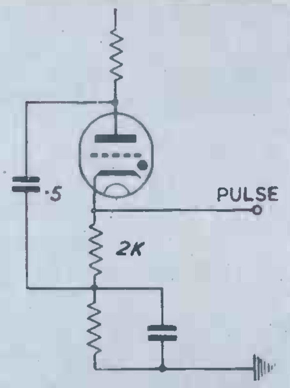


Fig. 3. Deriving the pulse from a thyratron frame time-base with a cathode resistor

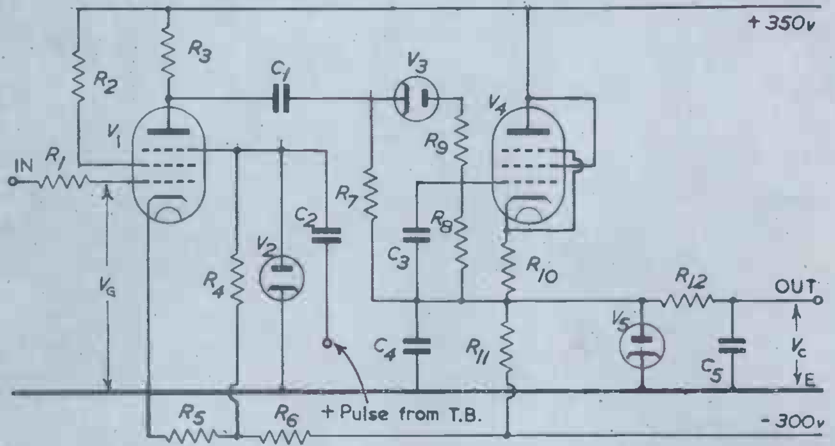


Fig. 2. A.G.C. circuit. Table 1 when deriving pulse from frame time-base; Table 2 with line time-base

Table 1

R_1	20K	C1	0.1μF	R_{10}	300	V_3	EA50
R_2	20K	C_2	0.1μF	R_{11}	100K		
R_3	50K	C_3	0.1μF	R_{12}	500K	V_5	EA50
R_4	1M	C_4	0.1μF				
R_5	25K	C_5	0.1μF				
R_6	75K						
R_7	100K						
R_8	2M	V_1 & V_4	EF50				
R_9	250K	V_2	EA50				

Table 2

R_5	40K
C_3	0.01μF
C_4	0.01μF

R_9, R_{12}, C_5 omitted.
Other values as in Table 1.

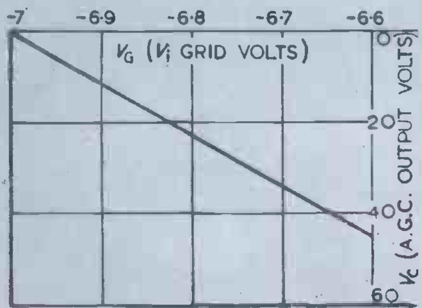


Fig. 4. A.G.C. circuit input/output voltage characteristic

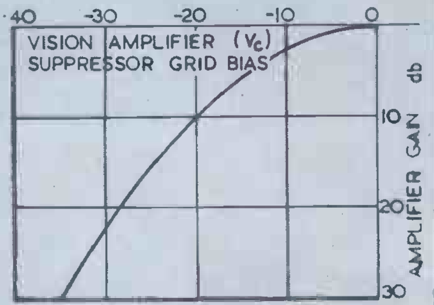


Fig. 5. Vision amplifier gain/bias characteristic

television signal, since the mean carrier power varies with the picture transmitted. With the present system in use in this country, maximum carrier power corresponds to white in the picture, 30 per cent. of maximum to black and zero carrier produces the synchronising pulses (*see* Fig. 1).

A diode connected as before will produce a voltage that is proportional not only to the strength of the received transmission, but also to the amount of white in the picture, and is therefore useless for A.G.C. purposes. With the American system this method is satisfactory, since the modulation is the reverse of that in use here. The synchronising pulses are radiated at maximum carrier power, black at 70 per cent., and zero carrier corresponds to white. The diode will therefore produce a voltage that is proportional to the synchronising pulse amplitude, which does not change with the transmitted picture, but only with signal strength.

From Fig. 1 it will be seen that the only level, apart from zero carrier, which is independent of variations in the picture transmitted is the black level (30 per cent. carrier power). This is radiated for 6 μS at the end of each line synchronising pulse and for 1,400 μS in the form of pulses for the frame synchronising. The A.G.C. diode must be operative only during these periods.

An A.G C. Circuit

A circuit which makes use of the frame synchronising period is shown in Fig. 2. The video signal before separation of the synchronising pulses is applied to the control grid of the gating valve V_1, and a positive gating pulse is applied to its suppressor grid. The length of this gating pulse must be approximately 1,000 μS and must occur during the frame flyback. It may conveniently be derived from the frame time base as shown in Fig. 3 for a thyratron, or a similar arrangement may be used for a hard valve time base. The amplitude of the pulse is about 100 volts. V_2 is a clamping diode and a standing bias of -75 volts is also applied to the suppressor grid of V_1. The amplitude of the resulting pulses at the anode V_1 is proportional to the black level in the vision waveform. It is important to note that there must be a D.C. connexion between the grid of V_1 and the detector, and that failing this the D.C. level must be restored with a diode. R_1 is included in the grid circuit to prevent the detector being heavily loaded when V_1 takes grid current during the white parts of the picture. The standing bias on the grid of V_1 is adjusted so that the valve commences to conduct when a voltage approximately equal to the desired black level voltage is applied to the grid. Auto-bias is not recommended, but if employed the bias resistor must not be by-passed or the bias will depend on the white content of the picture. There is therefore negative feedback and the sensitivity of the A.G.C. is reduced.

The pulses at the anode of V_1 are rectified by the diode V_3 and the negative voltage across C_3 is proportional to the amplitude of the pulses. R_9 is included to equalise the charge and discharge time constant of C_3 and to reduce the disturbing effect of impulsive interference on the circuit. The gain of the vision receiver used is controlled by varying the voltage on the suppressor grids of the R.F. amplifying valves for which up to about 30 volts is required. The voltage across C_3 is insufficient for this and is therefore amplified by V_4, the output being taken from the cathode so that the control voltage is of the correct polarity (negative). The diode V_5 is included to prevent the control voltage rising to a high positive value under no signal conditions.

The A.G.C. voltage output plotted against the control grid voltage of V_1 is shown in Fig. 4 and the amplifier gain against suppressor grid bias (which equals A.G.C. voltage) in Fig. 5. Combining these two curves in Fig. 6 it can be seen that a change in signal strength of 20 db. will alter the black level by only .25 volt which is negligible.

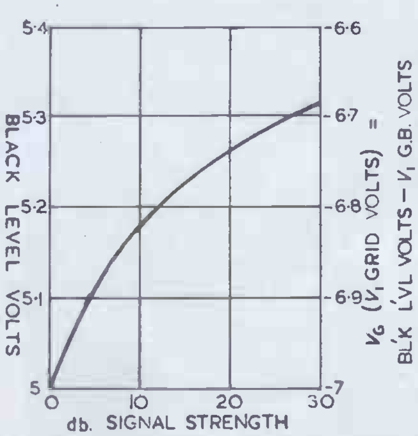


Fig. 6. Variation of black level volts with signal strength (A.G.C. on vision amplifier). Derived from curves in Figs. 4 and 5

The main limitation of the circuit is its inability to follow the rapid fading which is often produced by aircraft. This is because the time constant of the A.G.C. smoothing circuit C_3, R_8, C_4, R_{12}, C_5, must be large enough to prevent the A.G.C. voltage falling appreciably during the period of one frame. Allowing a 5 per cent. drop, the circuit will not compensate for fading at a greater frequency than about 4 per second.

Accordingly, the circuit was modified to utilise the 6 μS period of black after each line synchronising pulse. The values of the components were modified to those shown in Table 2 and the gating pulse being derived from the line time base. In this form the circuit responded in about 1/100th sec. to a change in signal strength of 20 db. However, in practice this circuit was found to be less effective in neutralising aircraft fading. Signals reflected from an aircraft may be delayed by several tens of microseconds relative to signals received directly, and thus the 6 μS black level period after the line synchronising pulse may be modified by these delayed signals which correspond to some other part of the previous line. Due to the same cause the synchronisation of the line time base is often affected, and this again will upset the operation of the A.G.C. circuit. When using the frame synchronising pulse period neither of these effects is of any consequence, since the gating valve is operative for 1,000 μS and the maximum delay on reflected signals is of the order of 50 μS corresponding to a path difference of about ten miles, the strength of signals reflected from objects at greater distances being inconsiderable.

Conclusion

In conclusion it may be said that the added complication to the receiver introduced by the A.G.C. circuit has been found to be well justified, as it has not been necessary to touch the sensitivity control on the writer's set since the A.G.C. was incorporated.

NOTES FROM THE INDUSTRY

National Institute of Industrial Psychology

A programme of lectures, short conferences and informal group discussions organised by the Institute to take place at various centres in England and Scotland during the winter 1948 and spring of 1949 has just been published. It is obtainable from the London address of the Institute, Aldwych House, London, W.C.2.

Clix uses P.T.F.E.

Polytetrafluorethylene (P.T.F.E.) a plastic made by I.C.I. is now being widely used in the manufacture of Clix components,* particularly in those where resistance to temperature and chemical action are important. Applications so far are to valve and C.R. tube holders, wave guide components and co-axial connectors, sealed capacitors, resistors and potentiometers, insulators and hermetic seals.

*British Mechanical Productions, Ltd.

W. J. Lloyd, and Philips Electrical Ltd.

It is announced that W. J. Lloyd, B.Sc., A.M.I.E.E., chief engineer of Guy R. Fountain, Ltd., until March of this year has now joined Philips Electrical, Ltd., as chief engineer of the Amplifier and Public Address Department.

S. S. West returns to Norfolk

S. Spencer West, recently of Cinema-Television, Ltd., has founded a research and manufacturing concern at *Quay Works, North Quay, Great Yarmouth.* Its object is to develop and manufacture industrial electronic devices (including metal detectors) and specialised television equipment.

F. C. Robinson and Partners

F. C. Robinson, until April of this year managing director of Cossor Radar, Ltd., is now acting as a consultant on the special applications of electronics to industrial manufacturing processes and control. The organisation which he has set up in Manchester acts as official agents for Cinema Television, Ltd., Dawe Instruments, Ltd., Furzehill Laboratories, Ltd., Sargrove Electronics, Ltd., J. Langholm Thompson and Co., and Wayne Kerr Laboratories, Ltd. The registered office of this new concern is *Dalton House, Hargate Drive, Hale, Cheshire,* the showroom and service department being at 308 *Deansgate, Manchester,* 3.

Dr. H. J. Denham, C.B.E.

Dr. H. J. Denham, C.B.E., D.Sc., F.Inst.P., has been re-appointed a member of the Ordnance Board and head of the Electronics Division, on his release from the Army. Dr. Denham became a member of the Board, with the rank of Colonel, in 1944, and was awarded the C.B.E.(Mil.) in Jan. 1946.

A Modern Home-Built

TELEVISOR

ANNOUNCEMENT

3rd Edition

A third edition of the *Electronic Engineering* booklet will be ready shortly and readers who have already placed orders will have copies despatched as soon as they are available.

Wiring Diagram

A detailed wiring diagram has been prepared for less experienced constructors, and and is now available, price 3s. 9d. including postage.

Components

The following components have been submitted for test and approved for use in the *Electronic Engineering* Televisor :—

Scanning Coils
(i) Haynes Radio Ltd.

Focus Coil
(i) Haynes Radio Ltd.
(ii) Porthminster Engineering, Ltd.
(iii) Scanco (R.I. Ltd.).

Line Output Transformer
(i) Haynes Radio Ltd.

E.H.T. Transformer
(i) Haynes Radio Ltd.
(ii) Partridge Transformers Ltd.

H.T. Transformer
(i) Gardners Radio Ltd.
(ii) Partridge Transformers Ltd.
(iii) Varley (Oliver Pell Control Ltd.).

250 mA. Choke
(i) Gardners Radio Ltd.
(ii) Partridge Transformers Ltd.
(iii) Varley (Oliver Pell Control Ltd.).

80 mA. Choke
(i) Gardners Radio Ltd.
(ii) Partridge Transformers Ltd.
(iii) Varley (Oliver Pell Control Ltd.).

Other makes of these components are at present under test and as they are given approval will be added to the list.

Publications Received

Mail Order Supply Co., 3 *Robert Street, London, N.W.*1. Newsletter No. 3 for August/September (price 6d.) constitutes a catalogue of their available equipment (both new and ex-Government) as well as an informative publication for the amateur and the engineer.

*The General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.*2. Folder No. BC532 covering the 1948 Autumn programme of their radio receivers.

*Erie Resistor, Ltd., Carlisle Road, The Hyde, London, N.W.*9. Publications Nos. 3M/2663/648FF and 2500/2642/548GHK dealing respectively with Interference Suppressors and Silvered Ceramic Condensers.

Radar Courses at Southampton

University College, Southampton, has vacancies in four Radar Courses of eight weeks each, the first course beginning November 1. Providing simple treatment of radar fundamentals and practical work based on Type 268—3cm shipborne radar. The syllabus embraces full requirements for the Ministry of Transport examination.

Birlec Ltd., and British American Research, Ltd.

An agreement is announced between these two companies whereby they are to combine their specialised experiences to design and produce high vacuum units for such applications as melting, sintering and annealing of all classes of metals.

Nameplates

Metal and plastic nameplates can be made to instructions by *British Engraving and Nameplate Manufacturing Co. (London) Ltd.,* 32 *Tottenham Street, London, W.*1.

Mullard Readership in Electronics

Mullard Electronic Products, Ltd., have offered to finance, and the authorities of the University of London have accepted, a Readership in Electronics at the City and Guilds College of Imperial College. The Readership will be mainly concerned with post-graduate teaching of research.

"Araldite"

"Araldite" Synthetic Resin Adhesive (Type 1) suitable for bonding such materials as metals, glass, porcelain, china and mica is now obtainable from *Aero Research, Ltd., Duxford, Cambridge.*

Molybdenum and Tungsten Products, Ltd.

This is the new name of the firm of Drawing Dies Maintenance, Ltd., of 37 *The Ridings, London, W.*5.

Ediswan and Plessey

The Edison Swan Electric Co., Ltd., announce that they have undertaken the sole distribution to the wholesale and retail trades of the range of components manufactured by the Plessey Co., Ltd., of Ilford.

Advance Components Ltd.

The Audio Frequency Generator reviewed in last month's issue of ELECTRONIC ENGINEERING has now been reduced in price from £23 10s. to £19 19s. subject to the same discounts.

New Telephone Number

Alfred Imhof, Ltd., have a new telephone number: MUSeum 7878 (20 lines).

Two Electronic Devices From America

High-Speed Paper Counter

This instrument, made by the Potter Instrument Co., of America, is entirely electronic in action and enables the counting of paper, labels, book pages, cardboard or any kind of sheet material, to be done easily and quickly by an unskilled operator. The count may be repeated several times in a matter of seconds.

