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Small-Scale Competitive Television

IN spite of much airing of views in prolonged Parliamentary debates, the Government's avowed intentions on the future of television may yet be subject to change. The agreed policy is set out in the latest White Paper,* but the Home Secretary made it plain in his closing speech in support of the document that, when the time comes to prepare legislation, the Government will still be willing to listen to new proposals, always provided they lead to something that will put an end to the B.B.C. monopoly. Thus there is some faint hope that broadcasting in general, and television in particular, may after all be rescued from the party-political arena into which it has now fallen.

For this small ray of hope we must be thankful; there is little other cause for satisfaction in the Government's proposals. The policy laid down in the White Paper, with its complicated system of programme companies buying time from a public corporation owning and operating the new stations, is not likely to lead to the healthy growth and rapid development of television. The system is a compromise that will not satisfy the advocates of full-blooded commercial competition; at the same time, it will fail to appease those who believe in public-service broadcasting. Neither does the proposed scheme seem to please the great majority of those concerned with radio as a livelihood.

Wireless World is not concerned with the political ideologies that go with either commercial competition or the principle of public service, but we want to see a rapid and orderly growth of television. The great fault of the Government scheme is that it is certain to be slow in developing. No detailed plans have yet been made and, even when they are decided upon, a prolonged legislative process (no doubt contested at every stage) will be needed before the scheme can be put into effect.

Even if planning and legislative processes can be speeded up, there remains the difficulty of finding channels for a useful number of the new competitive stations, which are to operate in Band 3 (174-216 Mc/s). At present only two channels are available in this band; the other six are occupied by other services. Although it is the avowed intention of the Government to clear the band in its entirety for television, this will take time; a period of seven years has been mentioned. The "squatters" at present occupying Band 3 have not yet, so far as we know, been given notice to quit.

To be a success, competitive television should from the very start be launched on a fairly big scale. A commercial system as proposed, with two or even three low-powered stations, is unlikely to attract good (and consequently expensive) programmes. As a natural result, the growth of the viewing audience will be slow.

Then there is the question of receivers, the manufacturers of which would have many embarrassing problems to face. The production of two-band sets in limited numbers for restricted areas of the country would clearly be uneconomic, and so prices would be high. Demand in turn would be limited, and so the elements of a vicious circle arise. From the point of view of the receiver manufacturer, and of the public as well, everything is in favour of starting a service on a new band, whether competitive or alternative, on the largest possible scale. Rather than wait for Band 3 to be cleared, it would probably be better, and quicker in the long run, to adopt the suggestion made in our September, 1953, issue, and by-pass Band 3 altogether in favour of Band 4 (470-585 Mc/s). Incidentally, the "mobile radio" industry is likely to find itself in an unenviable position unless something of this sort is done.

Finally, the cost of a competitive service on the lines of the White Paper seems to call for a heavy expenditure of national resources. We have already expressed the hope that an alternative scheme may yet be found. The Government's objection to the B.B.C. monopoly is that it is a monopoly in the distribution of ideas: would it not meet this objection more economically for the Corporation to continue the technical distribution of all television, but for the control of alternative programmes to be delegated to a suitably chosen independent body?

* Cmd. 9005: H.M.S.O., 4d.

Experimental Transistor

AN interesting method of gaining practical experience of the circuitry employed with transistors is to use them experimentally in radio receivers. Sets using them have a value, quite apart from their novelty or academic interest, because of their extremely low power consumption, and two possible circuit arrangements are described below giving useful performance with a total current consumption of 6.0 mA at 18 V.

Some elementary consideration of these circuits and the steps leading up to them may be of interest and help to experimenters when they have an opportunity to try transistors for themselves.

At a stage when transistors tend to be scarce and relatively expensive it seems appropriate to achieve the highest possible gain from the smallest number of transistors, even at the expense of making the circuit and its adjustment a little less simple. This consideration suggests reaction and reflexing, both common aids to sensitivity in the earlier days of thermionic valves. At first it seems somewhat doubtful whether a transistor with a collector dissipation limit of 100 mW could possibly give sufficient output for loudspeaker operation, but it was found that the volume obtainable with an input of about 20 mW into a sensitive instrument was surprisingly acceptable and perfectly adequate for following all types of programme. Some deliberate restriction of bass response by preventing overloading of the output transistor with frequencies making no audible contribution at this low power was helpful in this respect. It is also fortunate that quite a high degree of harmonic distortion sounds relatively innocuous at low output levels. Incidentally, to clear up what seems to be a very common misapprehension, it might be mentioned that at the present moment no junction transistors on the market anywhere appear to have collector dissipations exceeding 150 mW and many are limited to 50 mW. Junction transistors with higher dissipation are as yet in the laboratory stage.

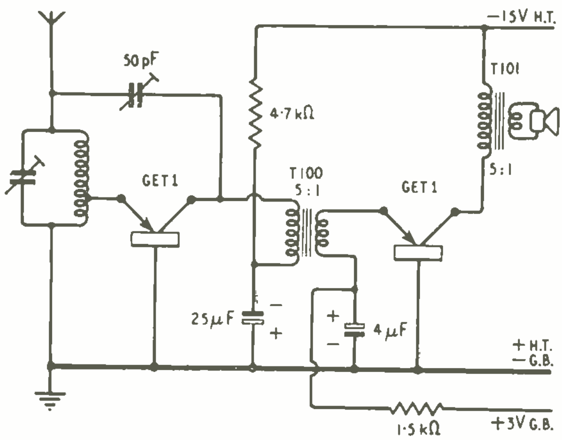


Fig. 1. Simple two-stage transistor receiver with reaction.

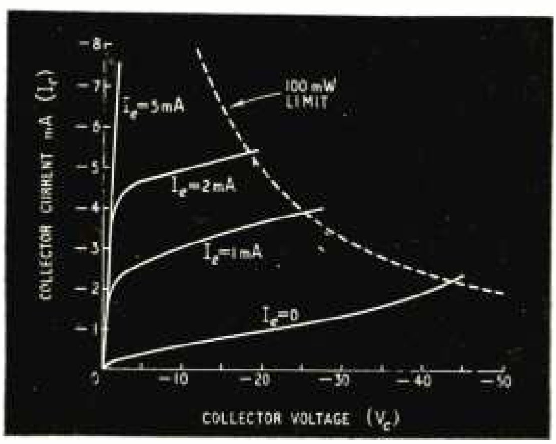


Fig. 2. Static characteristics of type GET1 point-contact transistor.

The simpler of the two circuits is shown in Fig. 1 and consists of one transistor acting as detector with reaction, transformer coupled to another transistor feeding the loudspeaker. The output stage will be considered first. Examination of the characteristics of a typical transistor, Fig. 2, shows that a conservative working point is with collector volts 15 and collector current 5 mA, and that a suitable load line is given by 4,000 ohms. A listening test, using a variable-ratio output transformer, confirmed that this value was suitable and by no means critical, so that slight variations from one transistor to another would be accommodated.

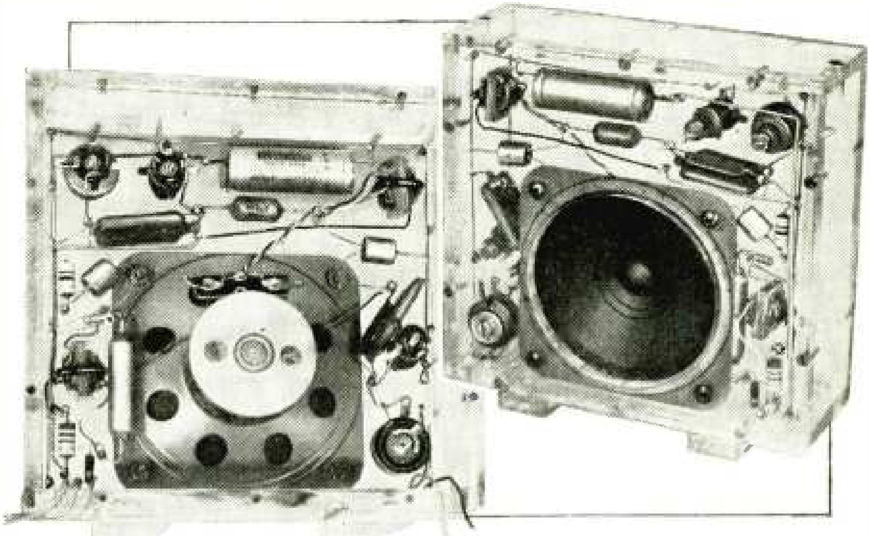
This empirical test of working conditions is easily carried out by feeding in a low-level audio signal from a broadcast receiver and in the absence of more elaborate equipment it seems well worth while to establish satisfactory operation in this way. It is suggested that the 5:1 coupling transformer (Multitone Type 100) shown in Fig. 1 should be used for this purpose, its primary being fed through a capacitor from a suitable point such as the anode of the first a.f. valve. The feeding in of high level signals or surges must be avoided. To obtain the correct working point the transistor requires an emitter bias current of 2 mA approx. which is obtained from a 3-volt supply through a suitable resistance. Part of the bass cut is achieved by using a small value of capacitance to decouple this. If all the required bass cut had already been obtained elsewhere, say in the coupling transformer, any convenient value of voltage and resistance which would give the correct current would be permissible. It is, of course, necessary when dealing with transistors always to think of bias in terms of current.

Resistance in the base circuit of a transistor will provide automatic bias and so avoid the necessity for a separate battery tap, but its use is not recommended. Whilst in the case of a thermionic valve automatic bias tends to compensate for characteristic changes and power supply fluctuations, with a transistor this type of circuit exaggerates the effects of such variations, and in some cases may produce trigger effects or relaxation oscillations. This is because there is no phase reversal between emitter and collector and

Receiver

Simple Circuit for Local Station Reception

By
B. R. BETTRIDGE,*
A.M.Brit.I.R.E.



With a 3½-in loudspeaker a very compact receiver can be built using two transistors.

the resistance in the base therefore gives positive feedback, the d.c. component of which remains even after the a.f. is shunted by a large capacitor. The attractive possibility of increasing a.f. gain by a deliberately unbypassed base resistor does not appear to be realizable in practice because of difficulty with stability, but further exploration might be rewarding.

Undoubtedly in some areas this output stage could be fed from a simple crystal diode detector but in the author's locality this is not possible. Rather than use a second a.f. stage it was thought better to use a further transistor as detector, bearing in mind that this would enable reaction to be obtained.

A transistor with no emitter bias acts as a detector, since only positive excursions of the emitter influence the collector current. It is necessary, therefore, only to couple a tuned circuit to the emitter and to feed the resulting a.f. signal in the collector circuit to the next stage. There is no particular difficulty about this, but a somewhat different approach is required from that appropriate to valves.

Although we are used to valves with their high input impedance we ought not to be disturbed when we hear that a transistor has a value of about 200 ohms for this parameter, except perhaps to the extent of wishing it were lower still. The thermionic valve is a voltage-operated device and hence its high input impedance means that very little power is required to drive its grid. The transistor, on the other hand, is a current-operated device and thus, in order to operate with minimum power, it is desirable for its input impedance to be as low as possible. If the input impedance of a transistor were low enough the emitter could be connected in series with the elements of the tuned circuit so that all the circulating current would be available for driving it. With values met with in practice we cannot do this, and we arrange for a suitable proportion of the current to flow through the transistor to get the best compromise between efficiency and damping.

* General Electric Company (Osram Valve and Electronics Dept.).

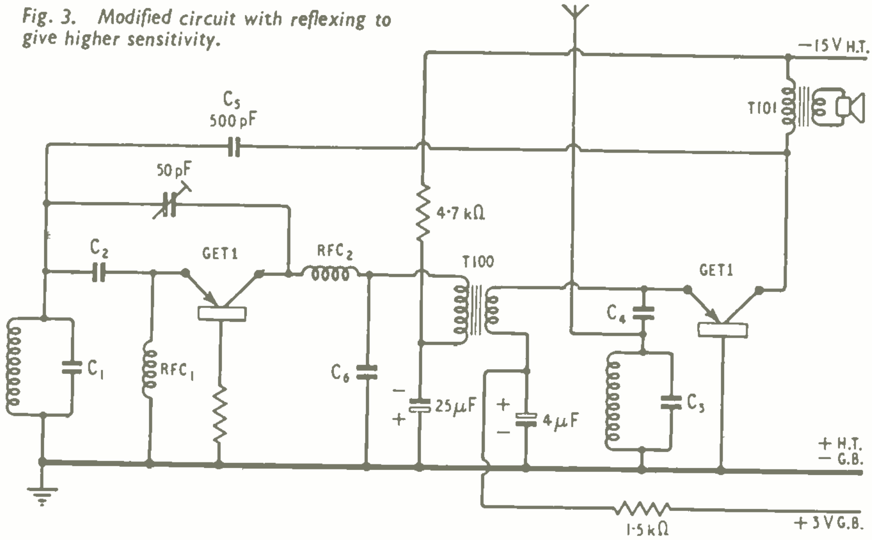
One obvious way of doing this, and quite an effective one, is to tap the inductor and this is the method used in Fig. 1. It will be found that a satisfactory tapping point is one-fifth from the earthy end. This tapping down does not sacrifice gain, as it would do in the case of a valve, because it increases the current driving the emitter and it must be remembered that couplings which give current step-up instead of voltage step-up are appropriate to transistor circuitry. Similarly the coupling between the collector of the detector and the output transistor is by a transformer having a turns step-down ratio of 5 : 1 which is better regarded in this connection as having a current step-up ratio of 1 : 5. The precise value of this ratio was not found to be critical, and variations between limits of one to three and one to seven made little audible difference.

The h.t. supply to the collector needs to be only about 10 volts for sufficient output to drive the next stage fully, so this enables decoupling to be incorporated. The introduction of reaction to improve gain and selectivity is delightfully easy and the trimmer between collector and tuned circuit is all that is required in view of the lack of phase reversal previously mentioned. This set is sensitive enough to operate at its full volume about 20 miles from a regional transmitter using a small outdoor aerial.

Frequency Limitations

A few remarks on transistor characteristics should be interposed here. Those at present available in this country have a nominal minimum cut-off frequency of about 250 kc/s (this is defined as the frequency at which the current gain has fallen by 3 db). Many operate up to 1 Mc/s, whilst some function at considerably higher frequencies. However, bearing in mind this possible limitation, experiments with reaction could well be tried first of all on the long-wave Light Programme rather than the medium-wave local station. Another point is that the current

Fig. 3. Modified circuit with reflexing to give higher sensitivity.



gain of a transistor does not reach a satisfactorily high value, nor does its input impedance fall to a satisfactory low value until a certain amount of emitter current is flowing, so that a little standing bias may be helpful in bringing the detector to its most sensitive point, and to a point, incidentally, where reaction effects are more readily obtained. A small amount of resistance in the base circuit will effect this, and a variable resistor of about 500 ohms should be used initially to determine the best value. The objections to auto bias mentioned previously hardly apply to this case, since the amount required is so small. Due to the resistance of the germanium crystal itself there is always unavoidable base resistance built into a transistor. This tends to vary somewhat from one specimen to another, hence the need to experiment with the amount to be added externally. It will be found that none at all is needed in some cases.

A more complicated circuit, based on the previous one, is shown in Fig. 3. This gives improved selectivity and higher sensitivity so that a "picture rail" aerial is adequate in the majority of cases. The two main points of difference are the avoidance of tapped inductors for matching, and the achievement of higher sensitivity by means of a reflex circuit. The method adopted to cover the first point has been described elsewhere[1] and consists of splitting the tuning capacitance into two parts, one being directly across the inductor and the other across the inductor in series with the emitter of the transistor, as illustrated by C_1 and C_2 in Fig. 3. By altering the relative sizes of the two capacitors any proportion of the circulating current can be caused to flow in the emitter circuit, which gives in effect an infinitely variable tap, and constitutes an extremely convenient circuit. A d.c. path for the emitter current must be provided and in the case of an amplifier this can consist of a resistor. With a detector, however, a rectified component would be developed across the resistance of such polarity as to cancel partially the a.f. signal already produced in the collector circuit, and in this case a radio-frequency choke must be used.

In the practical case of the aerial circuit in Fig. 3 an inductor requiring about 900 pF to tune it worked satisfactorily with 750 pF directly across it and the remaining 150 pF in series with the emitter. A low L/C ratio circuit was chosen deliberately and amongst other advantages allows the aerial to be connected directly to its live end, and eliminates the need for a further tap or coupling coil.

The reflex arrangement may require explanation to those not familiar with this type of circuit. The output transistor is required to amplify first at r.f. and then at a.f., and the aerial circuit is therefore coupled into its emitter by the split capacitor technique mentioned above. The presence of the secondary of the a.f. transformer is no embarrassment, and it provides the d.c. path for the necessary bias. Its r.f. impedance does not have to be particularly high, since that of the circuit at this point is about 200 ohms. The amplifier r.f. signal appears in the collector circuit and is developed across the primary of the output transformer, whence it is fed to the detector circuit via C_5. By using a low L/C ratio circuit here, damping due to doubtful r.f. properties of the output transformer primary is not serious. An r.f. choke could be included between collector and transformer to place this matter beyond doubt, but was never found to give any advantage with any components actually tried.

The matching to the detector emitter is effected by appropriate choice of C_1 and C_2 and RFC_1 provides the d.c. path for emitter current. The signal then reaches the output transistor for the second time *via* transformer T100, but only its a.f. component, the r.f. component being filtered by RFC_2 and C_6 to prevent any chance of it being fed back to the aerial circuit and causing instability.

Incidentally, omission of the tuned aerial circuit and connection of the aerial direct to the emitter of the output transistor gives a circuit arrangement the performance of which is midway between those shown in Fig. 1 and Fig. 3 and may be found worth while in certain cases.

Reflex arrangements are notoriously "temperamental," but the only trouble experienced when developing this circuit was a distressing form of overload due to an oscillation being momentarily triggered by loud signals. This was cured by the incorporation of the filter, RFC_2 and C_6, previously referred to in the detector collector circuit. Occasional overload on peaks, which is almost certain to occur when output power is so limited, is singularly free from unpleasantness, and the set seems superior in this respect to many receivers using in their output stages small battery pentodes which cannot be said to overload gracefully.

Anyone wishing to follow the author in these experiments should take special note of the following remarks, since transistors are still expensive and easily damaged.

A meter must be used in the collector circuit to guard against over-dissipation, and one in the emitter circuit is very desirable whilst setting up.

[1] "Transistorizing Communication Equipment," by G. S. Epstein, J. A. Bush and B. Shellhorn, *Electronics*, May, 1952, p. 98.

Resistors in emitter or collector circuits to act as limiters are a reasonable safety precaution in the initial stages, but their presence can upset circuit operation.