All that is necessary is that the material to be counted must be riffled so that a step-like edge is presented, though the riffling need not be perfect. The detector unit is in the form of a stylus, looking and held like a fountain pen. It is run down the edge of the sheets and generates an impulse as it drops from one step to the next. The total is shown immediately by means of an electronic counter, of which several types are available. The normal one has three decades which permit a total count up to 1,000, with local or remote resetting. If desired, predetermined counters can be used to enable selected quantities to be separated.

Potter Instrument Co.,
136-56, *Roosevelt Avenue,*
Flushing, New York, U.S.A.

An Electronic Nose

The detector shown in the photograph has been recently developed by the General Electric Laboratories of America for determining the presence of halogen vapour in the air.

The interior of the "nose" contains a platinum-wire-heated cathode which is at a positive potential to the surrounding anode. Positive ions emitted by the cathode are attracted by the negatively charged anode and give an indication on the meter. A flow of air is maintained between the cathode and anode and the presence of halogen vapour in the air causes an increase in ionisation and a consequent increase in the meter reading.

The "nose" will smell smoke produced by burning any substance containing halides, and is particularly sensitive to chlorine compounds such as carbon tetrachloride, chloroform, or Freon. The meter indication can be replaced by the usual relay system for sounding an alarm, if required.

Photo by courtesy of *Radio Craft*, (Radcraft Publications, N.Y.)

A Radio-Frequency Mass Spectrometer

NEGATIVE atomic ions have been detected for only a few elements since they were first discovered about 40 years ago, although accepted theory has indicated the possibility of producing such ions from many of the elements. Experiments begun at the National Bureau of Standards by Dr. Bennett in 1946 indicated that negative atomic ions might well exist in the many familiar forms of electrical discharge in vacuum tubes, but that they would not be detected if the distance through the tube between the discharge and the electrode was large. It was necessary, therefore, to devise an experimental method for separating and identifying such ions within distances of only a few centimetres. This was accomplished through a new two-stage mass-spectrometer tube.

The equipment consists essentially of a multi-grid tube in which an adjustable radio frequency is applied to two grids, while all other electrodes are held at the proper direct-current potentials and the ion current is measured at the plate. The more exacting requirements of negative-ion separation require the use of a small magnetic field produced with coils, but if positive ions are being separated, no magnetic field is needed.

One of the principal limitations upon the resolution possible with the ordinary mass spectrometers using magnetic deflection of beams has been the spread in energies of the ions at the ion source.

This can be reduced by increasing the voltage applied to the ions before they are magnetically resolved. The extent to which this can be done is limited, however, by the magnetic field that can be obtained in a space sufficient to contain the tube.

In the radio-frequency mass spectrometer, this difficulty is eliminated, and the voltage of the ions can easily be pushed up at least an additional order of magnitude to any value for which insulation can be provided. The frequencies required are then increased by an amount equal to the square root of the factor by which the voltage is increased. Raising the voltage from 100 to 10,000 volts, for example, increases the frequencies tenfold, and reduces the percentage spread of mass line due to velocity spread in the ion sources by a factor of one one-hundredth.

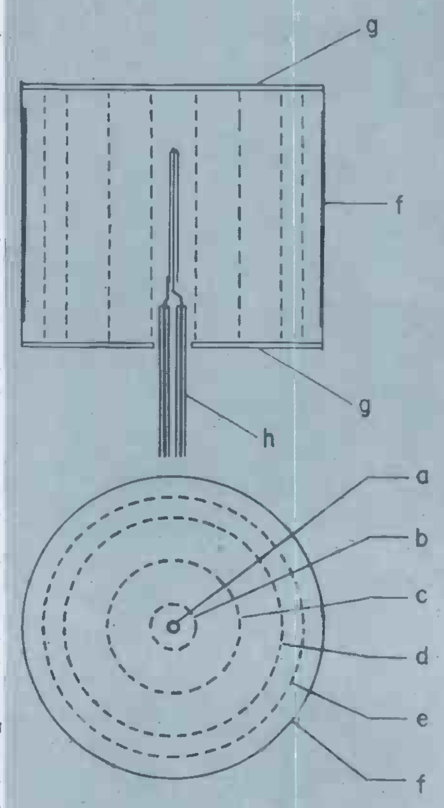


Diagram of R.F. mass spectrometer tube. a = cathode, b, c, d, e = grids, f = ion collecting plate

The first successful radio-frequency mass spectrometer, a single-stage six-electrode tube, consisted of a cathode about which were arranged four coaxial cylindrical grids and an ion-collecting plate. Helmholtz coils surrounding the tube provide a 100-gauss magnetic field in a direction parallel with the axis of the tube. Such a field is required in negative-ion work to confine the electrons to the space inside the first grid, and to prevent the formation of positive ions in parts of the tube where neutralisation of the negative ions may occur before they reach the detecting electrode.

In the operation of the single-stage negative-ion spectrometer tube, ions arising at the cathode are accelerated through the first grid at a velocity corresponding to the D.C. potential of that grid (say 15 volts). They are further accelerated by the field due to the potential on the second grid, which is an alternating R.F. (say 5 volts) plus a D.C. potential (reduced to 10 volts). The third grid is held at a D.C. potential (reduced to 5 volts). Those ions which pass the first grid at the proper phase of the R.F. field, and which have a mass and related velocity such that they pass through the second grid while the R.F. potential changes phase, receive an additional acceleration due to the R.F. field while travelling to the third grid. It was observed experimentally, verifying theoretical calculation, that ions passing the first grid at 45° 27.5′ of phase angle of the alternating current on the second grid, and having just the right mass (and corresponding velocity) to pass the second grid at 180° of phase angle of the current on that grid, will pass each of the first three grids with the same velocity (corresponding to 15 volts), although the D.C. potentials on those grids are successively reduced.

A blocking potential difference, nearly equal to the maximum energy that an ion with the proper mass (corresponding to the frequency) could pick up from the alternating current, is applied between the cathode and the fourth grid. The ion-collection plate is held at 40 volts positive with respect to the cathode to insure that no positive ions will reach the anode. An electrometer tube circuit and galvanometer are used for measuring the selected ion currents.

By extending the method to two stages in a nine-electrode tube, either with cylindrical or parallel-plane electrodes, and applying the radio frequency to two of the grids, a high order of mass resolution is obtained.

—National Bureau of Standards Technical News Bulletin. September, 1948, page 105.

CORRESPONDENCE

Review of "Television"

DEAR SIR,—An author should, I consider, confine to himself his reactions to the opinions of reviewers. Mr. R. C. Whitehead has placed no great strain on this ideal in his review of my "Television," for he has, on the whole, received it kindly, and describes such criticisms as he offers as matters of fine detail. But as most of them are questions of fact rather than opinion, I venture, in the interests of accuracy, to reply.

Mr. Whitehead accuses me of unfortunately failing to explain the denominator in the equation

$$f_{max} = al^2p/2$$

The relevant passage (p. 9) is "the maximum V.F. that need be considered is that caused by picture elements being alternately light and dark. Two successive picture elements thus correspond to one whole cycle, and the maximum V.F. is equal to half the number of picture elements scanned per second. This argument assumes a smooth (sinusoidal) transition from light to dark; a sharply defined change would necessitate still higher frequencies."

Later, he disagrees that the synchronising signals require a wider band for transmission than do the picture signals. So do I. As the contrary never entered my head, I should be interested to know where Mr. Whitehead can quote me for it.

He also considers it unreasonable to believe that the B.B.C. staff, with all their technical resources, are slower at operation than are the viewers at home. It may be unreasonable, but it has on occasion been a fact of experience, that when a switch-over has been made from one camera to another the brightness level has thereby been palpably upset and has been corrected at the B.B.C. end only after a lapse of more than five seconds. Such occasions are happily becoming rarer. It is perhaps also unreasonable to believe that the B.B.C. transmission staff with their technical facilities and training, and experience in sound broadcasting that extends much longer than for television, would quite often degrade serious broadcasts to the level of crude slapstick by allowing the needle to jump back repeatedly into the same turn of the groove, or forget to turn over the record when playing the second half. Yet it happened again only this week!

With regard to colour transmission, I did not "suggest" any particular method. Mr. Whitehead presumably refers to the sentence: "The most practical scanning sequence is to scan the whole scene in one colour, then in the second colour, and then in the third."

This is, I think, a mere statement of fact—an unfortunate fact if you like—which the recent history of the art confirms. Is Mr. Whitehead prepared to establish that any system employing a different scanning sequence is more *practicable*?
—Yours faithfully,

M. G. SCROGGIE.

Small Apertures in Plates

DEAR SIR,—With reference to the recent article on "Making Small Apertures in Metal Plates" which appeared in ELECTRONIC ENGINEERING for June, 1948, I would like to draw your attention to the fact that the method mentioned of etching the back of the plate is covered by Patent Specification No. 575,657 in the names of C. Bowden and A. J. Bull. This process was developed during the last war and was used for the production of large numbers of gun-sight graticules.

The method has been developed to a high degree of perfection, and has since been used for the production of optical slits for spectrographic and sound camera applications, and in special apertures for sound recording on film.

Optically precise holes down to 0.001 in. in diameter have been produced as apertures for use in electron microscopy. Further experimental work is still being done.—

Yours,

C. BOWDEN.

Northampton Polytechnic, E.C.1.
Instrument Making Section,

The Miller Integrator

DEAR SIR,—Mr. B. H. Briggs' articles under this title prompt me to draw attention to the usefulness of the circuit as an integrating meter for measuring speech energy.

I am using filters to analyse speech signals into narrow frequency bands. The output of each filter is rectified by a square law circuit and fed to a Miller integrator, which measures the total energy over an automatically timed period of 15, 30 or 60 seconds. A meter reading the change of anode current of the Miller valve provides the necessary indication. This apparatus has been found to offer a number of advantages over previously described methods of making such measurements:

(1) To avoid errors the time constant must be made long compared with the time during which the speech signal is measured. This is readily achieved; a time constant of, say, 2,000 seconds is obtainable with ordinary component values.

(2) Disconnexion of the charging resistance at the end of the integration time increases the time constant to a very high value, so that the meter reading is held constant almost indefinitely. This enables an operator to read 21 meters, indicating the energy in as many frequency bands.

(3) The circuit can be instantaneously restored to normal when desired.

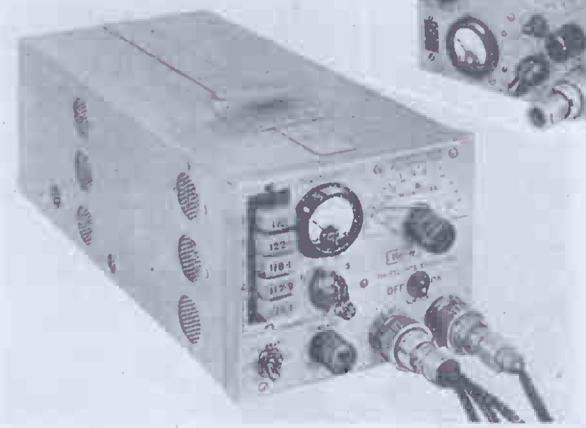
A model of this speech analyser was exhibited by the Research Branch of the Post Office at the Exhibition of the Physical and Optical Society this year. It is used for investigations pertaining to speech with particular reference to the behaviour of carbon granule microphones and the performance rating of telephone circuits.

Yours faithfully,

G. P. HORTON.

Electronic Equipment

A monthly record of British electronic apparatus, components, and accessories, compiled from information supplied by the manufacturers.



Above : Lightweight M.F. broadcast receiver with simple D.F. facilities. Left : 5-channel V.H.F. transmitter-receiver, type TR.51, for light aircraft

Radio for Light Aircraft

A FIVE-CHANNEL lightweight V.H.F. transmitter-receiver has been developed by the Plessey Co. to enable the private flyer and small charter aircraft owner to meet all expected official regulations for two-way radio communication.

A lightweight M.F. broadcast and H.F. receiver with simple D.F. facilities has also been developed as a companion set to provide all communication and navigational facilities for light aircraft flying anywhere in the world.

The V.H.F. set (TR.51) has a frequency range of 116-132 Mc/s., the five channels in this band being made available by plug-in crystals. Tuning is by one knob on the front panel. Remote control facilities and intercom. facilities are also available.

The TR.52 communication unit combines receiver and transmitter in one housing of similar shape to the TR.51, the receiver covering three bands: 144-440 Kc/s., 496-1500 Kc/s., 2.4 Mc/s.-8 Mc/s.

D.F. facilities are provided on the 144 Kc/s. and 496 Kc/s. bands by a screened rotating loop aerial.

The T.R.51 weighs only 9½ lb. complete with power unit and the TR.52 weights 10 lb. plus 2 lb. for the loop.

S.H.F. Connectors

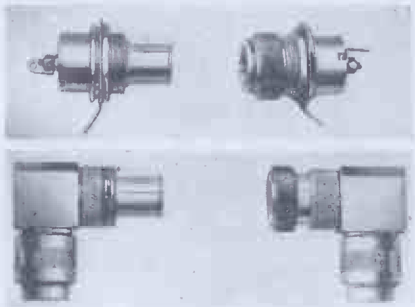
THE same Company has recently introduced a range of standard connectors intended for use in the S.H.F. region, but equally suitable for V.H.F.

Two series are available: Major and Minor, with four types in each—free straight, free right-angle, bulkhead mounting, and panel mounting, each in male and female versions.

Intercoupling between major and minor units is by means of adapters designed to maintain the correct impedance of 70-80 ohms.

Spacing dielectrics are of Distrene and the finish is silver plate. The photographs show the panel mounting and right-angle types.

The Plessey Company Ltd.
Vicarage Lane, Ilford, Essex.



Trix Ribbon Microphone

THIS model is of entirely new design and intended for high quality reproduction of both speech and music, combined with the minimum of feedback effects. The frequency response is substantially linear from 60 to 10,000 c/s.

The microphone is fitted with an internal transformer giving an output impedance of approximately 30 ohms, and is thus interchangeable with the standard moving coil pattern, and will be found to have considerable advantages where troubles due to feedback are encountered.

The microphone is mounted on shock absorber fitted with switch and plug and socket connexion.

This instrument is designed in a modern style and coupled with its technical features will be found to be of considerable advantage on numerous types of installations.

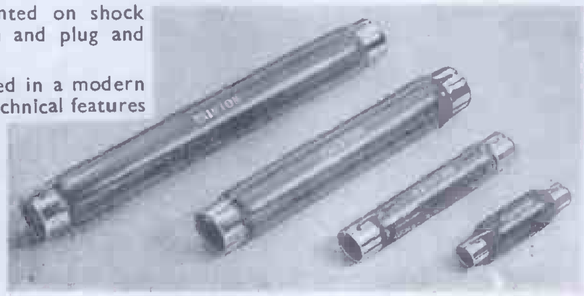
The Trix Electrical Co. Ltd.
1-5 Maple Place, Tottenham Court Road, W.1.

Heavy Duty Wire-wound Resistors

SERIES 5000 wire-wound vitreous resistor units are capable of withstanding very severe operating conditions and have exceedingly high dissipation properties.