In the final circuit the detector has a collector limiter in the form of a decoupling resistance, whilst the amplifier, although it has no resistance in its collector circuit except the resistance of the output transformer, has the bias resistor in its emitter circuit.

An h.t. line negative with respect to earth takes some time to get used to, but accidental reversal of polarity can in some cases ruin a transistor and special precautions should be taken to prevent such an accident.

It should be realized that quite a small capacitor can store sufficient energy to fuse the point of a transistor whisker if it is given the opportunity.

A little common sense will be a safe guide, taking into account that emitter and collector can be regarded separately as diodes, and a diode will pass very large current when its whisker is made more than about one volt positive; but current is limited to quite a small value when the whisker is made negative provided that this value does not exceed 20 volts or so.

A concealed danger exists in the negative resistance characteristic resulting from a base resistance, since this can cause a trigger effect with very high currents flowing.

More h.t. voltage than necessary should not be used. Point contact transistors work efficiently from an h.t. supply of 15 volts, so that two 9-volt grid bias batteries in series will supply this in addition to the 3 volts required for the current bias.

Since this receiver is experimental no detailed constructional information will be given, but a few notes about components may be helpful. Because the receiver itself can be made very small, it seems logical to use the smallest loudspeaker available. It has to be remembered, however, that considerable sacrifice of sensitivity results from decreased speaker size, so that some compromise seems desirable. The set shown in the photographs uses a $3\frac{1}{2}$ in speaker and the volume is sufficient for a quiet room. Substitution of a really sensitive speaker such as the Goodman Axiom 102 enables programmes to be followed against considerable ambient noise.

It will be noted that the set in the photograph uses a very convenient technique which has been recently described.[2] This makes use of the fact that a wire or bolt held in pliers and heated with a soldering iron can be pushed straight into Perspex sheet and is anchored firmly on cooling. This is very much quicker than drilling a chassis and using anchoring tabs, and it enables a breadboard layout to be used with modern components.

No form of volume control comparable to that using variable-mu valves can be employed, but a variable resistance in the aerial is quite effective. The circuits shown are not suitable for variable tuning and if more than one station is required separate tuned circuits should be switched.

The coils used were made by Weymouth Radio Mfg. Company.

[2] "Fabricating Circuits on Plastic Breadboards," by J. H. Bigbee, *Electronics*, Sept., 1952, p. 126.

BOOKS RECEIVED

Thermionic Valves, by A. H. W. Beck, B.Sc.(Eng.), A.M.I.E.E. Theoretical account of the physical principles of thermionic vacuum devices with emphasis on micro-wave valves and a chapter on picture converters and storage tubes. Pp. 570+XVI, Figs. 210. Price 60s. Cambridge University Press, 200, Euston Road, London, N.W.1.

Nuclear Physics, by W. Heisenberg. Translation from the German of a series of lectures on the history, state of contemporary knowledge and practical applications (up to 1948). An appendix gives an account of activities in Germany during the war. Pp. 225; Figs. 40. Price 12s 6d. Methuen and Company, 36, Essex Street, London, W.C.2.

Radio Engineering, Vol. 1, by E. K. Sandeman, Ph.D., B.Sc., A.C.G.I., M.I.E.E. Second edition revised and extended to include transmission line filters, and some further information on the calculation of noise factor in receivers. Pp. 779; Figs. 275. Price 60s. Chapman and Hall, 37, Essex Street, London, W.C.2.

Relays, by R. C. Walker, B.Sc., A.M.I.Mech.E., A.M.I.E.E. Reference book on the principal features and potentialities of relays as switching devices for electronic and industrial control. Pp. 303; Figs. 187. Price 42s. Chapman and Hall, 37, Essex Street, London, W.C.2.

Microwave Lenses, by J. Brown, M.A. Monograph on the underlying principles and mathematical relationships in the design of aerial systems for the 1 to 50-cm range, including "artificial dielectrics." Pp. 125; Figs. 57. Price 8s 6d. Methuen and Company, 36, Essex Street, London, W.C.2.

The Practical Electrician's Pocket Book, 1954. Edited by Roy C. Norris. Comprehensive manual of electrical installation work. Pp. 552 with numerous figures and tables. Price 5s. Odhams Press, 6, Catherine Street, London, W.C.2.

The Home Constructor. Booklet of circuits and wiring plans for building crystal sets, t.r.f. and superhet receivers, feeder units and a 10-watt amplifier. Pp. 40, illustrated. Price 2s 6d. Supacoils, 21, Markhouse Road, London, E.17.

Data and Circuits of Television Receiving Valves, by J. Jager. Book IIIC of the Philips series of books on electronic valves, giving complete characteristics of relevant Philips valves and typical associated circuits. Pp. 216+XI; Figs. 226. Price 21s. Cleaver Hume Press, 31, Wrights Lane, Kensington, London, W.8.

Television Receiver Design Monograph, by P. A. Neeteson. An analysis of saw-toothed generators, flywheel synchronization and automatic phase control. Pp. 170; Figs. 120. Price 21s. Cleaver Hume Press, 42a, South Audley Street, London, W.1.

La Télévision en Couleurs, by L. Chrétien. Review of principles and description of alternative systems. Pp. 92; Figs. 56. Price 360 Fr. Editions Chirons, 40 Rue de Seine, Paris 6.

Les Cahiers de l'Agent Technique Radio III, by P. Hemardinquer, R. Asmen, J. Lignon and G. Giniaux. Characteristics, methods of testing and calculations relating to resistors, potentiometers and capacitors. Pp. 64; Figs. 78. Price 405 Fr. Editions Chirons, 40 Rue de Seine, Paris 6.

Stereophony in the Cinema

Recent Developments Using Multiple Magnetic Sound Tracks

By J. MOIR,* M.I.E.E.

TALKING films had their commercial introduction in 1927, the sound being recorded either on 17-in diameter wax discs rotating at 33 r.p.m., or photographically on a 84-mil (0.084in) wide track to one side of the picture space, and inside the sprocket holes. At the time of introduction there is little doubt that the "sound on disc" systems gave better sound quality, mainly due to the considerable background of experience previously obtained in producing ordinary gramophone records. This advantage was insufficient to offset the practical disadvantages of having sound and picture on different carriers, and by 1930 the photographically recorded sound track was almost universal, and has remained so until recent months. Photographic tracks are capable of a high standard of performance when the processing and printing conditions are carefully controlled, but this care does not always extend down to the copies that reach the local cinema, with results that are only too obvious to the patron.

The deficiencies of photographic tracks are not the subject of the present discussion, but it can be said that the frequency range, signal/noise ratio and amplitude distortion do not measure up to the standards achieved in v.h.f. broadcasting or magnetic recording. In spite of this adverse comment there is little doubt that further improvement in sound quality beyond the standard achieved in the better theatres would not in itself attract a larger audience. However, in the normal course of development, hastened perhaps by the competition of television, it has been decided that there is a public demand for larger pictures, and as this has necessitated some change in the sound equipment the opportunity of introducing magnetically recorded stereophonic sound has been taken.

But first of all a brief comment on the picture size. Until recent months a picture having an aspect ratio (width/height) of 4:3 has been the standard with a picture size around 24ft × 18ft, but about the beginning of this year the industry began to move towards larger screens having an area around 1,000 sq ft, and almost any aspect ratio between 1.5:1 and 2.6:1. This was achieved not by making any change in the film standards, but by using a shorter-focus projection lens to give a larger 4:3 picture on the screen and then masking this down at top and bottom to achieve the desired aspect ratio. Unless the mask size was reviewed for each new film, this change had the ludicrous effect of chopping off heads and feet that strayed towards top or bottom of the screen, but in spite of this there has been a marked swing towards the use of these "panoramic" screens.

It became inevitable that the major film-producing organizations would introduce a properly engineered

* British Thomson-Houston Company (Electronics Engineering Dept.).

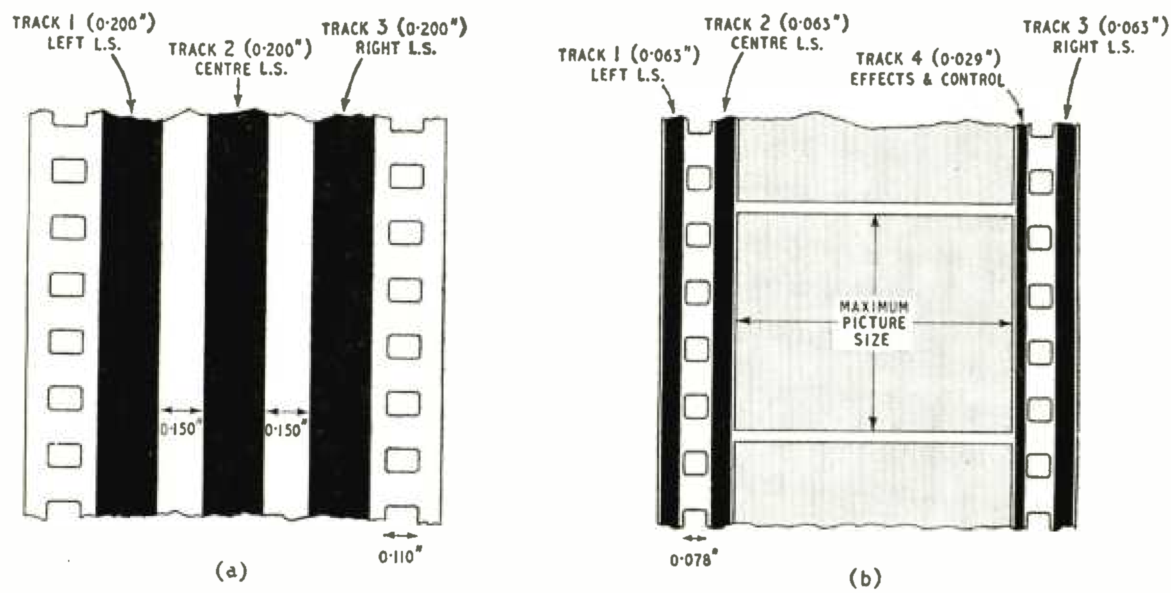


Fig. 1. Details of magnetic coatings on 35-mm film, (a) using separate film for the sound, and (b) in "CinemaScope" system with sound and picture on the same film.

wide screen, and the first of these, the 20th Century Fox "Cinema-Scope," has been recently introduced to London audiences for the showing of "The Robe" at the Odeon Theatre, Leicester Square. The screen used for the showing of this film has an aspect ratio of 2.55 : 1 and an area of nearly 1,000 sq ft.

Wide screens have their own particular problem for the sound system designer, for it would be ridiculous to have the visual image over on one side of a screen 50ft wide while the sound was obviously produced by a speaker system somewhere about the centre of the screen. This problem can be solved by the introduction of a stereophonic sound system requiring three sets of loudspeakers behind the screen, three amplifiers, three sound tracks, and on the recording stage three microphones and recorders.

The fundamentals of stereophonic sound systems have been dealt with in an earlier article[1] and need not be repeated, but it is worth remembering that the use of a three-channel stereophonic system enables the positions of the sound image and visual image to be brought into coincidence at any point on the screen width. A true stereophonic system enormously heightens the dramatic impact of the sound upon the audience for both speech and music.

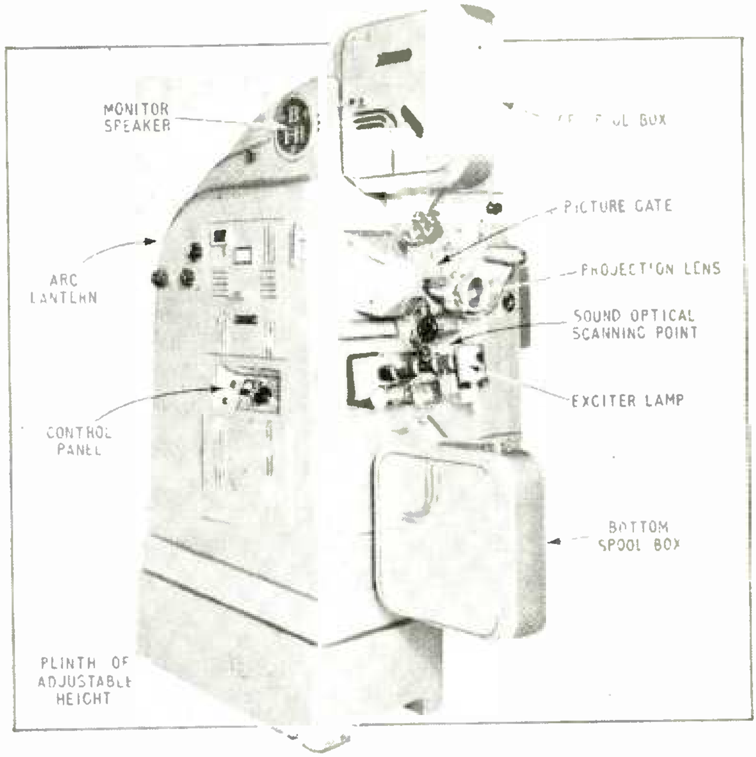


Fig. 2. Modern projector showing normal sound-scanning optical system below the picture projector.

The first full-length stereophonic film to be released was Walt Disney's "Fantasia," a film having the standard aspect ratio with stereo sound photographically recorded on four tracks on a separate sound film. The disadvantages of photographic recording were overcome to some extent by recording the three signal tracks at substantially full amplitude, using the fourth track to carry signals to control the gain of the main amplifiers.[2]

A true stereo system provides accurate location of the sound image across the width of the screen and in depth behind the screen, but there are situations where "effect noises" might be expected to have their origin to either side of or behind the audience. For this purpose it has become the practice to mount small loudspeakers on the rear and side walls of the auditorium, the operating signal being carried by a fourth sound track.

The recording engineer therefore has the problem of finding space on the film for four separate sound tracks, and as for other reasons the space devoted to the picture cannot be reduced the problem is one of considerable difficulty. No universally acceptable solution has yet appeared but two suggestions seem to be finding favour. In the first, Fig. 1 (a), as used by Warners for such films as "House of Wax," a separate 35-mm film is provided for the three stereophonic signals, magnetic recording on 200-mil wide tracks being employed. A separate sound reproducer machine is employed to run this film, the picture projector and sound reproducer being locked and synchronized by a Selsyn link. The sound signal for the auditorium speakers is carried by a standard type of photographic track on the picture film.

An alternative solution, favoured by 20th Century Fox, is illustrated in Fig. 1 (b). Three 63-mil wide tracks and one 29-mil magnetic track are located on the picture film in the space on either side of the sprocket holes which have been reduced in width from 0.110in to 0.078in. Films to this standard have been used for such films as "The Robe" and "How to Marry a Millionaire."

Both proposals merit careful consideration. The separate sound film has the potential advantage of providing better sound quality, but the disadvantage of requiring a second machine and an interlocking system, a disadvantage that is overcome when sound and picture are on one film. However, it cannot be denied that in the single film system the sound tracks located outside the sprocket holes are particularly vulnerable to damage in handling. Location of tracks in this position and the use of narrow sprocket holes are bold steps to take, and require the justification of experience.

A point of more immediate interest is that photographic recording has been abandoned in favour of magnetic recording in order that current standards of film sound quality should not only be maintained but improved upon, in spite of the small amount of space available for the tracks.

Magnetic sound recording has already virtually

[1] *Wireless World*, March, 1951, p. 84.
[2] *Wireless World*, Nov. 1941, p. 276.

supplanted photographic recording for all the original shots taken both on location and in the film studios, but the difficulty of adapting the many thousands of projectors installed in cinemas has delayed its adoption in cinemas. It is fairly obvious that there must be a transition period of several years during which films will be available with either method of recording, and the same projector will have to deal impartially with either magnetic or photographic tracks as the week's programme demands. To achieve this the magnetic reproducer head has had to be designed as an extra unit that could be added to existing picture projectors without disturbing the photographic track reproducer.

Existing industry standards require the sound accompanying a particular picture action to be located 19 frames ahead of that picture, this order of spatial separation being required for the mechanical filtering devices necessary to convert the intermittent motion of the film in the picture gate to the perfectly uniform motion necessary at the sound scanning point. As the film travels downward through the projector from a spool box above the mechanism to a similar storage magazine below the projector, the mechanical filters and optical scanning system (sound head) are located *below* the point at which the picture light beam passes through the film, as indicated in the photograph of a modern picture projector Fig. 2.

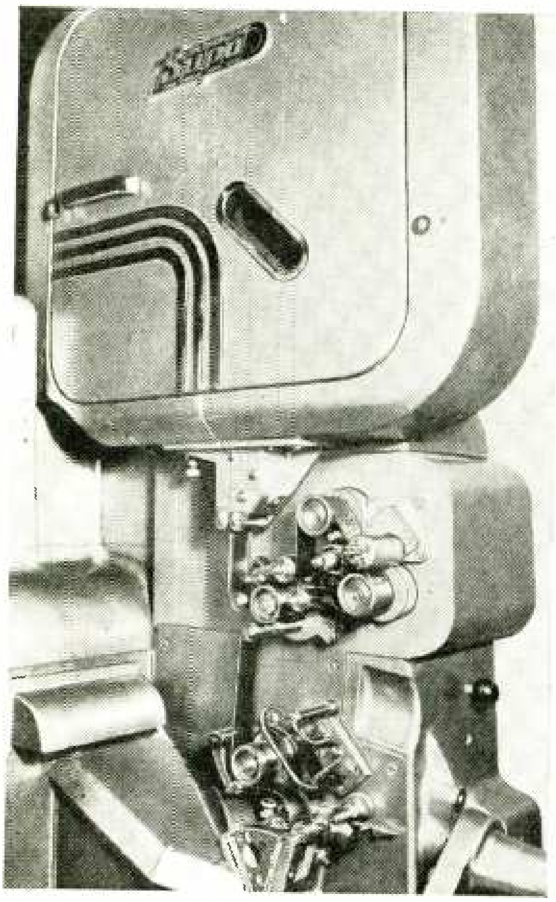


Fig. 3. Experimental "bolt-on" unit mounted above the picture projector for scanning multiple magnetic tracks.

Magnetic Pickup Head

Installation of a further sound reproducer head is facilitated by placing it *above* the picture gate at a point tentatively standardized at 28 picture frames behind the picture frame being projected. A typical "bolt on" magnetic reproducer head is shown in Fig. 3, the simplest form of head being installed by merely unbolting the top spool box and mounting the magnetic reproducer head in its place, the spool box being replaced on top of the reproducer head.