A P.5007 resistor will dissipate 1½ kW. with an air-blast at 80-100 ft./sec., and with a loading equivalent to 250° C. rise, the resistance variation is less than ½ per cent. Dimensions: P.5007, 8½ in. by 1¼ in. dia.; P.5005, 4 in. by 1¼ in. dia. P.5005 is now in production, and P.5007 will be available at the end of the year.

Painton & Co. Ltd.
Kingsthorpe, Northampton.



Pulse Generator Type 412A

OPERATED from A.C. mains with stabilised H.T. supply, this pulse generator is capable of supplying variable amplitude pulses from 0 to 75 V., directly read on a meter, of duration 1, 10 and 100 microsecs. Either negative or positive pulses are available from a low impedance source, and the pulse rises to its maximum in 0.1 μS. for pulses up to 40 V. Pulses can be repeated from 1 to 10,000 times per second, and the changes in periodicity have no effect on the amplitude. A variable frequency audio amplifier having an output of 15: 20 V r.m.s. is sufficient to drive the pulse generator, or it can be driven from the mains supply, single impulses, or closure of external contact.

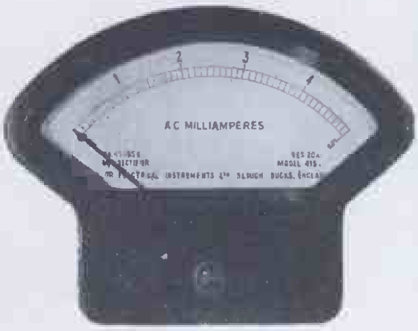
Dawe Instruments Ltd.
Harlequin Rd., Brentford, Middlesex.

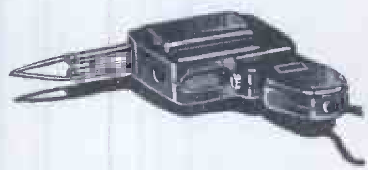
New Sector Instruments

THE new Series 415 sector-shape instruments occupy little space and are very suitable for control panels in equipment where the panel space is small but a clear dial is required.

The instruments are now available as moving coil ammeters in ranges from 0—10 μA upwards; as moving coil voltmeters from 0—5 mV upwards; as rectifier ammeters from 0—25 μA upwards; and as rectifier voltmeters from 0—1 V. Thermocouple instruments are also available and the series will shortly be extended to cover moving iron types.

Taylor Electrical Instruments Ltd.,
419 Montrose Ave., Slough, Bucks.





Universal Output Transformer

THIS heavy duty model D.P.61 is a multi-ratio output transformer capable of handling 20 watts without distortion. It is specially suitable for 6L6 valves or equivalents. The sectional and interleaved windings are carefully balanced to ensure level response over a wide frequency range.

It is supplied in eleven ratios for a single valve and for push-pull. Other details are as follows:—

Primary inductance	45 henries
Primary resistance ...	300 ohms each half
Primary current ...	100 mA each half
Ratios	13: 1-100: 1

List price 45/-

Oliver Pell Control Ltd.
Burrage Rd,, S.E. 18.

The Burgoyne Solder-Gun

THE Burgoyne 7-second solder-gun is used in the same way as an ordinary soldering iron, but eliminates waste and effects a considerable saving over the conventional soldering iron in that it heats up instantaneously and switches off automatically on releasing the push-button in the handle.

The solder-gun operates on A.C. mains only, the " bit " being the heating element. This is easily renewable, and there are no fragile parts to cause breakdown.

Models are available for 100/130 V. A.C. and 200/250 V. A.C., price 79s. 6d. with flex and spare bits.

Burgoyne Engineering Co. Ltd.
1 Robert St., Hampstead Rd., N.W.1.

Inductance Meter

THIS instrument has been designed to provide simple and direct reading measurement of inductance values between .05 μH and 100 mH. A standard variable frequency oscillator is used to resonate the unknown inductance with a fixed standard capacitor. Provision is also made for the measurement of small capacities and Q at resonant frequency. An overlap is provided on the scale to facilitate the measurement of values at the ends of the calibration.

Subject to limitations of dial reading, the accuracy for measurement is 2 per cent., but greater accuracy is obtainable by substitutiuon methods using external standards.

The basic circuit consists of an oscillator of high stability, tunable over the range 15.9 Kc/s. to 5.03 Mc/s., loosely coupled via a buffer valve to a resonant circuit formed by a standard fixed capacity and the unknown inductance. Resonance is reached by tuning the oscillator frequency, and the scale is calibrated directly in inductance. The resonance point is indicated by the magic eye.

The instrument is housed in a steel case with sloping front panel, measuring 7¼ in. high, 7¾ in. wide and with a depth at the base of 7⅝ in.

Price: £38 5 0.

Wayne Kerr Laboratories Ltd.
New Malden, Surrey.

BOOK

A Manual of Vacuum Practice

By L. H. Martin and R. D. Hill (Melbourne University Press—Cambridge University Press, London). 120 pp. 56 figures and 3 plates. 1947. Price 10s. 6d. net.

THIS little volume will certainly be welcomed by many workers in the high vacuum field. Primarily intended to assist post-graduates in their first research years, it contains a vast amount of useful information presented in a lucid and practical form. Its four chapters deal with the principles of producing low pressures, the gauges, the pumps and the plumbing.

In the first chapter the principal formulae are given concerning the calculation of flow in tubes, speed of pumping and the measurement of speed based on Knudsen's, Gaede's and Langmuir's work. A few worked examples show the application of these formulae in some typical cases.

In Chapter 2 the principal types of gauges are described in an adequate manner, comparatively much space being devoted to radiometer gauges while tilting type compression gauges are not mentioned.

The description of the diffusion pumps and their development given in Chapter 3 is specially well written and contains also a brief account of Alexander's recent investigations. Some of the pump drawings are dimensioned, a feature which will be welcome to many readers. In the discussion of the work of Copley and coworkers the statement that the performance of the pump with straight nozzle is so much inferior to that with long divergent nozzle—although certainly correct to some extent—is not quite convincing as the boiler pressure of the two pumps compared differs greatly. Mechanical pumps are dealt with only under the heading "backing pumps" and data are given on American products only. It should have been mentioned that in many cases, where not too high a vacuum is required, mechanical pumps are working alone without diffusion pumps.

The fourth chapter deals with vacuum plumbing and comprises sections on materials, joints, valves, the transmission of motions through special seals, vapour traps and baffles and a brief paragraph on leak hunting.

Eighteen appendices give some useful information, e.g., on adjustable leaks, glass to metal seals, the cleaning of mercury, the pump oils and greases, gettering, dehydrating agents, tables of gas densities and vapour pressures and conversion factors.

A considerable number of references to modern literature are given enabling the reader to find more detailed information where desirable.

The authors, professor and senior lecturer of physics at Melbourne University, and the publishers can be congratulated on having produced such a valuable addition to the literature of high vacuum technique.

R. NEUMANN

Vibration and Sound

(2nd. Edition)

By Philip M. Morse. 468 pp. with 98 illustrations. McGraw-Hill Publishing Co., Ltd., Aldwych House, London, W.C.2. Price 33s.

Among the factors which affect and even set a limit to the technical quality in modern broadcasting systems, are the acoustic devices rather than the electronic apparatus. Consequently the study of vibration and sound phenomena is becoming of increasing importance to telecommunication and broadcast engineers.

This book is intended as a text book for students of physics and engineering. Its mathematical standard assumes a thorough knowledge of calculus, and the analytical methods used for the solution of the problems in room acoustics are employed in this field for the first time. The author derives the majority of the formula from the fundamental laws of physics, concentrating on the physical reasoning behind the analysis and then interpreting and discussing the results in a conversational style.

Before commencing on the subject proper, the mathematics to be employed is surveyed. In the second chapter the theories of vibrating systems with lumped constants are considered by developing the displacement equations of their mass or masses about their equilibrium positions. Since the vibrating string is the simplest system with an infinite number of allowed frequencies it is treated in considerable detail in Chapter III. The effects of friction and the motion of the end supports are analysed and the experience gained with the idealised string is applied in the next chapter to the vibration of bars where stiffness rather than tension is the restoring force. Chapter V extends the theory to surfaces of two dimensions and considers the motion of membranes and plates of circular and rectangular shape.

The remaining chapters are devoted to sound, including its propagation in free space, in horns and tubes. The terminology and treatment of the latter parallel microwave practice. The familiar standing wave technique and circle dragrams of the aerial engineer are employed in places to determine the impedance of driven strings and acoustic materials. The absorption of

REVIEWS

sound by porous substances, thick and thin vibrating panels, is also treated. The reviewer would have welcomed here a discussion on the Helmholtz resonator as a selective or wide band sound absorber, but realises that techniques in acoustics are developing rapidly. Chapter VIII, which has been completely rewritten, is the most interesting. It treats the important subject of studio acoustics on the assumption that the sound source excites one or more of the normal modes of vibration of the air in the room. The analytical methods employed are powerful and the solutions new and full of interest.

There are problems at the end of each chapter, tables of hyperbolic and Bessel functions, a bibliography, and a glossary of symbols which the reader would be well advised to study.

Engineers and physicists concerned with sound should acquire their own copy of this book. It is not, nor was it ever intended to be, a book for beginners, but it can still be recommended to those who have no extensive mathematical knowledge but are interested in and prepared to study the application of mathematical methods to practical problems in vibration.

A. E. ROBERTSON

Ionospheric Radio Propagation

Supt. of Documents, U.S. Government Printing Office, Washington, 25, D.C., U.S.A. $1.00 U.S. Currency + postage.

THE physical and mathematical theory underlying electromagnetic-wave propagation, with particular reference to radio-wave propagation, by reflexion from the ionosphere, is presented in this new publication. and these fundamental principles are brought into understandable relation with the practical problems of radio communication.

The variations of the ionosphere with locality, season, time of day or night, and solar activity, constitute a complex geophysical phenomenon, the principles of which must be understood in order to achieve the best use of radio. The mathematical theory underlying the propagation of radio waves by way of the ionosphere is first presented. Subsequent chapters deal with measurement techniques; structure and variations of the ionosphere; maximum usable frequencies: practical problems of ionospheric absorption; radio noise of atmospheric, solar, and cosmic origin; and lowest useful high frequencies. A number of problems are worked out in detail to assist the reader in applying the methods to specific cases.

Electron and Nuclear Physics

By J. Barton Hoag and S. A. Korff (3rd. edition 1948. Published by D. van Nostrand Company Inc., agents for British Empire, Macmillan and Co., Ltd.,) 522 pp—xii. Price 27s. 6d.

THIS text-book which falls into three main sections (viz. Electron Physics; Nuclear Physics; and Laboratory Techniques), uses a treatment which is logical rather than chronological, and aims at avoiding reference at any stage to later sections. Each chapter treats its subject in the briefest manner compatible with completeness and includes references both to original papers and to texts for further reading.

Sixteen of the 19 chapters include at least one representative experiment to be carried out in the laboratory, but the wise student and demonstrator will do well to heed the warning in the preface about their relative difficulty.

Particularly pleasing is chapter 2 where the authors note that there are 43 variations of methods for measuring e/m for electrons, of which the more important are dealt with and extended to laboratory experiments; it is claimed that one of these, called the helical method, has not been given elsewhere. This chapter forms probably the best and most complete review of this subject. Similarly, there is a good summary of methods for obtaining high voltages in the chapter on the acceleration of ions.

A considerable amount of new material has been added to this third edition, chiefly in the Nuclear Physics section. It must have required some restraint to confine counters and counting to only 12 pages since Korff has written a complete textbook on this subject alone. This serves to show that the whole has been kept well balanced. There is a pleasing absence of misprints as of course should be in the case of a third edition.

The book can be strongly recommended to physics students and to libraries as a key text in the field of electron and nuclear physics.

E. E. SHELTON

Practical 5-Figure Mathematical Tables

C. Attwood. 74 pp. (Macmillan and Co. 3s. net.)

A COMPREHENSIVE collection of tables of mathematical and trigonometrical functions with notes on their use. The usefulness of the tables is considerably increased by the addition of columns of mean proportional parts, which have been specially calculated by the author. Small sections of certain tables (fractions of π, 4th. and 5th. roots) have also been specially calculated, and the result is an excellent production at a reasonable price.

(*continued overleaf*)

BOOK REVIEWS *(continued)*

Electron and Nuclear Counters

S. A. Korff. (D. Van Nostrand Company Inc., New York. 212 pp. Price 18s. net.)

THIS book was announced in February, 1948, by Messrs. Macmillan and Co., Ltd., as agents in the British Empire for the American publishers. The inscription on p. iv makes it clear that this is not a new edition but is a fourth printing of the book originally published in the U.S.A. in April, 1946.

The author says in his preface, "The book is written on an intermediate level for users of counters, most of whom are persons with scientific training, but who do not possess specialised knowledge in the field of Geiger counters . . . . It is intended to be of use to graduate students and to the many industrial laboratories and medical research institutions which are finding counters to be useful tools of research." This, however, is excessive modesty because, as this appears to be the only book devoted mainly to counter *tubes*, it has become the standard reference and handbook for all workers in this field. It can be regarded as authoritative as it is written by a specialist who has himself made important contributions to the theory of G.M. counter tube action.

For those still unacquainted with this book, we must say that Korff deals in the first chapter with the history of the counter tube, its uses, and characteristics as a function of applied voltage, including both the proportional region and the Geiger region. Further chapters are concerned with ionisation chambers, proportional counters, neutron counters, and special purpose tubes. The section on Geiger counters (both internally and externally quenched) includes a full discussion of the internal mechanism, and the effects of various fillings. There are chapters on the preparation and construction of counters, errors and corrections in counting, and the various circuits required for use in conjunction with counter tubes. There are 69 line diagrams, slightly more than half being circuit diagrams in chapter 7.

This last chapter ends with a short bibliography, then follows a list of references which was fairly exhaustive up to 1943, but as there are no references more recent than 1944, workers in this field will naturally need to add their own list of references, and should not overlook those given by Monica Healea in the issues of *Nucleonics* for December, 1947, and March, 1948.

The author only resorts to mathematical expressions as a shorthand for some physical statement, and not for the elaborate exposition of theories, in fact the style of the book is descriptive and in consequence it is quite easily read. What symbols are used are summarised in a table at the beginning of the book, and the reader should be justified in assuming that the author has been meticulous in his use of them; unfortunately symbols R and I, quite properly ascribed to resistance and current, are used occasionally for radius and ionisation (or excitation) potential respectively.

The longest chapter is the one on the Geiger counters, which reflects the importance of these, but the reviewer has occasionally found some brief difficulty here in referring to paragraphs in the two sections headed "' Non-self-quenching counters" and "Self-quenching counters." This sort of confusion is probably due to some telescoping of these sections, such as the use of a graph (Fig. 4-5) for a self-quenching counter, to illustrate a paragraph on non-self-quenching counters. The reviewer feels that the term "non-self-quenching counter" is rather unwieldy, and to be compared with the description of the ordinary gear-box of an automobile, as a "non-preselector gear-box." The term "externally quenched" is much more informative; "self quenched" could be retained if desired as an alternative to "internally quenched."

Only a passing mention is made about the effect of the quenching vapour in shifting the threshold voltage, whereas the relation between starting potential and pressure in the absence of quenching vapour is given for three gases up to 11 cms. (Fig. 4-6) and for helium up to 60 cms. Since a small pressure change of ethyl alcohol has approximately ten times the effect of the same pressure change for argon, in shifting the threshold, one feels that this is a notable omission.