The magnetic reproducer head has not the same simplicity as the "tape decks" available to the public for use with 0.25-inch tape running at 7.5 inches per second, the added complexity resulting from the rather elaborate mechanical filters necessary to achieve uniform motion of the film at the sound scanning point. The film is moved intermittently through the picture gate during projection, light only passing through the film while it is stationary, the stationary period being followed by a very rapid "pull down" to the next picture frame while the light is cut off by a rotating "flicker" shutter. If tolerable values

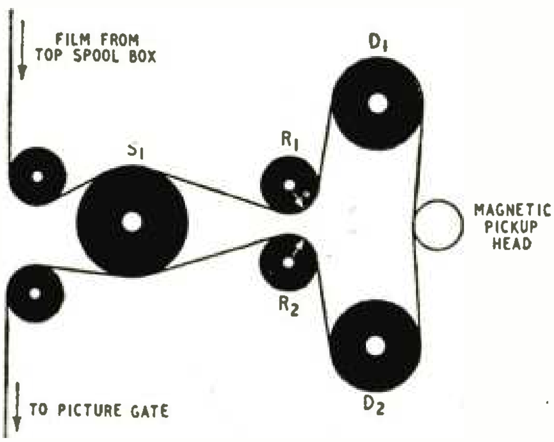


Fig. 4. Diagrammatic arrangement of mechanical filter for magnetic head.

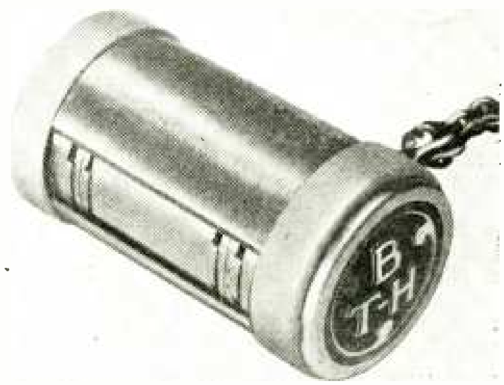


Fig. 5. Four separate pickups are accurately spaced and aligned in the magnetic head.

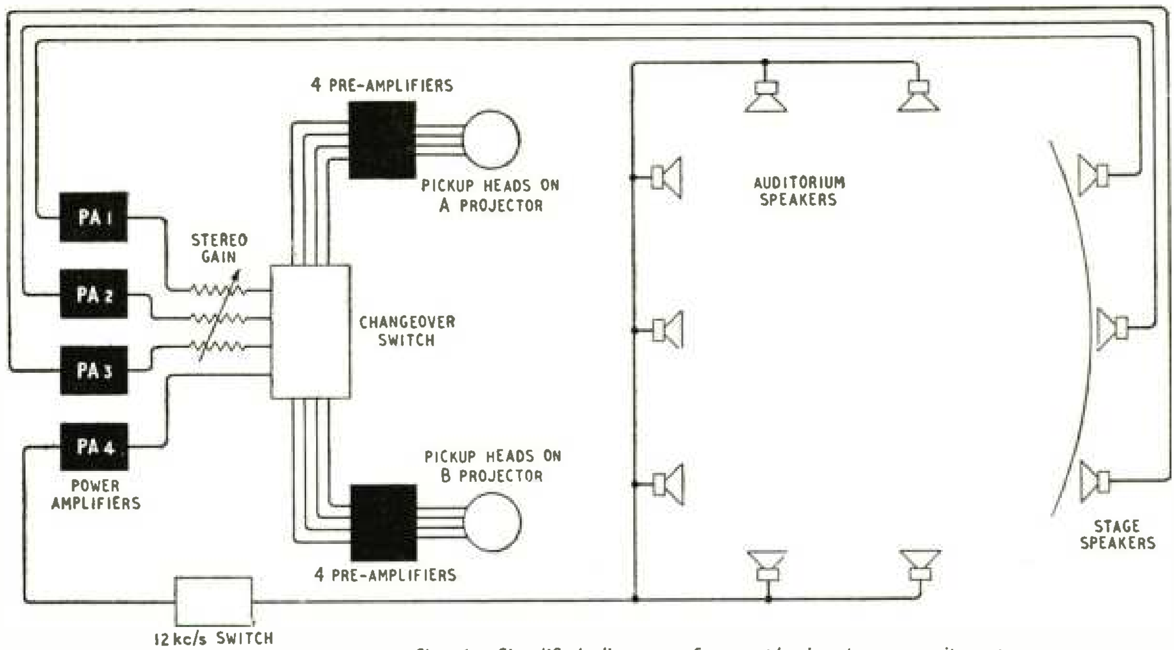


Fig. 6. Simplified diagram of stereophonic cinema equipment.

of "wow" and "flutter" are to be achieved this intermittent motion of the film must be completely smoothed out at the sound scanning point.

Elimination of all intermittent film motion is achieved by passing the film through the filter assembly shown in Figs. 3 and 4. Film from the top spool box passes over a sprocket S_1, over the first of a pair of light guide rollers R_1 spring-biased in the downward direction and then over a drum D_1 having a fairly heavy flywheel on its shaft and on to the picture gate by way of a second drum D_2 and light spring-biased guide roller R_2. Disturbances in the film motion orignating in the picture gate or top spool box are taken up by the movement of the light pivoted guide rollers R_1 and R_2, movement of the film over the actual magnetic pickups being stabilized by the flywheels on the drum shafts. The r.m.s. sum of all the "wow" and "flutter" components is less than 0.1 per cent.

The magnetic pickup group (Fig. 5) is an assembly of four separate toroids, jig assembled to ensure that none of the four scanning gaps deviates from the mean position by more than 0.0002in or has an angular misalignment greater than 10 minutes of arc. Maintenance of this high order of accuracy permits the head group to be adjusted in azimuth as a single unit.

The block schematic of Fig. 6 indicates the system circuit layout. Signals from the magnetic pickup heads on each machine are amplified by a group of four pre-amplifiers, which raise the signal level sufficiently to ensure a "clickless" changeover by the machine selector relay R_1 operated by a push-button on either machine. The same push-button simultaneously opens the light shutter on the incoming machine and closes the light shutter on the outgoing machine. The four signal outputs from the pre-amplifiers are further amplified by the power amplifiers PA1-4 to drive the three sets of stage loudspeakers behind the screen.

The output of the "effects track" power amplifier is used to drive a group of high-quality loudspeakers mounted on the rear and side walls in the auditorium. The "effects track" has a scanned width of only 25 mils, hardly sufficient to give adequate signal/noise ratio, a difficulty that is increased by the nearness of the actual speakers to the audience. Stray noise during silent periods is eliminated by an automatic switch which opens the speaker circuit, except during the time when "effects noises" are to be reproduced. This switch is actuated by the appearance of a 12-kc/s tone on the "effects track," the tone being recorded at a level 18 db below maximum modulation depth. The tone is separated from the "effects" noise spectrum by a two-stage filter, amplified, rectified and applied to a small relay having its contacts in the auditorium speaker circuit, the 12-kc/s tone being eliminated from the speaker circuit by an appropriate low-pass filter.

Sound film reproducing equipment has been getting more and more complicated with each successive design, a trend that is paralleled in almost every other field of engineering, but the introduction of stereophonic sound and auditorium speaker effects has resulted in a sharp increase in complexity, the amount of equipment required being almost four times that required for a straightforward monaural system. Justification for this complication must be in the results obtained, but the public's opinion is awaited with considerable confidence.

"TECHNICAL TRAINING"

TWO of the colleges listed in our note on Technical Training in the November issue have advised us of additional facilities provided by them. Bradford Technical College's curriculum includes, in addition to the courses quoted, Higher National Certificate courses with telecommunications and B.Sc. degree courses with electronics or telecommunications. Walsall Technical College also includes electronics in its H.N.C. course in electrical engineering.

Economy Battery Set

Straightforward Superhet Using the Latest Miniature Valves

By R. S. CHANNON,* B.Sc.(Eng.), Grad.I.E.E.

THE introduction of a new range of valves with 25-mA filaments has made possible the design of a battery receiver with very low l.t. consumption—actually 125 mA at 1.4 V. The circuit, which is quite conventional, gives a sensitivity of 100 µV at the signal grid of the frequency changer for 50 mW at the output. Three wavebands are covered—long waves in the frequency band 150-360 kc/s, medium waves in the band 530-1,530 kc/s and short waves in the band 6-18.7 Mc/s. The total h.t. consumption is 9.8 mA at 90 V.

For the oscillator section of the frequency changer, V_1, a conventional series-fed tuned-grid circuit is used. By using tightly-coupled coils of high Q it has been found possible to keep the variation of grid current within the recommended limits of 90 µA to 150 µA on both the long- and the medium-wave bands. On the short-wave band, however, the variation of grid current with the normal circuit arrangement is considerably greater (approximately 85 to 200 µA), and to avoid the consequent extensive changes in conversion conductance a booster circuit is used. This consists of a coil and a fixed capacitor of 68 pF, the combination resonating at approximately 4.8 Mc/s. This has the effect of increasing the drive at the lower frequency end of the waveband, thus permitting the coupling between the oscillator coils to be reduced. In this design a separate booster coil is used, but if necessary it can be wound on the same former as the oscillator windings.