It is to be regretted that the book was not brought up to date when the new printing was decided on, and if it is not practicable to bring out a new edition of Korff shortly, it is to be hoped that one of the British workers will write a treatise on this subect.

E. E. SHELTON

NOVEMBER MEETINGS

The Institution of Electrical Engineers

Unless otherwise stated, all meetings are held at the Institution of Electrical Engineers, Savoy Place, London, W.C.2.

Radio Section

Date: November 2. Time: 5.30 p.m.
Lecture: "A Storage System for use with Binary Digital Computing Machines."
By: Professor F. C. Williams, O.B.E., D.Sc., and T. Kilburn, M.A.

Date: November 3. Time: 5.30 p.m.
Lecture: "Aids to Training—The design of Radar synthetic training devices for the R.A.F."
By: G. W. A. Dummer, M.B.E.

Date: November 9. Time: 5.30 p.m.
Discussion: "To what extent does distortion really matter in the transmission of speech and music?"
Opened by: P. P. Eckersley.

Date: November 23. Time: 5.30 p.m.
Informal Lecture: "Printed Circuits, including miniature components and sub-miniature valves."
By: J. E. Rhys-Jones, M.B.E.

Measurements Section

Date: November 16. Time: 5.30 p.m.
Discussion on: "Measurement of Telecommunications Efficiency."
Opened by: W. West, B.A.
The Secretary, Institution of Electrical Engineers, Savoy Place, London, W.C.2.

Cambridge Radio Group

Date: November 2. Time: 8.15 p.m.
Held at: The Cavendish Laboratory, Cambridge.
Discussion on: "To what extent does distortion really matter in the transmission of speech and music?"
Opened by: P. P. Eckersley.

Date: November 16. Time: 6 p.m.
Held at: The Cambridgeshire Technical College.
Address by the Chairman of the Radio Section (F. Smith, O.B.E.).
Secretary: H. G. Booker, M.A., Ph.D., Cavendish Laboratory, Cambridge.

South Midland Radio Group

Date: November 29. Time: 6 p.m.
Held at: The James Watt Memorial Institute, Great Charles Street, Birmingham.
Lecture: "Activities and Equipment of Industrial Electronics Laboratories."
By: G. A. Hickling, B.Sc.
Secretary: H. G. Foster, M.Sc.(Eng.), Electrical Engineering Dept., The University, Edgbaston, Birmingham, 5.

North-Eastern Radio and Measurements Group

Date: November 1. Time: 6.15 p.m.
Held at: Kings College, Newcastle-on-Tyne.
Lecture: "Great Personalities in the Fields of Electrical and Magnetic Measurements."
By: Professor J. T. MacGregor-Morris.

Date: November 15. Time: 6.15 p.m.
Held at: Kings College, Newcastle-on-Tyne.
Discussion: "To what extent does distortion really matter in the transmission of speech and music?"
Opened by: P. P. Eckersley.
Hon. Secretary: G. A. Kysh, Carliol House, Newcastle-on-Tyne, 1.

North Midland Centre

Date: November 23. Time: 6.30 p.m.
Held at: The Yorkshire Electricity Board Offices, 1 Whitehall Road, Leeds.
Film: "Atomic Physics."
Hon. Secretary: H. S. Moody, The Yorkshire Electricity Board, Manor Farm, Bramhope, Leeds.

North Staffordshire Sub-Centre

Date: November 15. Time: 7 p.m.
Held at: King Edward Grammar School, Stafford.
Lecture: "The Application of the Recurrent Surge Oscillograph to the Study of Surge Phenomena in Transformers."
By: E. L. White, B.Sc.(Eng.), and W. Nethercot, M.A., B.Sc.
Secretary: R. G. Kitchenn, Post Office Engineering Dept., Central Training School, Duncan Hall, Stone, Staffs.

SECOND AMATEUR RADIO EXHIBITION

The Second Annual Amateur Radio Exhibition, organised by the Inc. Radio Society of Great Britain. will be opened at 2.30 p.m. on Wednesday, November 17, 1948, by Dr. R. L. Smith-Rose, Director of Radio Research. Department of Scientific and Industrial Research, and an Honorary Member of the Society. The exhibition. which is at the Royal Hotel, Woburn Place, will remain open until November 20 (hours 11 a.m. to 9 p.m.).

Admission will be by catalogue, price 1s., purchased at the door, or 1s. 3d. on application to the Society (New Ruskin House, Little Russell Street, London, W.C.1.).

ELECTRONIC ENGINEERING will be pleased to welcome readers at its Stand No. 22, where the "Televisor" and "Synchrodyne" receivers will be shown.

Rugby Sub-Centre

Date: November 2. Time: 6.30 p.m.
Held at: The Electricity Showrooms, Rugby.
Lecture: "Three-Dimensional Cathode-Ray-Tube Displays."
By: E. Parker, M.A., and P. R. Wallis, B.Sc.(Eng.).
Secretary: J. H. Walker, Ph.D., A.C. Engineers Dept., The B.T.H. Co., Ltd., Rugby.

North-Western Radio Group

Date: November 17. Time: 6.30 p.m.
Held at: The Engineers' Club, Albert Square, Manchester.
Lecture: "Practical Aspects of Marine Navigational Radar."
By: A. K. Nuttall, M.A.
Asst. Secretary: A. L. Green, 244 Brantingham Road, Chorlton-cum-Hardy, Manchester, 21.

Scottish Centre

Date: November 10. Time: 7 p.m.
Held at: The Heriot Watt College, Edinburgh.
Lecture: "The Wartime Activities of the Engineering Division of the B.B.C."
By: H. Bishop, C.B.E., B.Sc.(Eng.).
Secretary: H. V. Henniker, 172 Craigleith Road, Edinburgh.
Note: This is a joint meeting with the Institution of Post Office Engineers.

The Institute of Physics

Electronics Group

Date: November 9. Time: 5.30 p.m.
Held at: The Institute of Physics, 47 Belgrave Square, W.1.
Lecture: "The Physical Properties of very high voltage X-rays and Electrons and their Medical Interest."
By: P. H. Flanders.
Secretary: G. W. Warren. F.Inst.P., Research Laboratory, The General Electric Company, Wembley.

S.I.M.A.

Date: November 18 and 19.
Held at: Caxton Hall, Westminster, S.W.1.
A series of technical papers will be read by specialist engineeers.
Secretary: A. G. Peacock, 26 Russell Square, London, W.C.1.

British Sound Recording Association

Date: November 19. Time: 7 p.m.
Held at: E.M.I. Studios, Ltd., 3 Abbey Road, N.W.8.
Lecture and Demonstration: "Basic Principles of Magnetic Recording."
By: E. W. Berth-Jones.
Hon. Secretary: R. W. Lowden, "Wayford," Napoleon Avenue, Farnborough, Hants.

(Continued overleaf)

MEETINGS—*Continued*

The Television Society

All meetings are held at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, W.C.2, unless otherwise stated.

Date: November 24. Time: 7 p.m.
Lecture: "Some Aspects of Television Circuit Technique, Phase Correction and Gamma Correction."
By: T. C. Nuttall, B.Sc.(Tech.).
Lecture Secretary: T. M. C. Lance, 35 Albemarle Road, Beckenham.

Programme Group

Date: November 17. Time: 7 p.m.
Lecture: "Producing for Television in Copenhagen."
By: E. Fawcett.
Hon. Secretary: N. E. B. Wolters, 22 Sharps Lane, Ruislip, Middlesex.

Constructors Group

Date: November 12. Time: 7 p.m.
Lecture: "Television Aerial for Indoor Installation in Areas at High Signal Strength."
By: N. M. Best and P. J. Duffell.
Group Secretary: A. E. Sarson, 22 Union Road, Bromley, Kent.

Midlands Centre

Date: November 2. Time: 7 p.m.
Held at: Room 6, The Chamber of Commerce, New Street, Birmingham.
Lecture: "Luminescent Materials for C.R. Tubes."
By: G. F. J. Garlick, Ph.D.
Hon. Secretary: R. R. T. Baxendale, 50 Alcester Road, Birmingham, 13.

Radio Society of Great Britain

All meetings are held at the Institution of Electrical Engineers, Savoy Place, London, W.C.2.
Date: November 26. Time: 6.30 p.m.
Lecture: "Equipment for the 144 Mc/s. Band."
By: E. A. Dedman.
General Secretary, New Ruskin House, Little Russell Street, W.C.1.

The Institution of Post Office Electrical Engineers

Date: November 8. Time: 5 p.m.
Held at: The Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2.
Lecture: "The Possibilities of Super H.F. Radio and Waveguide Systems for Telecommunications."
By: W. J. Bray, M.Sc.(Eng.),
Secretary: W. H. Fox, Engineer-in-Chief's Office, (T.P. Branch), Alder House, E.C.1.

Institution of Electronics

Date: November 26. Time: 7 p.m.
Held at: The Gas Showrooms, Manchester.
Lecture: "Remote Control using an U.H.F. Link."
Hon. Secretary: L. H. Berry, 105 Birch Avenue, Chadderton, Lancs.

ABSTRACTS OF ELECTRONIC LITERATURE

CIRCUITS

An Inductively Coupled Series Tube D.C. High Voltage Regulator

(R. Pepinsky and P. Jarmotz)

A new D.C. high voltage stabiliser, operating from 5 to 50 KV and for currents up to 50 mA, is described. The stabiliser is of the usual degenerative type, but the series regulator valve, which at high voltage, is inductively coupled to the feed-back amplifier at ground potential. The signal from the amplifier amplitude-modulates an R.F. oscillator, the output voltage of which is passed through a transformer, rectified, filtered, and applied as a D.C. correcting signal to the series valve grid. Performance data are quoted. Long-term stabilisation, which depends chiefly upon constancy of the reference level, has not been measured, but means to its attainment are suggested.

—*Rev. Sci. Inst.*, April, 1948, p.247.*

Magnetostriction Generators

(J. A. Osborn)

The first section of this article is devoted to a qualitative discussion of some of the fundamental mechanisms involved in magnetic and magnetostriction phenomena. In the second section, the performance of a representative transducer or "generator" is analysed by means of an electromechanical equivalent circuit. This method provides means of visualising the interaction of electrical and mechanical parts in magnetostriction devices, and predicting results of such a device.

—*Elec. Eng.* June, 1948, p.571.*

C. R. TUBES

Oscilloscope Camera

A description is given of an oscilloscope camera which has been designed for both still and continuously moving film photography. For still photography, a shutter with speeds of 1 to 1/400 seconds is used; for continuous recordings, a speed range of 3,600 to 1, from 1 in./min. to 5 ft./sec. is provided by means of a specially designed electronic motor control system and a two-speed clutch. Details of the clutch and of the electronic control device are given. Data can be recorded on 35 mm. film or paper. Either film motion or the oscilloscope sweep can be employed as time base. The apparatus can be applied to the study of transients, fluorescent lamp analysis, frequency drill, etc.

—*Electronics*, June, 1948, p.102.*

* Abstracts supplied by the courtesy of Metropolitan Vickers Electrical Co. Ltd. Trafford Park, Manchester

THERMIONIC DEVICES

Barrier Grid Storage Tube and its Operation

(A. S. Jensen, J. P. Smith, M. H. Mesner and L. E. Flory)

A differential method of measuring the characteristics of a storage tube is described and used. Though this method and nomenclature relating to such a subtraction or cancellation procedure is used, relationships are indicated between the characteristics described to those needed in the design of any arbitrary system involving storage of a signal.

The theory of the barrier grid target behaviour is discussed. Tube data and operational limitations are presented, and it is shown that it is actually advantageous to use output amplifiers no wider in bandpass than is absolutely necessary to the overall system.

—*RCA Review*, March, 1948, p.112.

X-Radiation from a 20 MeV Betatron

(W. Bosley, J. D. Craggs, W. F. Nash and R. M. Payne)

Investigations have been carried out on the spectrum of the radiation from a 20-MeV. betatron (Kerst type) using two methods, namely, the study of (a) electron-positron pairs produced in a thin lead sheet in a Wilson chamber, and (b) the protons liberated in the photo-disintegration of deuterons using either a scattering chamber with a heavy wax target or deutrium-loaded plates (Ilford C2 Emulsion). Histograms have been constructed from 65 electron-positron pairs, and of 75 recoil proton tracks detected in an Ilford C2 Nuclear Research plate in a special camera, designed so that protons emitted at 30°-90° with the incident X-rays could be detected.

—*Nature.* 6/6/48, p.1,022.*

ELECTRON OPTICS

Numerical Computation of the Constants of Magnetic Electron Lenses

(M. V. Ments and J. B. Le Poole)

The paraxial quantities of magnetic electron lenses are computed in their relationship to the size of the pole pieces, the number of ampere-turns and the accelerating voltages by using special methods of integration and field measurements. For a number of cases spherical aberration constants are calculated. The distortion of projector lenses is determined experimentally. Some of the practical results are gathered in praghs which proved to be of great help in the design of magnetic lenses.

—*Appl. Sci. Res. B.I.* No.1, 1948, p.3.*

CLASSIFIED ANNOUNCEMENTS

The charge for these advertisements is twelve words or less 5/- and 4d. for every additional word. Box number 2/- extra, except in the case of advertisements in "Situations Wanted" when it is added free of charge. A remittance must accompany the advertisement. Replies to box numbers should be addressed to: Morgan Bros. (Publishers) Ltd., 28, Essex Street, Strand, London, W.C.2 and marked "Electronic Engineering." Advertisements must be received before the 10th of the month for insertion in the following issue.

OFFICIAL APPOINTMENTS

Vacancies advertised are restricted to persons or employments excepted from the provisions of the Control of Engagement Order, 1947.

THE CIVIL SERVICE COMMISSIONERS announce that a Supplementary Reconstruction Competition will be held for about twelve permanent appointments as Wireless Technician (Male) in the Regional Wireless Service under the Home Office. Candidates must have been born on or after 2nd August, 1898, and on or before 1st August, 1927. They must have a sound theoretical and practical knowledge of Wireless Engineering, with at least three years' experience in the construction and maintenance of wireless communication equipment, including experience with Very High Frequency apparatus, and be able to use technical equipment and simple machine tools. Salary, £280 (at 25)—£370. Further particulars and application forms from Secretary, Civil Service Commission, Scientific Branch, 27, Grosvenor Square, London, W.1, quoting No. 2303. Completed application forms must reach the Civil Service Commission by 17th November, 1948.

LECTURER in Telecommunications and Mathematics to City and Guilds Final Standard, for Radio Engineering School. Qualifications: Degree in Telecommunications, or similar; preference to recent Graduate with teaching ability. Salary according to qualification and experience, on scale from £450 per annum. Applications to Commandant, Air Service Training, Hamble, Southampton.