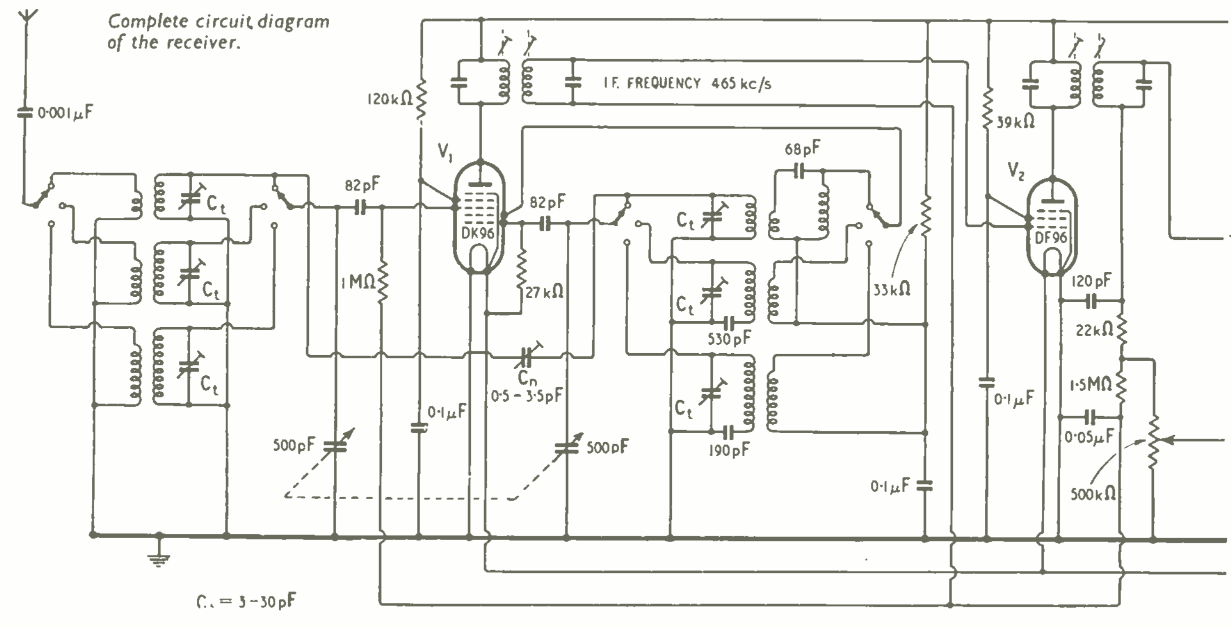
All the oscillator coils are wound on ½in diameter Paxolin former and fitted with Neosid 900 dust cores. The winding data is as follows.

Short-wave Coils.—The tuned winding consists of 9 turns of 18 s.w.g. tinned copper wire, open wound. Spacing between turns is 0.7 of the wire diameter. The feedback winding is 7¼ turns of 38 s.w.g. silk-covered enamelled copper wire, 4¼ turns being interwound with the earthy end of the tuned winding. For the booster coil, 40 turns of 36 s.w.g. enamelled copper wire are wave wound on a 6.5-mm former over a length of 3 mm.

Medium-wave Coils.—Here the tuned winding consists of 55 turns of 38 s.w.g silk-covered enamelled copper wire, wave wound over a length of 4.5 mm. For the feedback winding, 15 turns of 42 s.w.g. enamelled copper wire are close wound in a single layer on top of the tuned winding. The two windings are separated by a double layer of thin insulating paper.

Long-wave Coils.—For the tuned winding, 140 turns of 38 s.w.g. silk-covered enamelled copper wire are wave wound over a length of 5 mm. The feedback winding is 22 turns of 42 s.w.g. enamelled copper wire, close wound in one layer on top of the tuned

* Mullard, Ltd.



Complete circuit diagram of the receiver.

winding. Again the windings are separated by a double layer of thin insulating paper.

The aerial coils and i.f. transformers are all standard types. It is essential to use a good wave-change switch and care should be taken with the wiring around it. As for the aerial itself, a frame aerial is adequate for medium and long waves, but an outdoor aerial is recommended for short waves.

To avoid excessive pulling of the oscillator whilst trimming the aerial circuit, a variable neutralizing capacitor, C_n (0.5-3.5 pF Polar Type S50.01/1) is connected between the signal grid and oscillator grid. This should be adjusted until the oscillator voltage on the signal grid is a minimum. As the required neutralizing capacitance (approximately 2 pF) varies only slightly with the frequency, it is possible to neutralize at the upper trimming point, which for this receiver is 16.9 Mc/s, without adversely affecting the short-wave performance at 18.5 Mc/s. It is, of course, possible to use a fixed neutralizing capacitor, but the tolerances on these small capacitors are large, and there is a risk that if the capacitance is at the limit of the tolerance the peak pulling may increase from 10 kc/s to at least 35 kc/s, and this is liable to make trimming difficult.

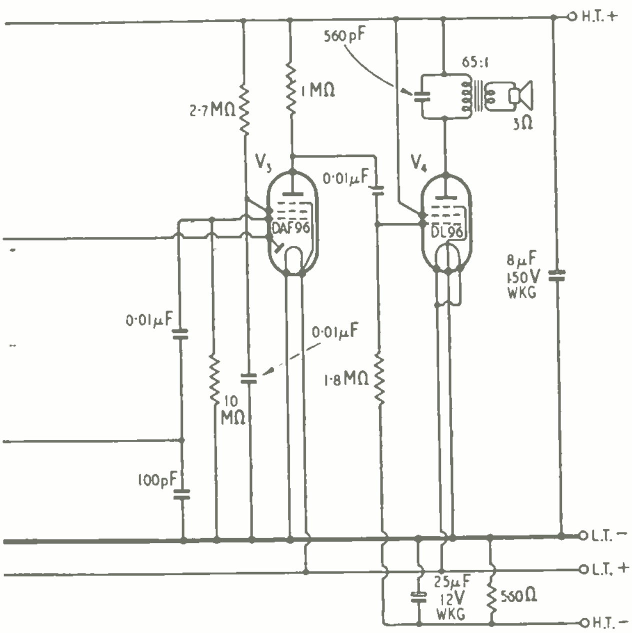
If a booster coil is not used, and the grid current is allowed to rise to 200 μA at the high-frequency end of the band, the peak pulling is reduced to 4 kc/s. However, the drift with a.g.c. bias is then greater and is sufficiently large to affect the tuning of the receiver, and in these circumstances it may be necessary to modify the switching so that the a.g.c. bias is not applied to V_1 on the short-wave band.

While the high-frequency effects improve with decreasing frequency, and are normally negligible below 10-12 Mc/s, it is necessary to earth the casing of the tuning capacitor between the two sections; otherwise the oscillator voltage on the signal grid is liable to increase from something less than 100 mV to approximately 250 mV at the low-frequency end of the short-wave band.

The operating voltages and currents of the four valves under normal conditions are given in the table below. In V_1 the accelerator grid g_1 should be at a voltage of 72 V and draw a current of 0.11 mA.

Valve	V_a	V_{g2}	I_a(mA)	I_{g2}(mA)	I_k(mA)
V_1	85	32	0.4	1.6	2.11
V_2	85	66	1.5	0.48	1.98
V_3	22	31	0.063	0.02	0.083
V_4	83	85	4.7	0.9	5.6

As a result of the early start of diode current in V_3 there will be a standing bias on V_1 and V_2, the mean value of which is approximately 0.5 V. This bias reduces the total cathode current of these two valves, and to allow for this the resistor in the h.t. negative line, which produces a bias for the output valve, has been specified as 560Ω. The bias for the output valve is then approximately −5.5 V, which, although slightly higher than the recommended value, results in only a slight decrease in the maximum power obtainable from the valve.



CLUB NEWS

Barnsley and District Amateur Radio Club recently celebrated its fortieth anniversary with a dinner to which representatives of a number of neighbouring clubs were invited. The president, G. Wigglesworth, a founder-member of the society, was in the chair. The club meets on the second and fourth Fridays of each month at 7.0 at the King George Hotel, Peel Street, Barnsley. Sec.: P. Carbutt (G2AFV), 33, Woodstock Road, Barnsley.

Brighton.—Under the title "A Novel T.R.F. Receiver," the Amos-Johnstone t.r.f. set detailed in our October and November, 1951, issues was described and demonstrated by Mr. Winyard at the meeting of the Brighton and District Radio Club (G3EVE) on December 8th. The club meets every Tuesday at 7.30 at the Eagle Inn, Gloucester Road, Brighton, 1. Sec.: R. T. Parsons, 14, Carlyle Avenue, Brighton.

Chester.—The new low-power transmitter of the Chester and District Amateur Radio Society (G3GIZ) is now being operated on 80 metres and in the top band. Meetings of the club are held in the Tarran Hut, Y.M.C.A., Chester, on Tuesdays at 7.30. On the first and third Tuesdays of each month lectures are given in preparation for the forthcoming Radio Amateur Examination. Sec.: N. Richardson, 23, St. Mary's Road, Dodleston, Nr. Chester.

Cleckheaton.—The January meetings of the Spen Valley and District Radio and Television Society, which meets on alternate Wednesdays at the Temperance Hall, Cleckheaton, include films lent by the G.P.O. (13th) and a visit to the Service Bureau of the Electric Lamp Manufacturers' Association in Leeds (27th). Sec.: N. Pride, 100, Raikes Lane, Birstall, Nr. Leeds.

Coventry.—The transmitter of the Coventry Amateur Radio Society (G2ASF) has now been installed in the new headquarters at 9, Queen's Road, Coventry, where the club meets on alternate Mondays at 7.30. Sec.: K. G. Lines (G3FOH), 142, Shorncliffe Road, Coventry.

Wellingborough.—Meetings of the Wellingborough and District Radio and Television Society are held on Thursdays at 7.30 at the C.W.S., Silver Street, Wellingborough. On January 21st, G. A. Wilford will give a lecture-demonstration on "Some V.H.F. Phenomena." Sec.: R. J. Henty, 6b, Silver Street, Wellingborough.