VACANCIES EXIST for technically qualified staff in an Admiralty Establishment near Warrington, Lancs., as follows:—
(a) To take complete charge of a testing section handling either all types of Naval radar equipment or all types of Naval communication and D.F. equipment. The work will include the organising of the testing of new equipment, the maintenance of existing stock, technical investigations, liaison with the Scientific Staff and designers, and the design of special test equipment.
Applicants must have had a regular engineering training and be fully qualified for Corporate Membership of the Institution of Electrical Engineers. They should be between 35 and 50 years of age, and have had experience in a responsible position on radio or radar work.
(b) To take charge of sub-sections engaged on the testing of communications, D.F. and radar equipments, radio components, valves, C.R. tubes, power-supply machines, distribution boards, transformers, etc.
Applicants should have served a full engineering apprenticeship and hold Higher National Certificate or have passed the R.N. Dockyard Inspectors' examination. They should be between the ages of 30 and 40, and have had responsible experience in some of the branches of work mentioned above.
Appointments are likely to be for at least two years in the first instance. Entry will normally be at the minimum of the range £720-£960 per annum for vacancy (a) and £595-£720 per annum for vacancy (b), but a higher rate may be offered exceptionally according to age and experience.
Write, quoting D.342/48-A, for vacancy (a) or D.343/48-A for vacancy (b), to the Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, for application form, which must be returned completed by 4th November, 1948.

THE UNIVERSITY OF MANCHESTER
TWO TECHNICAL ASSISTANTS are required for the construction of electronic apparatus in the Electrical Engineering Department of the University. Salary will be according to age and experience, together with Children's Allowance. Applications should be sent to the Steward, Electrical Engineering Laboratories, The University, Manchester, 13, as soon as possible. (By permission of the Ministry of Labour and National Service, under the Control of Engagement Order, 1947.)

SITUATIONS VACANT

TECHNICAL ASSISTANT for Automobile Radio work. Minimum of three years' industrial radio experience or radio maintenance, preferably as officer in the Forces. London area. Five-day week. Salary according to experience. Full details to Box 364, E.E.

MEDICAL ELECTRONICS. A vacancy arises for an Electronic Engineer (sales) in the Electro-Medical Department of a large London company. The candidate, in addition to possessing technical qualifications equal to final City and Guilds standard (Radio Communications), should be willing to travel, and should have some commercial acumen, as his duties are mainly concerned with technical/commercial sales of electro-medical equipment. Apply, in the first instance, in writing, stating qualifications, experience, age, etc., to Box 326, E.E.

PATENT AGENT or TECHNICAL ASSISTANT required in Patent Department of Company engaged in manufacture of precision instruments, radar, etc. Knowledge of electronics and radar technology desirable. Salary according to qualifications and experience. Full details to Personnel Manager, Sperry Gyroscope Co., Ltd., Great West Road, Brentford, Middlesex.

E.M.I. ENGINEERING DEVELOPMENT offer outstanding opportunities for experience and advancement in development work in many branches of electronic engineering, including major radar projects, radio communication, television receivers, audio-frequency engineering, radio heating, etc. Applications will be welcomed from men with Engineering or Physics Degrees or the equivalent, with design experience. Starting salaries £400 to £800, according to qualifications, experience and degree of responsibility. Senior Engineers are also required for cathode ray tube and klystron valve development, with degree qualification and some years experience in this or allied fields: also juniors for the same work with Inter-B.Sc. and, preferably, some practical experience. Send full details of experience and qualifications to Personnel Department, E.M.I. Limited, Blyth Road, Hayes, Middx.

RADAR ENGINEERS required to operate from London headquarters for installation and maintenance of marine installations home and overseas. The essential qualifications are: practical knowledge of electronic circuits and equipment, ability to work without supervision after training, and resourcefulness. Initial salary according to experience. Box 342, E.E.

TWO SENIOR DEVELOPMENT ENGINEERS required by well known company in Essex. Considerable experience in theory and design. of V.H.F. transmitters up to powers of 200 watts or on V.H.F. receivers are essential requirements. Applications, giving age, qualifications, experience, and salary required, quoting Ref. No. 133, to Box 348, E.E.

VACANCIES for Senior Television Development Engineers, Draughtsman/Designer (Mechanical) and experienced Model Shop Mechanics. Write Personnel Manager, Sobell Industries, Ltd., Langley Park, Langley, Bucks., stating age, qualifications, experience and salary required.

THE RESEARCH LABORATORIES of Messrs. High Duty Alloys, Ltd., 89, Buckingham Avenue, Trading Estate, Slough, have a vacancy for an Assistant capable of developing and servicing audio-frequency amplifiers and associated electrical equipment for vibration research. Student or Graduate Members of the I.E.E. and others holding Higher National or City Guilds Certificates in Electrical Engineering, or possessing equivalent standard of knowledge within the field specified are invited to write for an application form to the Personnel Manager at the above address. Salary approximately £400 per annum, according to qualifications.

SENIOR DESIGNER REQUIRED. Must possess solid theoretical education and first-class drawing office and experimental experience in mass-produced light mechanisms. Permanent post in long-established concern with wide interests. Liberal salary. Contributory pension scheme. Apply, in writing, with complete details, experience and training, to Parkinson & Cowan (Gas Meters), Ltd., Victory Works, Stretford, Manchester.

RESEARCH ENGINEER required by firm manufacturing industrial electronic equipment. Applicants must be of Degree standard or equivalent and must be capable of taking full responsibility for the complete design and development of modern electronic equipment. Salary according to age, qualifications and previous experience. Box 362, E.E.

A MATHEMATICIAN for research work on the physical concepts of radio transmissions, etc., particularly as applied to beams at all frequencies. Assessment of probabilities, fundamental design of complete systems. Good Honours Degree essential. West London area. Write, giving details of experience, etc., to Box 365, E.E.

BELLING & LEE, LTD., Cambridge Arterial Road, Enfield, require services of experienced and qualified Electronic Engineer to investigate problems in connexion with broadcast and television receiving aerials, radio interference suppression and radio and electronic components. This type of work presupposes a working knowledge of Physics, Electronic Mathematics and, to some extent, mass-production design together with an inventive flair. Applicant's age should lie between 25 and 35 years, and the scale of salary commensurate with experience and knowledge will not exceed £600 per annum.

THE MULLARD RADIO VALVE CO. have vacancies in their Vacuum Physics Laboratory for:—
(a) A Principal Scientist to lead research and development in the microwave valve field.
(b) A Senior Scientist to work primarily on the theoretical and mathematical aspects of microwave valves.
(c) A Senior Physicist to undertake the development of microwave and other specialised valves.
(d) A Senior Engineer, with experience of vacuum tube design, to work on constructional and engineering techniques applicable to specialised valves.
(e) Junior Scientists, preferably (but not necessarily) with experience of vacuum tube development, to work as Juniors in the above fields.
All candidates must have an Honours Degree in Physics, Mathematics or Engineering. Salaries: Principal, about £800 per annum, depending on experience and qualifications; Senior, £500-£800 per annum; Junior, £350-£500 per annum. Apply, in the first instance, for a form of application, to the Works Personnel Officer, The Mullard Radio Valve Co., Ltd., New Road, Mitcham Junction, Surrey, quoting the reference "K.B."

SENIOR DEVELOPMENT ENGINEERS required. Must have good technical training, preferably with Honours Degree in Physics or Engineering and Radio Laboratory experience. Able to carry through development, with assistants, to production stage. Salary up to £800, according to qualifications. Apply, in writing, to Personnel Department, Murphy Radio, Ltd., Welwyn Garden City, Herts.

ELECTRONIC ENGINEERS are required by works situated on the Treforest Trading Estate, near Cardiff, preferably with factory experience. Men with service training will be considered, but knowledge of the basic principles of design is essential. Applicants should give full details of training and experience to Box 367, E.E.

RADIO DRAUGHTSMEN required by large light engineering company situated in North London. Applicants with knowledge of Electronics equipment design are preferred, but practical shop and drawing office experience is essential. Write, stating age, experience and salary required, to Box 368, E.E.

ELECTRICAL INSPECTOR, fully qualified, urgently required for progressive light electrical engineering company in South Wales. Must have experience in inspection and testing of small fractional horse-power motors, transformers, etc. Excellent conditions. Please reply, stating fully previous experience, age, salary required, to Box 371, E.E.

ELECTRONIC CIRCUITRY ENGINEER, with Degree and preferably some experience in video frequency pulse techniques and servo mechanisms, required for advanced development work. Apply to The Technical Director, Woodlau Industries, Ltd., Kenwood Works, Hipley Street, Old Woking, Surrey, stating age, experience, academic qualifications and salary required.

TWO ELECTRONIC ENGINEERS required by large organisation with operational bases in England and Canada. Technical qualifications equivalent to C. & G. Final Radio-communications. Manufacturing experience in A.F. and/or recording apparatus, with ability to control specialist staff. Substantial salary in accordance with qualifications and experience. Box No. 382, E.E.

CLASSIFIED ANNOUNCEMENTS (Cont'd.)

LARGE MANUFACTURERS in North London require Radio Engineer for Service Department. Details of education (not below School Certificate standard), technical training and experience, age and salary required, to Box 322, c/o Era Publicity. Ltd., 7, Fitzroy Square, London, W.1.

THE S.W. DIVISION of leading radio company invites applications for post in development laboratories engaged on radar and allied equipment. Candidates should have at least three years' industrial experience in this type of work and show educational qualifications equivalent to A.M.I.E.E. examination standard. The post offers considerable opportunity for advancement. Commencing salary will be commensurate with qualifications and experience. Forms of application may be obtained on request. Box 374, E.E.

A PROGRESSIVE COMPANY in London, engaged in the manufacture of radio and electrical components, requires a Chief Research Engineer. Applicant must possess good Degree in Physics and Engineering, and have had several years' industrial experience. Knowledge of Dielectrics would be an advantage. There are excellent prospects but initial salary would be in accordance with experience and qualifications. Box 377, E.E.

MALE TECHNICAL ASSISTANT required for examination and analysis of reject cathode ray tubes. Previous experience essential. London area. Applications should include details of qualifications, experience and salary required and be addressed to Box 376, E.E.

DEVELOPMENT ENGINEER required for work on experimental types of cathode ray tubes. Applicants should possess a Physics Degree and have had practical experience in the design, development and manufacture of cathode ray tubes. London area. Applications should include details of qualifications, experience and salary required, and should be addressed to Box 375, E.E.

RADIO AND ELECTRONIC SENIOR ENGINEER required by leading firm of manufacturers. Applicants must have extensive practical experience in Technical Development of Electronic Equipment, with special knowledge of circuit techniques. Post is within twenty miles' radius of London and is progressive. Recognised qualifications are desirable, but practical ability is the essential factor; age preferably not over 35 years. Fares paid for interview. Salary, approx. £450 per annum, according to qualifications and experience. Written applications, giving date of birth, full details of qualifications and experience, etc., and quoting reference 439M, should be addressed to Regional Appointments Office, Ministry of Labour and National Service, 23, Valpy Street, Reading.

SENIOR DESIGN DRAUGHTSMAN required for Radio and Television. Previous experience on advanced development and design work essential. Apply Personnel Manager, Dynatron Radio Limited, Ray Lea Road, Maidenhead, Berks.

CHIEF INSPECTOR REQUIRED. Full responsibility radio and television production. First-class experience and technical ability essential. Knowledge of A.I.D. and C.I.E.M.E. procedure desirable. Apply Personnel Manager, Dynatron Radio Limited, Ray Lea Road, Maidenhead, Berks.

MECHANICAL DESIGNER with production engineering experience required as Deputy Chief of a development department in a well established company employing 2,000 people. Applicant must have experience of the design of small semi-precision mechanical assemblies and have had adequate technical training. An engineer with outstanding drive, experience and initiative, will obtain a permanent and progressive position. Our own staff have knowledge of this vacancy. Write stating age, details of experience and qualifications to Box 380, E.E.

RESEARCH ENGINEER, aged 25-30, is required by the Research laboratories of the General Electric Co., Ltd., East Lane, North Wembley, Middlesex, for work in connexion with pulse techniques and electronics. Good experimental experience is essential and an Honours graduate is preferred. Apply to the Director, stating, academic qualifications and experience.

REQUIRED AS TECHNICAL ASSISTANT to Chartered Patent Agent in Patent Department of the General Electric Co., Ltd., at Research Laboratories, Wembley, Middlesex, a young man with an Honours Degree or similar qualifications and preferably with some experience or knowledge of radio engineering and electronics. The assistant would receive training for qualification as a Chartered Patent Agent. Apply by letter to the Director, stating age, academic qualifications and experience.

THE MEDICAL RESEARCH COUNCIL have a vacancy in their Field Research Station at Fajara, Gambia, West Africa, for a senior technician (male) for training for maintenance of X-ray, geiger counter and other equipment. Candidates should be aged 25-35 and be physically fit for service in Gambia. They must have had experience in an applied electronics field and be capable of modifying equipment to local requirements. In addition they should have taken the City and Guilds Intermediate Certificate in Telecommunications or some equivalent qualification and have some knowledge of workshop practice. Initial salary will be fixed according to the qualifications and experience of the selected candidate who will also receive an overseas allowance, when in Gambia. The appointment would be subject to a six months' probationary period, and if this period were served satisfactorily, the member of the staff would be admitted to a contributory superannuation scheme. Annual and sick leave would be given at the same rate as for Civil Servants in an analogous grade who are serving in Gambia. Applications in writing giving name, age, address and full details of scholastic and subsequent career and the names and addresses of two referees under whom candidate has worked, should be sent to the Director, Human Nutrition Research Unit, National Hospital, Queen Square, W.C.1.

ELECTRONIC ENGINEERS with Honours Degree or equivalent are required for research and advanced development work by the Nelson Research Laboratories, English Electric Co. Ltd., Stafford. Preference will be given to men with sound electrical engineering experience. Salary according to qualifications. Apply by letter to Chief Administration, Nelson Research Laboratories, English Electric Co., Ltd., Stafford, stating age, experience and academic qualifications.

DESIGN DRAUGHTSMEN are required by the English Electric Co., Ltd., Stafford, for research and development work on electronic equipment. Applicants must have Higher National Certificate or equivalent and shop experience. Salary according to experience. Send full details to Central Personnel Services, English Electric Co., Ltd., Queens House, Kingsway, W.C.2, quoting ref. DO.25.

AN EXPERIENCED ENGINEER, preferably with some knowledge of industrial applications, wanted to take charge of small laboratory in London. Salary £550. Excellent prospects for man with ability. Box 368, E.E.

SITUATIONS WANTED

TECHNICAL SALES REPRESENTATIVE, 33, resident South Bucks, seeks to undertake representation in London and Home Counties of provincial manufacturer. Fine business man with good technical qualifications and long experience in R.F. equipment, industrial electronics and medical gear. Many good contacts already established. Could undertake complete area sales and installation organisation. Own car and telephone available. Box 379, E.E.

EX-NAVAL RADAR OPERATOR, 4 years' experience in maintenance and repair of radar equipment, seeks work in radar or electronics industry. Studying Radio Engineer, keen and willing to learn. Box 369, E.E.

FOREMAN. Assembly, inspection; experienced radio, electrical and radio service. Nat. Cert., Elec. Box 370, E.E.

EMPLOYERS requiring production, service or research staff for radio, radar, television, communication industries, should apply to Technical Employment Agency, 179, Clapham Road, S.W.9 (BRIxton 3487).

SCIENTIFIC OFFICER, Honours Degree and 15 years' experience in communication and instrument engineering, desires change from present Government research, to medical or domestic electrical development work. Anywhere at home and abroad. Box 372, E.E.

TECHNICAL REPRESENTATIVE, Scotland. Engineer (45), experienced electronic equipment and application, desires post sales, installation, service, etc. Industrial equipment and plant. Sound commercial and practical experience. Highest references. Box 373, E.E.

EDUCATIONAL

NEW METHODS IN RADIO SERVICING. Full details and publication, "Modern Radio Servicing" free. BCM/CIRCUIT, London, W.C.1.

SERVICE

LOUDSPEAKER repairs, British, American, any make, moderate prices.—Sinclair Speakers, 12, Pembroke Street, London. N.1.

REWINDING. A specialist winding service covering A.F. transformers, relays, solenoids, and to specification. S.T.S., Ltd., 297/299, High Street, Croydon, Surrey. Telephone: CROydon 4870.

RADIO MANUFACTURERS can undertake development and assembly of radio or electronic equipment. Winding shop with vacuum impregnation plant. Ample space and labour available. Box 316, E.E.

MISCELLANEOUS

WE WILL BUY at your price used radios, amplifiers, converters, test meters, motors, pick-ups. speakers, etc., radio and electrical accessories. Write, phone or call, University Radio Ltd., 22, Lisle Street, London, W.C.2. GERrard 4447.

PHOTOGRAPHY. We specialise in advertising and catalogue-photography, and in series photographs for instruction sheets. Our pictures tell the story. Behr Photography, 44, Temple Fortune Lane, N.W.11 (SPEedwell 4298).

FOR SALE

WEBB'S 1948 Radio Map of World, new multi-colour printing with up-to-date call signs and fresh information; on heavy art paper, 4s. 6d., post 6d. On linen on rollers, 11s. 6d. post 9d.

IN STOCK. Rectifiers, Accumulator Chargers, Rotary Converters, P.A. Amplifiers, Mikes, Mains Transformers, Speakers of most types, Test Meters, etc. Special Transformers quoted for.—University Radio, Ltd., 22, Lisle Street, London, W.C.2. GERrard 4447.

1948 VADE MECUM listing 10,000 valves. Universal Services, 13, Newburgh Street, London, W.1.

COPPER WIRES: enamelled, tinned, Litz, cotton, silk covered. All gauges. B.A. screws, nuts, washers, soldering tags, eyelets. Ebonite and laminated Bakelite panels, tubes. Paxolin coil formers. Tufnol rod. Permanent detectors, etc. List S.A.E. Trade supplied. Post Radio Supplies, 33, Bourne Gardens, London, E.4.

RELAYS, RELAYS, RELAYS, 150 types, also 12/24V cut-outs, starter switches. Telephone components, carbon insets, switch keys, jacks, plugs, selector switches, handsets, cords, 4½V solenoid with ratchet action, drop indicator jacks. Block condensers including 250 μF. 6V electrolytic. High-speed relays. 12/24V indicator lamps, jacks and lenses. Jack Davis, Dept. E.E., 30, Percy Street, London, W.1. MUSeum 7960.

WAKE THE EASY WAY with the "Reveille" clock-radio, retails 12 gns., plus tax. Stamp for leaflet. Thames Valley Products 28, Camden Avenue, Feltham.

METAL RECTIFIERS. STC, 575V 1.2 amp., 90s.; 290V 0.75 amp., 17s. 6d.; 250V 75mA, CT, 5s. 6d.; Pen46 valve for E.E. televisor, new, boxed, 7s. 6d.; microswitches, 2s.; vitreous resistors, 200 ohm 75 watt, 7s. 6d.; 500 ohm and 3K 20 watt, 2s.; wire potentiometer, 2-gang, 200 ohm 50 watt, 9s.; 200 ohm 3-watt short-spindle, 1s. 9d.; 2μF 600V Mansbridge, 2s. Box 363, E.E.

A SPENCER WEST Television preamplifier will generally effect a considerable improvement in reception for users on the fringe of the service area. This unit, which is completely self-contained and can be used in conjunction with any television receiver, enjoys great popularity. Several of these installed before the war are still giving first-class results. The latest model employs advanced circuit technique to ensure the viewer consistent reception in regions of low field strength. List price, 10 gns., complete with accessories. Ask for leaflet SWTP, which gives full technical details. Spencer West, Quay Works, North Quay, Great Yarmouth.

FIVE-CORE CABLE (9/012), cotton packed tough rubber sheathed, 9d. yard; with tinned copper screening, 10d. yard. Armes, 37, Birchwood Drive, Leigh-on-Sea.

SPEAKER (Woven) fabric, 8s. 9d. yard. Send 9s. 6d. sample yard, carriage paid. Petter Radio Supplies, The Component Specialists 203, Forest Road, Walthamstow, E.17.

CLASSIFIED ANNOUNCEMENTS
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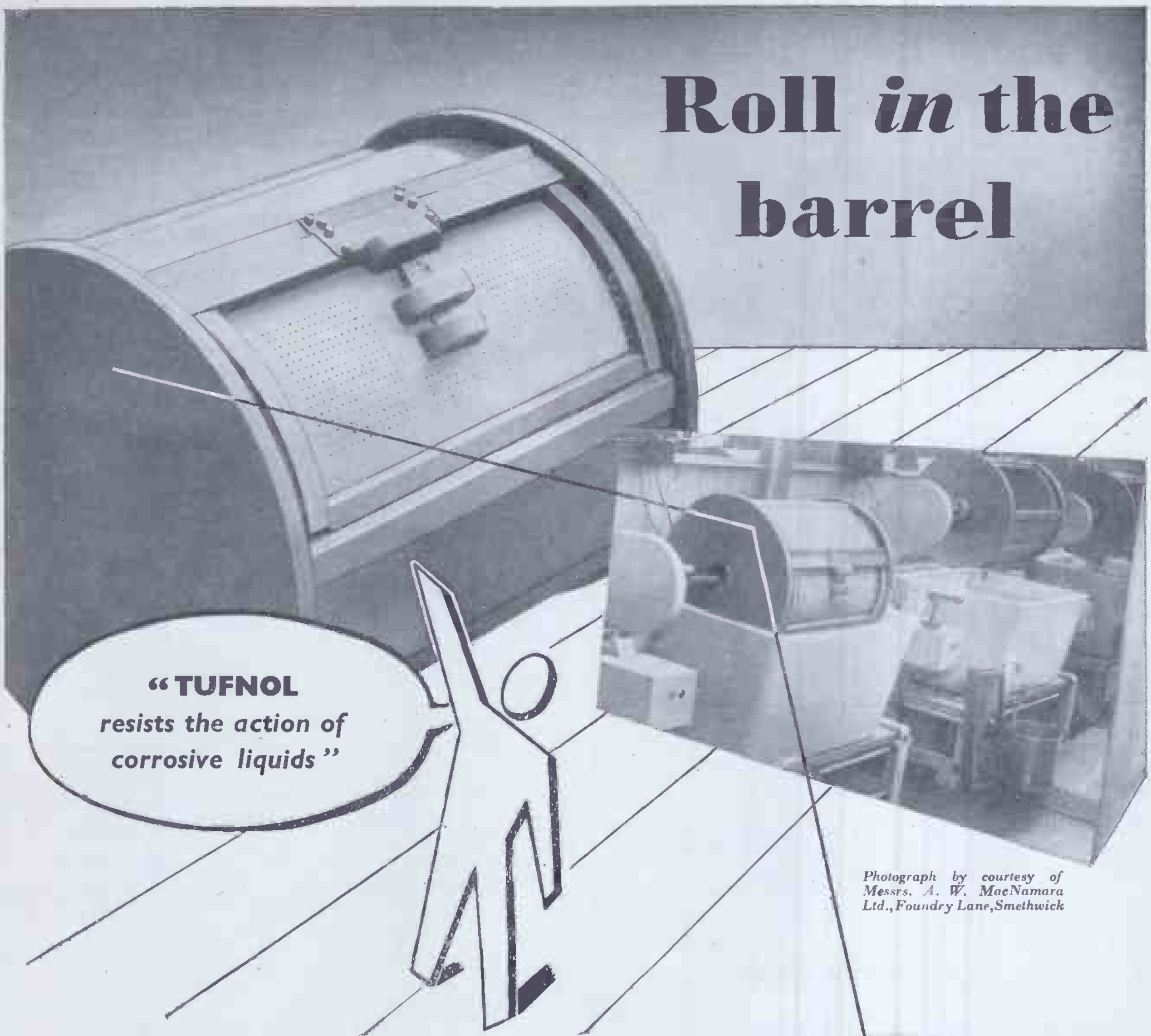

Made entirely of Tufnol, barrels for electroplating show no sign of deterioration even after many months of service. Furthermore, they have retained their shape though constantly immersed in liquid.

This is only one way in which Tufnol is proving an advantage to engineers in every industry.

Can TUFNOL *improve your products or plant?*

Our Engineers will gladly help you

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CLASSIFIED ANNOUNCEMENTS (Cont'd.)

BRAND NEW PHASE-CONTROL UNITS. design " E." Input, 230V 50 cycles, containing transformer. Output, 250-0-250V, 75-0-75V, 4V at 3 amps., 4V at 1.5 amps., valves UU4 rectifier, thyratron GT1C, condensers, resistances, etc., in super metal cabinet and packed in wooden container, £3, carriage paid. Brand new ex-R.A.F. power units. containing 0-1mA MC meter, meter rectifier, 2×32 μF 600 VDC condensers, 2X300mA 20 Henry L.F. chokes, heavy duty mains transformer, input 230V 50 cycles, output 350-0-350V at 300mA, 2X6.3V, 5V, 20-0-20V, 2X EF50, EA50, 5U4G condensers, resistances, thermal delay switches, fuses, etc., all in wooden packing case, bargain, £6 15s., carriage paid. Valves: GT1C, 10s.; EF50, 5s.; EF54, 7s. 6d.; EA50, 4s.; V1907 (5,000V rectifier), 7s.; 5U4G, 10s.; television condensers: 0.01-4,000 VDC, 0.03-2,500 VDC, 0.05-3,500 VDC, 1s. S.A.E. list, Cross, Skerries, Cross Lane, West Kirby, Cheshire.

MICROPHONES. Moving coil, manufactured by Lustraphone. Impedance approx. 20 ohms. Response does not exceed plus or minus 6db between 50 and 8,000 c/s. Employs patented method of diaphragm suspension reducing acoustic leakage and distortion to minimum. 4 in. diameter, 2½ in. deep. Complete with 4-tier telescopic chromium stand and 4½ yards of microphone cable. Limited quantity. Price £5 17s. 6d. Postage, 2s. 6d. extra. Teleonics, Ltd., 181, Earl's Court Road, London, S.W.5.

DISK RECORDING EQUIPMENT by Bourne Instruments, complete with modulation meter and run-out mechanism. New and unused. £34. Dawe Instruments Limited, 130, Uxbridge Road, Hanwell, London, W.7.

RADAR SETS, type AN/APN4, 5 in. short persistence electrostatic C.R.T., suitable for oscilloscope or television, 25 valves, circuit diagram available, £7; 6SN7's, 6SJ7's, 6SL7's, tested, 6s. each. Stamp for details. Box 378, E.E.

AMAZING BARGAIN. 9s. 6d. Complete kit of parts for 3W.B. superhet coil pack, including Yaxley, coils, chassis, trimmers, etc. I.F.Ts. 465, 7s. 6d. pr.; droppers, 2s. 9d. Send for cheapest list in England, Sussex Electronics, Ltd. (T), Bevendean, Brighton, 7. Tel.: 4446.

AIR POSITION INDICATORS. Ex-R.A.F. An incredible bargain, containing a host of precision parts, approx. 40 gear wheels, 14 roller bearings, repeater motor rev. counters, etc. Ideal for experimenters, model constructors, 25s., carriage paid. Passingham (Dept. E.E.), North Street, Keighley.

AMERICAN MAGAZINES. "Radio News," "Radio Craft," "Q.S.T.," and others by subscription. Stamp for details. B. H. Warren, Wilburton, Ely.

HAZLEHURST R.F. E.H.T. for all television receivers, including A.C./D.C. types, 5-8KV, complete with valves (6V6GT and EY51), 5 gns.; coil only, 26s. 8d. Use 25L6 or equivalent for series heater operation. Magslips and Selsyns, large selection, send for technical leaflet. For A.C. bridges, linear wire-wound potentiometers, Berco M.10, 10 watt 1K, 4s. 9d.; 50K, 5s. All goods guaranteed and post free. Technical correspondence welcome. Hopton Radio, 1, Hopton Parade, Streatham High Road, London, S.W.16. STReatham 6165.

THE MORDAUNT DUPLEX REPRODUCER has a treble section which employs a high flux P.M. unit, having a specially designed twin cone. This last, together with low frequency filtering, avoids intermodulation, "feather-edge" effect, and decay factor troubles. The frequency response is exceptionally smooth up to 20,000 c/s, and the transient response is of a very high order. The unit feeds into a multi-reflector assembly which gives, with the aid of the surrounding walls, the wide dispersion and freedom from "point-source" effect so essential to realism and atmosphere. Price 98 gns.; whitewood, "skeleton," model, £88. Telephone or write for a demonstration. Joseph Enock, Ltd., 273a, High Street, Brentford, Middlesex. EALing 8103.

CONSTANT VOLTAGE TRANSFORMERS, 1,650 and 850 watts output, oil filled, good condition. £30 and £20 respectively, ex-store London. Hazlehurst Designs, Ltd., 186, Brompton Road, London, S.W.3. KENsington 7793.

THE ENOCK AMPLIFIER is expressly designed to obtain the highest standard of performance without regard to first cost. Total distortion, including noise, less than 0.1 of 1 per cent at 12 watts output. Hum level less than −75db. Frequency response practically flat from 20 to 30,000 c/s. No electrolytic condensers used whatsoever. Inputs for radio and 'gram. (Any type of pick-up.) The pre-amplifier is a separate unit designed to mount on the control panel or motor-board and contains all controls. It is low impedance coupled to the main amplifier. Thus, flexible couplings and hum troubles due to long leads are eliminated. Price £75. Telephone or write for a demonstration. Joseph Enock, Ltd., 273A, High Street, Brentford, Middlesex. EALing 8103.

THE ENOCK PICK-UP incorporates a diamond stylus, precision ground and highly polished to an optimum contour. To reproduce the full flavour of modern recordings this contour must retain its shape indefinitely within very close limits. Diamond is the only known material which satisfactorily fulfils this condition. This, therefore, is the basic reason for its selection for use in the Enock Pick-up. Where absolute constancy of shape can be relied on, less weight is required at the needle point for correct tracking, which, in turn, permits lighter "damping" of the movement. These three features reduce record wear to an exceptionally low level.
These are only some of the reasons why the Enock Pick-up is the only possible choice for the discriminating user who requires consistently the best possible results. A diamond stylus finished to such fine limits is necessarily expensive and, in actual fact, accounts for three-quarters of the price of £29 5s. for the Enock Pick-up. (Patent No. 538058, others pending.) Telephone or write for a demonstration. Joseph Enock, Ltd., 273A, High Street, Brentford, Middlesex. Telephone EALing 8103.