SIMPLIFIED TRI-COLOUR C. R. TUBE

THE possibility of mass-producing tri-colour c.r. tubes for colour television at a cost not very much greater than that of equivalent monochrome tubes has been opened up by an improved type of tube recently introduced in the U.S.A. Made by CBS-Hytron, a division of the Columbia Broadcasting System, it works on the same principle as the well-known RCA tri-colour tube,* that is, using a mask with perforations through which the three electron beams are directed on to their appropriate colour phosphors. The mask in the new tube, however, does not require heavy spacing rings to keep it stretched out flat in front of the phosphors: it is merely held in place, without stretching, by three suspension points at 120-deg intervals around its periphery. An important distinguishing feature of the mask is that it is curved rather than flat—the object being to reduce faulty registration of the electron beams with the phosphor dots at the outer edges of the picture.

Another saving in material is made by depositing the groups of phosphor dots not on a separate glass plate but directly on the inside surface of the tube face. This is done by a photo-engraving technique which is said to permit greater speed in production than the previous silk screen process.

According to *Tele-Tech* (in the November, 1953, issue of which the tube is described), the "Colortron," as it is called, gave excellent results "more than comparable with that noted on tubes of other manufacture" when it was tested on a closed circuit using colour slides as a signal source.

* *Wireless World*, October 1950, p. 367.

TELEVISION INTERFERENCE

AT intervals, discussions have taken place between representatives of the Post Office and the Radio Society of Great Britain on the question of interference from amateur stations with television receivers. The discussions have been with particular reference to cases where there is no appreciable harmonic radiation from the transmitter and the only emission is within the amateur bands.

Due to inadequate selectivity and "other undesirable features in the design" of some television receivers, signals from an amateur transmitter can cause interference due to (a) image response within the amateur band; (b) leakage into the i.f. amplifier where the pass-band of the amplifier embraces the amateur band, and (c) cross modulation and blocking in the early stages of the receiver. At the early meetings the Post Office took the view that the responsibility for causes, (b) and (c) must be borne by the amateur, and that he, therefore, had to close down during television transmitting hours until such time as the receiver was modified.

At a more recent meeting it was pointed out by the R.S.G.B. that despite representations to the industry some modern receivers have i.f. pass-bands which embrace amateur transmitting frequencies or suffer from cross modulation when in the vicinity of a transmitter. It was, therefore, suggested by the Society that where the trouble could be remedied by modifications to the receiver the amateur should not be held responsible.

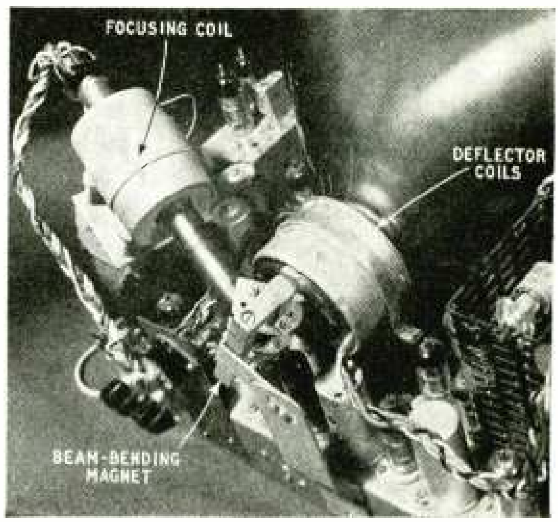
The Post Office has recently reviewed its policy on amateur interference with sound and vision reception and has decided to continue the present arrangement until the end of September, 1954, to enable manufacturers to introduce the necessary modifications in receiver design. After that date, the G.P.O. will continue to expect the amateur to suppress all harmonics outside his authorized bands, but once this has been done, if the wanted signal "is a good one" and the interference is due to choice of the i.f. for the complainant's receiver, or to the image response of his receiver, the G.P.O. will allow the amateur to continue operating after an interval of one month from the date on which the cause of the trouble is notified to the complainant by the Post Office.

The R.S.G.B. states that the Post Office does not feel justified in automatically applying the same arrangement where the interference is proved to be due to the close proximity of the amateur station to the complainant's receiver. In such cases the amateur will continue to be expected to prevent interference.

These new arrangements will be confined to areas in which the television signal is good. So far as fringe areas are concerned the Post Office wishes to make it clear that it will have to look to amateurs to cease any interference which their operations might cause in those areas.

FOLDED-UP C.R. TUBE

TELEVISION sets with large screens are obliged to have rather deep and unwieldy cabinets to accommodate the considerable length of their picture tubes. By bending the neck of the tube back on itself, however, and using a small permanent magnet to deflect the electron beam round the bend, it is possible to reduce the depth of the cabinet to less than the diagonal of the screen. This has been done as an experiment by the Philips research laboratories at Eindhoven, and they have built a 16-in receiver, which, with a width of 20in and a height of 14½in, has a depth of only 13¾in. In fact, it is no larger than a medium-sized sound broadcast receiver. As the bent part of the tube can be somewhat longer than that of an equivalent straight tube the focusing in this arrangement can be made correspondingly better than normal. Moreover, the focus coil (see picture) can be made long and narrow, and by bending the neck through an angle greater than 90 deg the thickness of the coil can be kept within the overall front-to-back length of the tube. It goes without saying, of course, that the bend in the neck and the beam-deflecting magnet together act as a very effective ion trap. J. L. H. Jonker describes the scheme more fully in the June, 1953, issue of the *Philips Technical Review*.



The American Television Scene

An Engineer's Impressions of Recent Happenings

By M. J. L. PULLING*

No one who is in any way directly concerned in television affairs could spend a month in the U.S.A. without being immensely stimulated. Infuriated he may be by some of the things he sees on the screen, but the ebullience, the vitality of the whole business of television in that astonishing land is highly infectious. The visiting engineer, in particular, is bound to find much to interest him. In the technical field so much is going on in so many places. And American engineers are generous—generous with their time, generous with their information and with their help.

All these are solidly based impressions, formed as a result of an immersion in the atmosphere of American television, radio and electronics generally, for a period of a month. Generalities are notoriously dangerous and any attempt to put on paper one's conclusions after so short a visit is bound to lead to a quota of such generalities, but the discriminating reader will know how much discount to apply to these.

First of all, then, for monochrome television, and there is plenty of it: in New York, from 6 a.m. till after midnight, there is usually a choice of seven programmes. The fact that the American picture standards are 525 lines with 30 complete pictures per second, giving a line-repetition rate of 15,750 per second as against ours of 10,125 per second, should lead to a more detailed picture with less flicker by contrast to ours. Personally I did not find the difference striking—certainly not unless I consciously thought about it. Possibly the fact that one is generally looking at larger screens than in England tends to offset the effect of the greater number of lines. For 21-in tubes are the current best sellers; 17-in tubes are still being sold but the trend in sales to the public is still upwards. Many people whose views command respect seem to think that with 21-in the upper limit of tube size for the "average" receiver has been reached. On the other hand, the same prediction was made about the 17-in tube and soon proved false. But perhaps the argument that the adoption of 24-in or larger tubes produces a receiver so large that it will not readily go through the doorways of an average home is a valid one. Certainly, I would not myself get very enthusiastic about a screen size much greater than 21-in.

Projection-type receivers appear to have vanished—and indeed it is difficult to see how they could effectively compete against receivers with 21-in direct-viewing screens costing around $250 to $300.

The quality of pictures seen in studio control rooms, at its best, is impressive, especially on important programmes, for which pick-up tubes would be specially selected. But there is a certain monotony in the type of picture produced, simply because no pick-up tube other than the Image Orthicon is used in any studio or in any outside broadcast equipment in the U.S.A. In this respect we have a marked advantage in this country with our variety of different types of pick-up tube.

The network of vision circuits which now covers the country has reached the fabulous figure of 40,000 circuit miles, and the switching of programmes between sources hundreds and even thousands of miles apart, on exact time cues, is carried out without any apparent trouble. The majority of these links are by radio, using centimetre or decimetre waves, with a bandwidth of 4.5 Mc/s, while coaxial cable circuits have a smaller bandwidth of 2.7 Mc/s. The quality of pictures received over the coast-to-coast radio link of 3,000 miles is remarkably good under normal conditions, though trouble is sometimes met with when atmospheric conditions cause deep fading on one or more sections. There is little doubt that the performance of the permanent vision links is of such a high order that distortion introduced by them would pass unnoticed on any but the highest class of receivers—it being noted, though, that the performance of the American receiver is, by and large, less good than that of a British receiver in the corresponding class.

The television industry is now rapidly readjusting its outlook to take in the colour scene. The remarkable success of the demonstration staged in New York on October 15th is now history. This demonstration was the climax of 18 months' work by the National Television System Committee. The Committee had said in effect "We have devised a truly compatible system of colour TV which is immediately applicable to existing v.h.f. and u.h.f. transmitters with only minor modifications and to existing vision links, provided proper colour cameras and equipment and colour receivers are used." And October 15th was the date set for a great "showing up of home work" to members of the Federal Communications Commission, the body which regulates all such matters in the U.S.A.

The American TV industry is evidently not superstitious, for 13 colour receivers—one from each of 13 different manufacturing firms—were on show. Pictures came from a studio, an outside broadcasting unit and a colour slide scanner during a demonstration which lasted about two hours. Even making allowance for the fact that the receiver tubes were all 12 in, and therefore small by monochrome standards, the subjective effect of the colour pictures was most pleasing on the majority of the receivers for the majority of the time. There were times when the colours were garish and there were receivers on which the tone rendering was poor, but these were rather the exceptions.