New Edition

RADIO COMMUNICATION TRANSMITTERS

by

J. J. HUPERT, M.Sc.

There are numerous publications on the principles of radio receiver design in existence, but there is not a single handbook dealing exclusively with the design and construction of radio transmitting stations.

This publication represents the first attempt to bridge this gap in radio literature.

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Maximum Anode Voltage (volts) ...	V_a(max)	250
Maximum Cathode Current (mA) ...	$I_{k(av)}$max	5
Mutual Conductance (mA/V)	gm	*3.4
Anode Impedance (ohms)	r_a	*9,300
Amplification Factor	μ	*31.5
Maximum Mean Diode Current per diode (mA)	$I_{a(d)av(max)}$	0.1
Maximum Potential Heater/Cathode (volts rms)	V_{h-k}(max)	150

* Taken at V_a = 100v; V_g = 0v.

10 P 14
OUTPUT TETRODE

(List price 13/-)

RATING

Heater Current (amps)	I_h	0.1
Heater Voltage (volts)	V_h	40
Maximum Anode Voltage (volts) ...	V_a(max)	250
Maximum Screen Voltage (volts) ...	V_{g2}(max)	250
Maximum Anode Dissipation (watts)	w_a(max)	10
Maximum Screen Dissipation (watts)	w_{g2}(max)	3
Mutual Conductance (mA/V)	*gm	7.2
Inner µ	$^*\mu_{g1, g2}$	*11.2
Maximum Potential Heater/Cathode (volts RMS)	V_{h-k}(max)	150

*Taken at V_a = 175; V_{g2} = 175; V_{g1} = −9.4

10 P 13
OUTPUT TETRODE

(List price 13/-)

RATING

Heater Current (amps)	I_h	0.1
Heater Voltage (volts)	V_h	40
Maximum Anode Voltage (volts) ...	V_a(max)	250
Maximum Screen Voltage (volts) ...	V_{g2}(max)	250
Maximum Anode Dissipation (watts)	w_a(max)	6
Maximum Screen Dissipation (watts)	w_{g2}(max)	1.8
Mutual Conductance (mA/V)	gm	*7.5
Inner Mu	μ_{g1-g2}	*13
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* Taken at V_a = V_{g2} = 150v; I_a = 30 mA.

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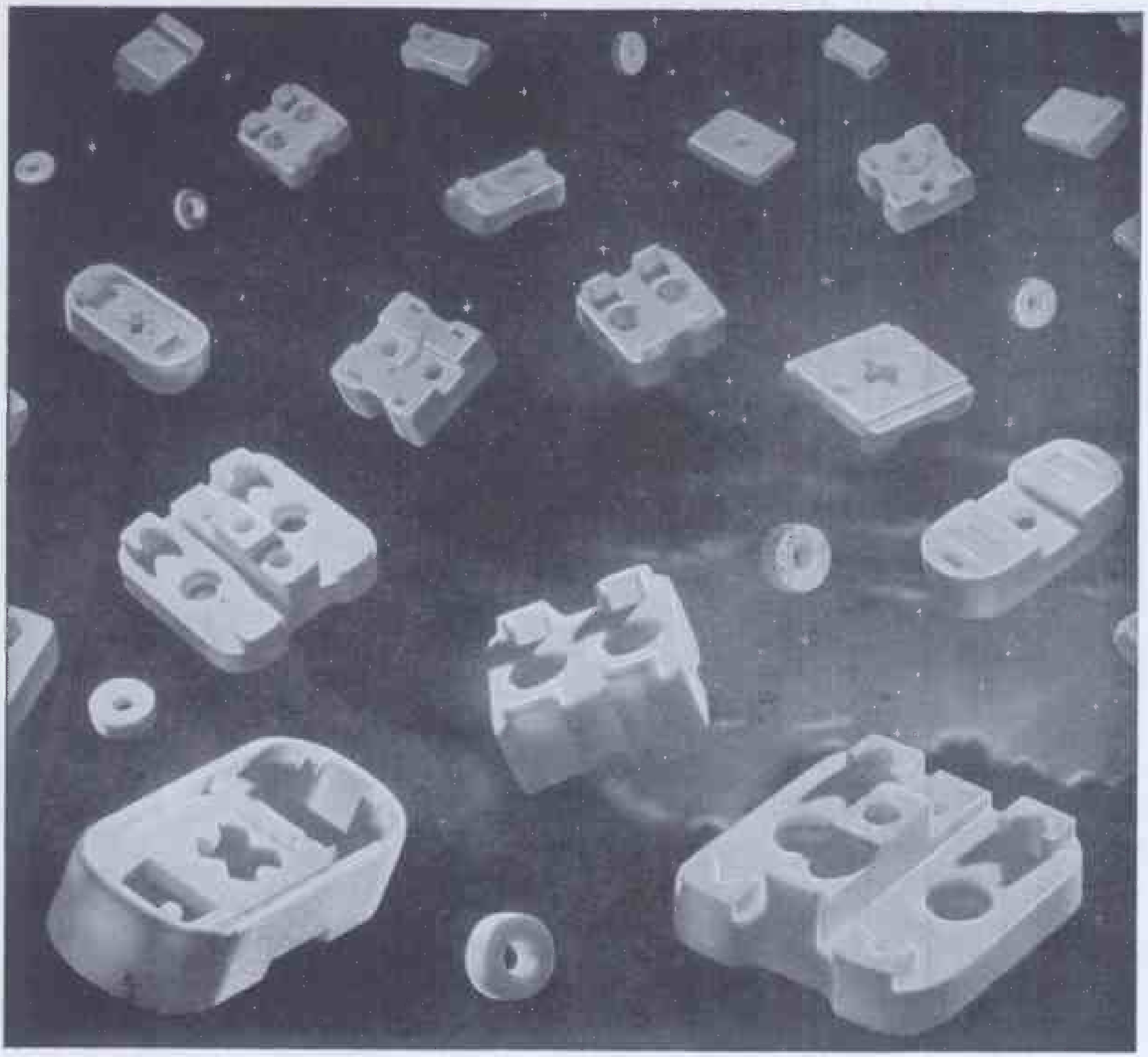

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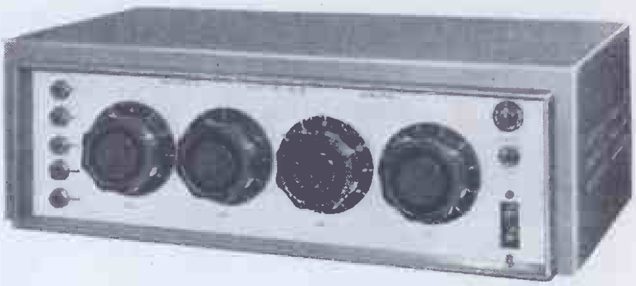

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6mV r.m.s./cm.

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D.C. — 50 Kc/s.
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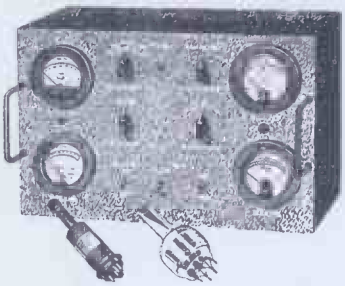

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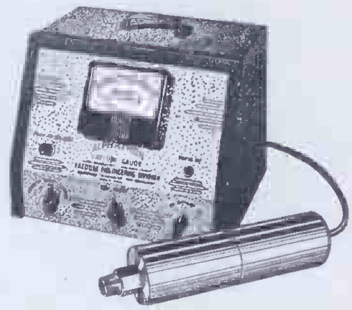

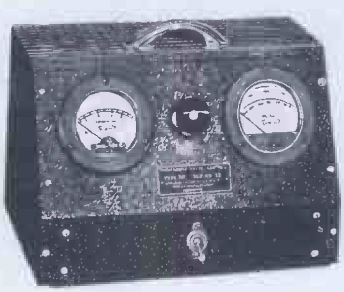

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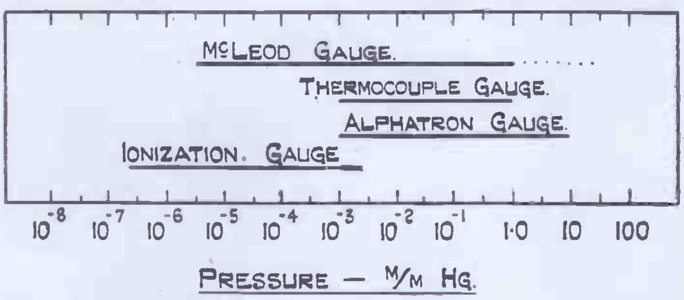

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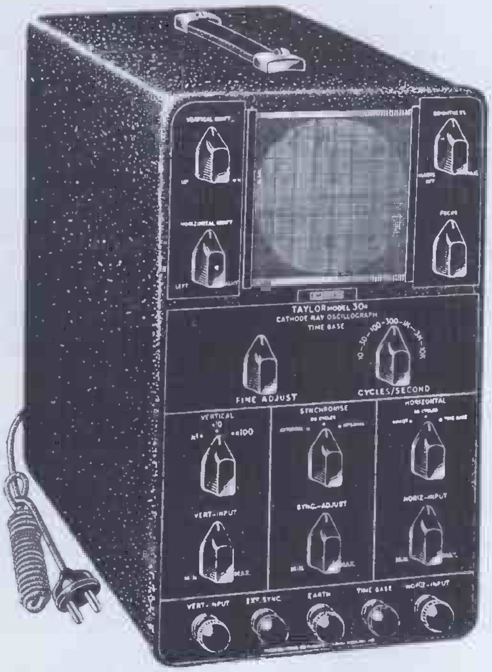

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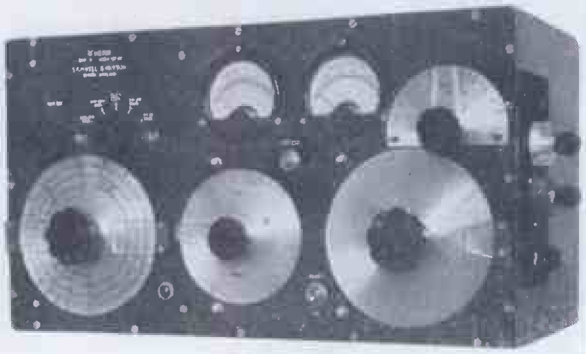

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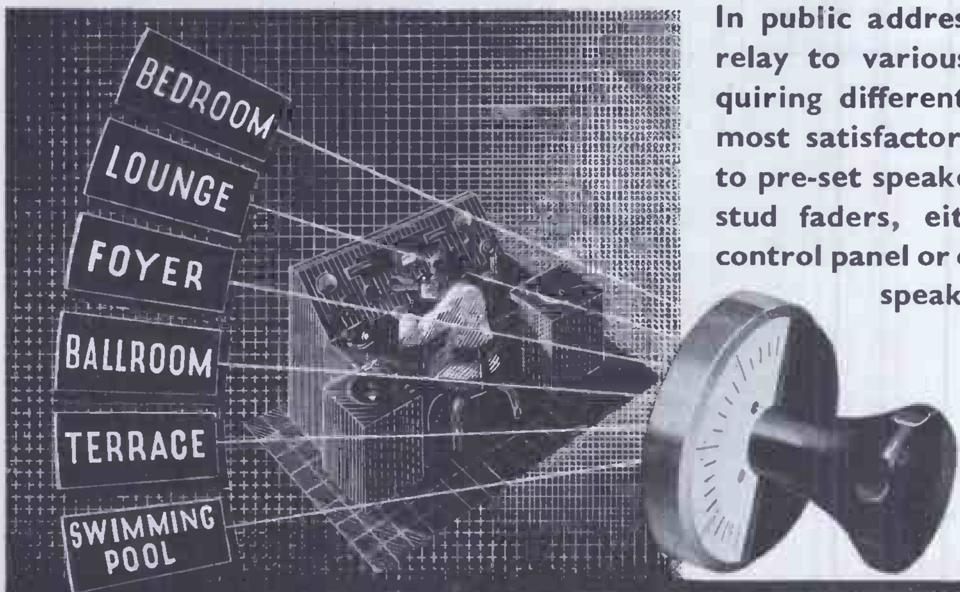

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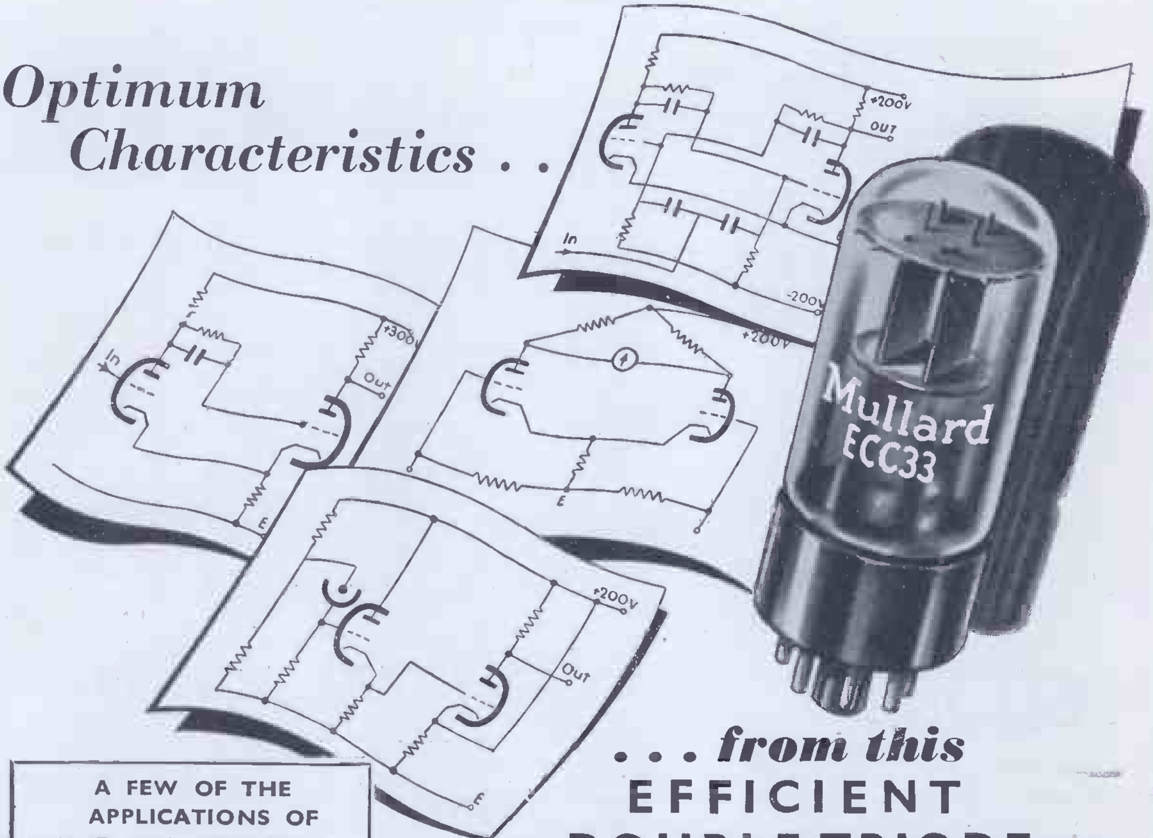

. . . from this EFFICIENT DOUBLE-TRIODE

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Heater Current	...	0.4A	Anode Resistance	...	9,700Ω
Anode Voltage	...	250V	Mutual Conductance	...	3.6mA/V
			Amplification Factor	...	35

Mullard

Please write to Transmitting & Industrial Valve Dept. for full technical details of this and other double-triodes in the Mullard range.

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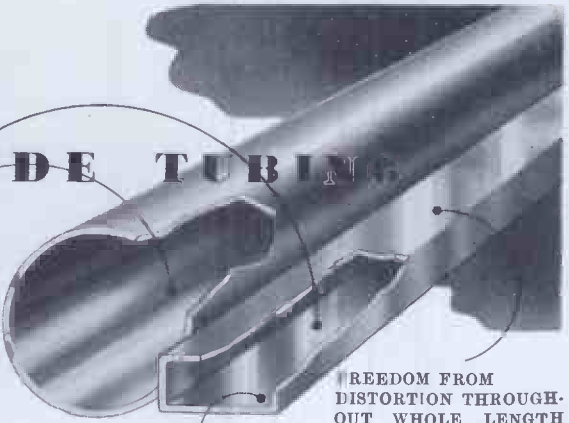

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The type L.O.50 Beat Frequency Oscillator is essentially portable.

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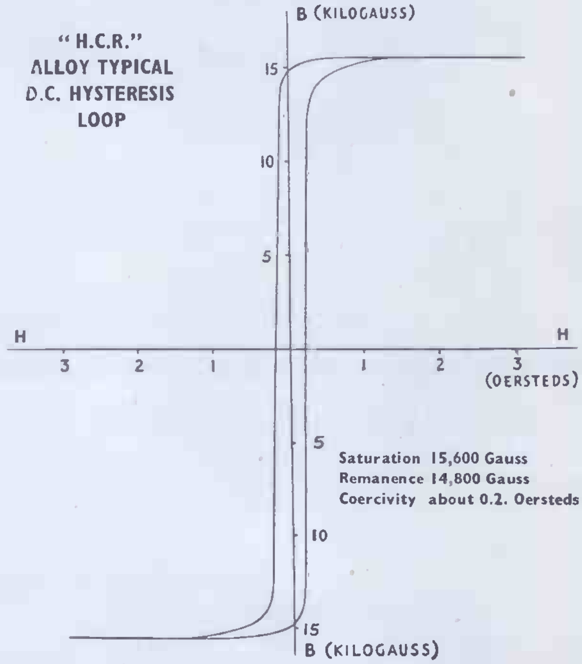

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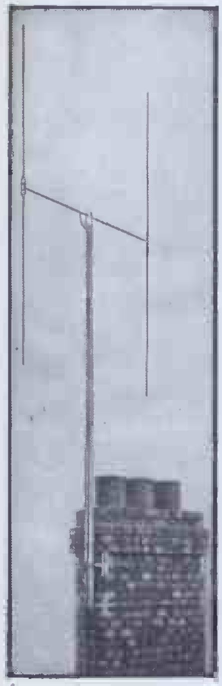
BELLING-LEE

'QUIZ' (No. 16)

Answers to questions we are often asked by letter and telephone



Question 42. *How many television receivers can I run from one† aerial ?*

Answer 42. *This depends upon certain important factors :—*

(i) *Signal strength in the locality.*

(ii) *Gain of receivers.*

(iii) *Length of feeder cable involved.*

Item (i) above is the main deciding factor and really should be stated as the voltage received from the aerial. If the voltage available is sufficient, it is possible that four or five television receivers could be fed from the common aerial. In this case, however, it would be necessary to insert padder units in the main feeder line to prevent interaction between receivers and to terminate the main feeder correctly at the far end.

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†VIEWROD (Regd. Trade Mark) television aerials

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BELLING & LEE LTD
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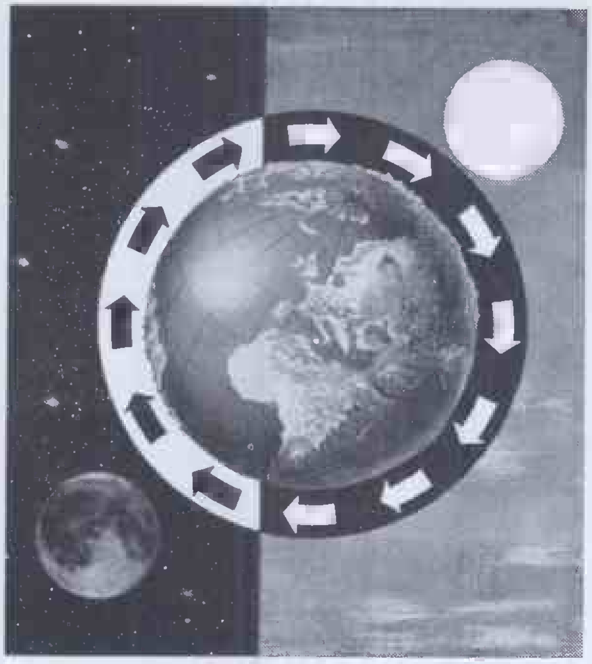

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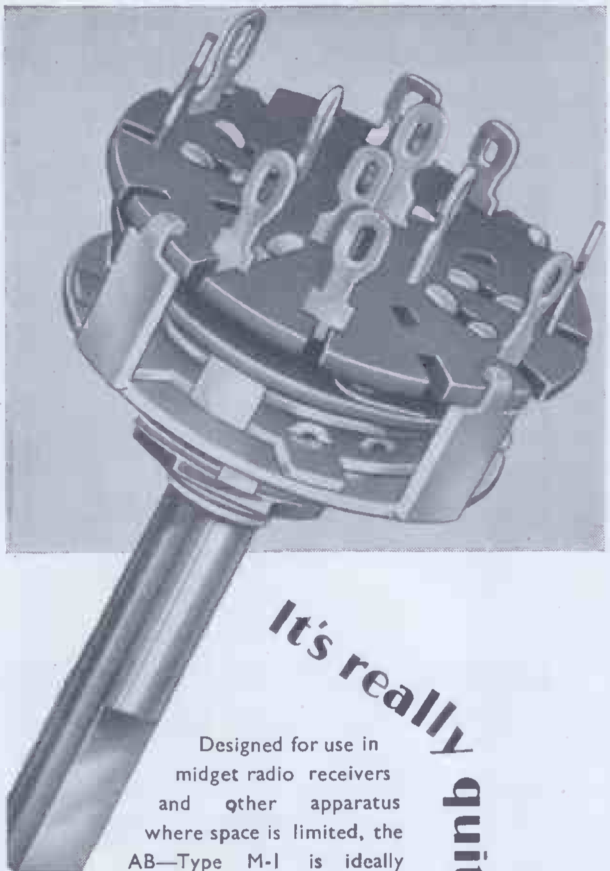

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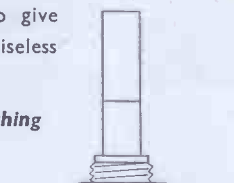
Available in all popular switching combinations.



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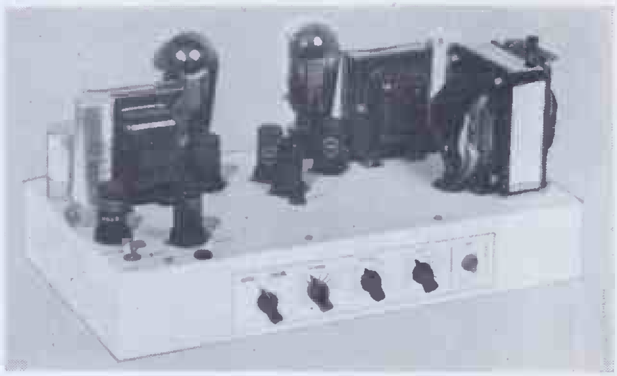

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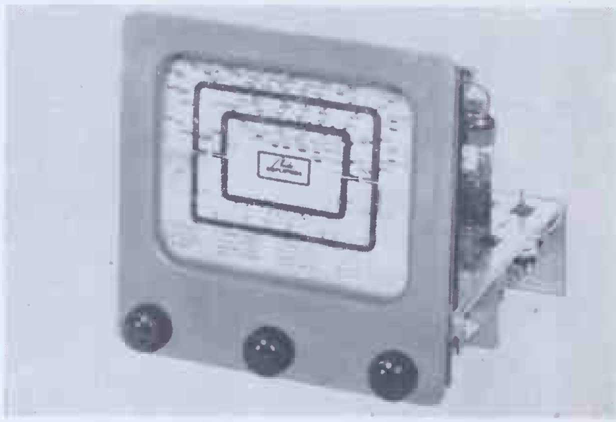

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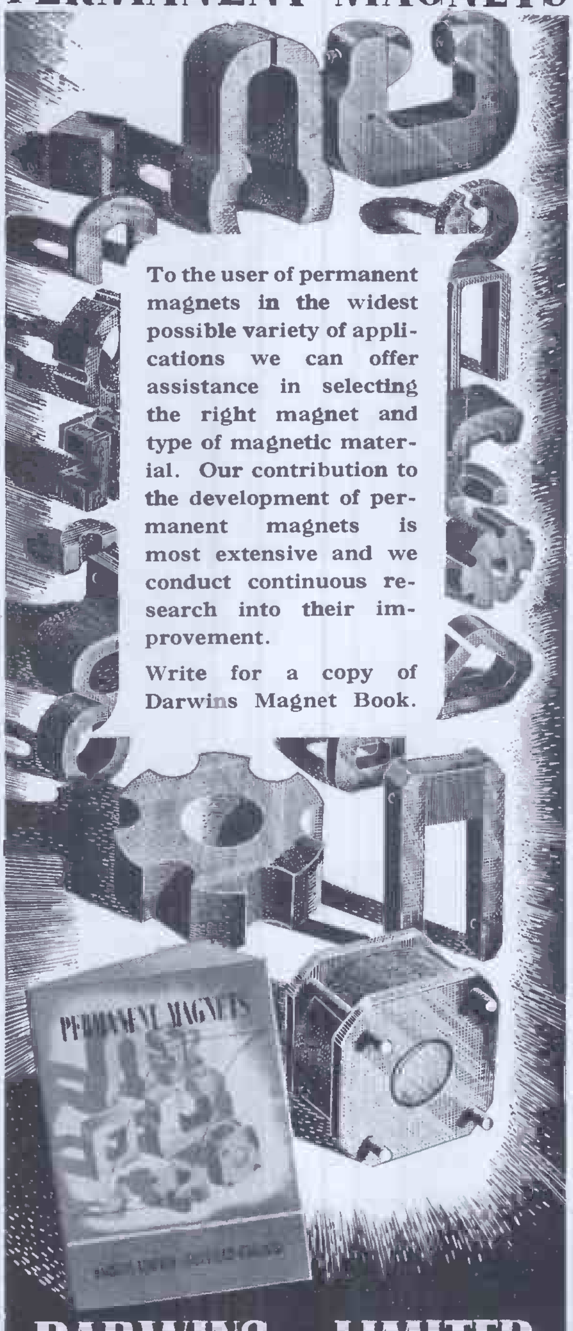

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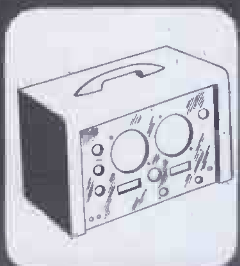

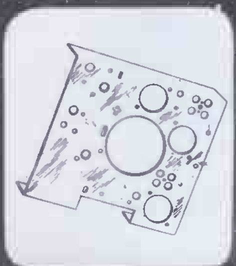

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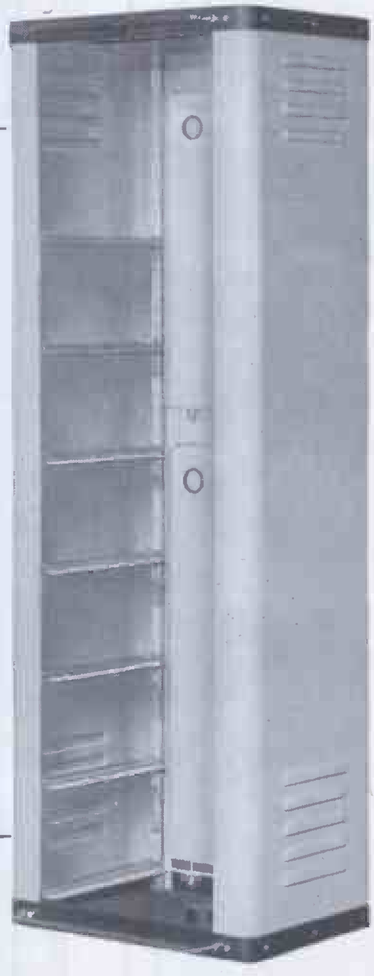

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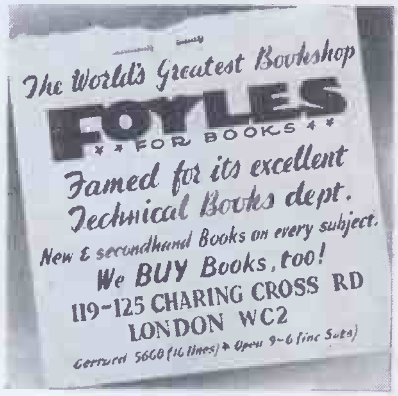

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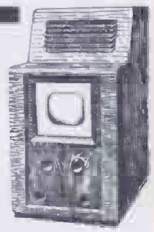

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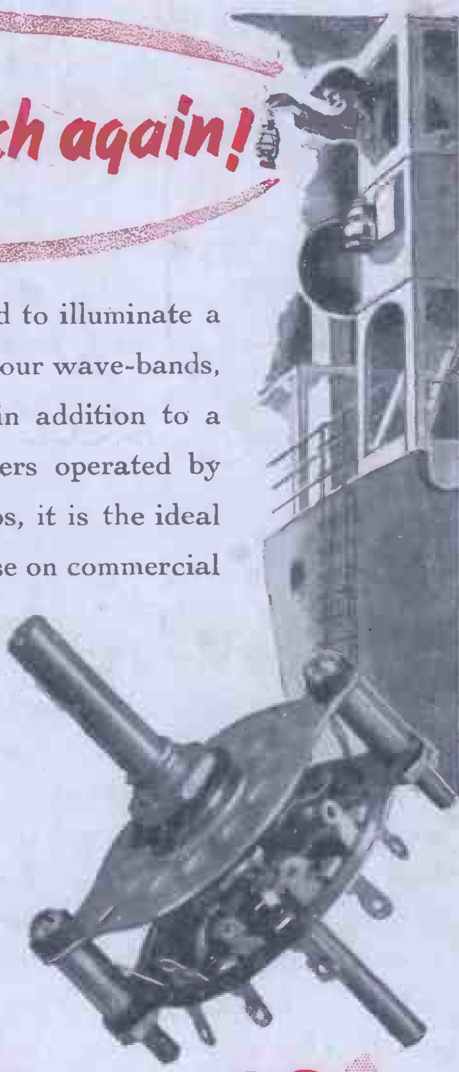

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