A comparison with colour films is natural enough and here it must be admitted at once that modern

* British Broadcasting Corporation.

colour films are definitely superior. But when one remembers the comparative crudity of early colour films, the present state of the art in colour television is not to be despised. Of course this was an important demonstration and of course there was an immense amount of very high-grade engineering effort and technical competence behind it. It was scarcely representative of the conditions which exist in normal day-to-day broadcasting. But, as against that, it would be hard to find a more highly critical audience or an occasion which, by its very importance, would be more likely to give rise to the sort of gremlins which visit all complex technical gear at times.

None the less, the whole performance went through without any evidence of significant technical blemish. For this achievement alone the American electronics industry and broadcasting companies deserve our respectful congratulations.

Each receiver was allowed one attendant, but it was noticeable that little manipulation of the controls seemed to be needed to keep the pictures in adjustment. At each end of the room there were monochrome receivers working off the colour signals. These gave results at least as good as would be expected from a monochrome signal. In parenthesis there would be good reason to expect the results on monochrome receivers to be satisfactory since these were probably hand-picked receivers and also because the camera pick-up tubes used for these tests were also, no doubt, very carefully selected.

For the greater part of the time the programme came from nearby sources, via normal monochrome broadcasting transmitters adapted for colour, direct to the receivers. But at one stage in the proceedings, we were shown the effect of switching first 540 miles of radio links and then 500 miles of coaxial cable into circuit by diverting the signals to Washington and back on each of two routes. The effect of the radio links was not noticeable at a normal viewing distance, but the cable introduced some loss of definition and showed some evidence of phase distortion.

There is a further aspect of the demonstration which calls for comment, namely the performance of the colour receivers on a monochrome input. In this respect, performance was more variable. On all receivers the pictures had a definite tint, and this tint, though constant on any one receiver, varied between receivers, and tended to be more marked round the edges than it was near the centre, due probably to slight errors in registration. It is difficult to say to what extent this effect could be tiresome in practice, or, to put it another way, how easily the eye would accustom itself to this condition. It is undoubtedly an important factor, since the average person who buys a colour receiver will trade in his monochrome receiver, and for a long time—perhaps always—a proportion of programmes will continue to be transmitted in monochrome.

The only noticeable omission from the programme was the transmission of film. This, however, was seen at a later date when a British 16-mm colour film was used as part of the programme on November 3rd, when R.C.A./N.B.C. demonstrated the transmission of colour pictures across the continent, the programme originating in New York and being viewed by an invited audience in the N.B.C. studios at Burbank, outside Los Angeles. The results obtained from the colour film, as seen at the sending end, were highly satisfactory.

The American television industry is fairly confident that the N.T.S.C. compatible colour standards will be approved by the F.C.C., probably by the end of the year or soon afterwards. If this happens, 1954 should see the start of serious colour broadcasting in the U.S.A. It will be slow at first, for both studio equipment and receivers will be available in only small quantities, but the end of the year might see about 2 hours a day in colour on the principal networks and perhaps 25,000 to 50,000 colour receivers with 12-in tubes in use.

Another aspect of television which has been attracting much attention recently is the attempt to record video signals on magnetic tape. A few years ago, when it was considered by sound-recording engineers as something of an achievement to record frequencies up to 15,000 c/s on magnetic tape, the very suggestion of recording a waveform which contained frequencies up to 3 or 4 Mc/s would have been dismissed as absurd. Yet the potential importance of a practical solution to this problem was felt to be so great that several firms tackled it. This importance arises from the useful attributes possessed by magnetic recording systems. First, that by comparison with systems of recording the image on photographic film, no processing (with attendant time delay) is required between recording and playback. Secondly, that it is possible to check the recording for quality while the recording operation is in progress. Thirdly, as soon as a particular recording is no longer needed, the tape can be magnetically wiped and used again. These attributes are significant enough in relation to the recording of monochrome pictures. They are far more significant when it comes to recording colour pictures, where the cost and complication of using colour film might well be prohibitive. R.C.A. announced on November 3rd that it had achieved magnetic tape recording of both monochrome and colour programmes. On December 1st the present state of the art was demonstrated at their laboratories at Princeton.

The demonstration appears to have been successful both in monochrome and in colour. When direct comparisons between the original picture and its recorded reproduction were possible, some degradation could be detected, but R.C.A. made it clear that they did not consider the system to be far enough advanced for commercial exploitation. They thought the present development programme would occupy a further two years. The width of the tape is ½ in and its speed is 30 ft per second, which gives a playing time of 4 minutes for a 17-in diameter spool.

Other firms are known to be working on this problem and it seems fairly certain that the system will have a profound influence on current practice in television recording and may well affect the motion-picture industry as well.

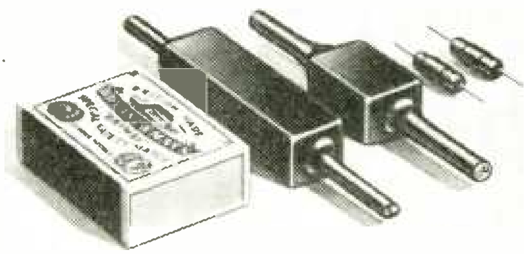
So far as television is concerned, it is worth noting that this system records and reproduces the electronic signal, or something closely approximating to it. Its principal application, therefore, is likely to be in respect of programmes to be reproduced in the country in which the recordings are made, or in another country using the same television standards. Recordings would not be suitable for reproduction in a country using different standards unless, in addition, some form of standards converter were used, with consequent additional distortion.

Some of these latter-day developments of the prolific electronics industry which has been built up in the U.S.A. are still just below the horizon so far as the experience of the average man goes. But I can, I am glad to say, report one innovation which, to quote the persuasive gentleman who suddenly appeared on my screen after 10 minutes of a one-act play, is "new, revolutionary, and in your dealer's window." He was trying to persuade me to buy the latest model of a well-known brand of television receiver which, it appeared, ". . . . embodied this unique device, the product of months of tireless research . . . etc., etc." With mounting excitement I listened to the catalogue of its virtues. What could it be? The suspense was intolerable . . . "call your dealer to-day and ask for a demonstration of the marvellous new XYZ . . . (pause for effect) . . . THE ELECTRONIC CLARIFIER."

Inductor Suppressors

Eliminating Television Interference From Electric Motors

By F. R. W. STRAFFORD,* M.I.E.E. and R. R. TEESDALE *



Inductor suppressors compared in size with a matchbox. On the left is a cut-lead type containing terminals and cable grips, in the middle is a smaller unit with leads moulded in, and on the right are two inductors for wiring directly inside an appliance.

AFTER motor-car ignition systems the most serious source of interference to television reception is the fractional horse-power commutator motors which are widely used in small domestic appliances, such as sewing machines, hair-dryers and vacuum cleaners. These are, in fact, responsible for about 50 per cent of the complaints received by the Post Office Radio Branch.

Most domestic appliances can be suppressed very effectively by fitting capacitors and inductors inside the machine frame. In most cases, however, the procedure is complicated because there is insufficient space in which to house the suppressor unless radical design changes are effected. Even then the services of a skilled technician are required if a workmanlike job is to be done which will be free from introducing shock hazards in the event of an unearthed appliance being used in "earthy" conditions. For these reasons, the possibilities of flex-lead suppressors have been investigated, and it has become apparent that two small inductors, mounted in the mains leads fairly close to an appliance, can, in a great majority of cases, be surprisingly effective.

Considering the two input terminals of the mains operated appliance, we may apply Thevenin's theorem, and regard the motor as an r.f. generator in series with its own impedance. In Fig. 1, the motor generates, at a given frequency, an open circuit interfering e.m.f. E_i. Here Z_g is the effective generator impedance and Z_m the mains impedance.

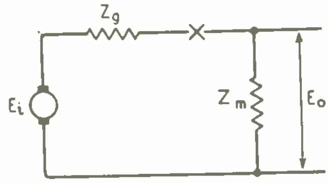


Fig. 1. Showing the interfering motor as an r.f. generator feeding into the mains.

* Belling and Lee, Ltd.

The e.m.f. passed into the mains, E_o, is given by :—

$$E_o = \frac{E_i Z_m}{Z_g + Z_m}$$

Suppressors usually comprise capacitors and inductors. One simple form consists of a low-impedance capacitor which is shunted across Z_m. Thus, if the capacitor impedance is Z_c, and is small compared with Z_m or Z_g, the output voltage becomes

$$E_{o1} \doteqdot \frac{E_i Z_c}{Z_g}$$

When a single high-impedance inductor is used it is inserted in series with Z_g at X. If the inductor impedance is Z_L and is much greater than Z_g or Z_m the output voltage becomes

$$E_{o2} \doteqdot \frac{E_i Z_m}{Z_L}$$

Obviously capacitors are efficient when used to suppress high-impedance machines, and inductors should be used with low-impedance machines. Most small motors possess a high impedance at low frequencies, which falls (often substantially linearly) as the frequency increases. For example, a typical two-wire hair-dryer showed an impedance of 13,000 ohms at 200 kc/s and 40 ohms at 60 Mc/s. These figures explain why capacitors are very suitable for suppression on sound broadcasting frequencies but suggest that they may fail at higher frequencies. Experiment confirms that capacitors alone are seldom effective as v.h.f. flex lead suppressors, excepting the special bushing types where large values of capacitance may be achieved without inductive losses.

There is another reason for the failure of capacitors

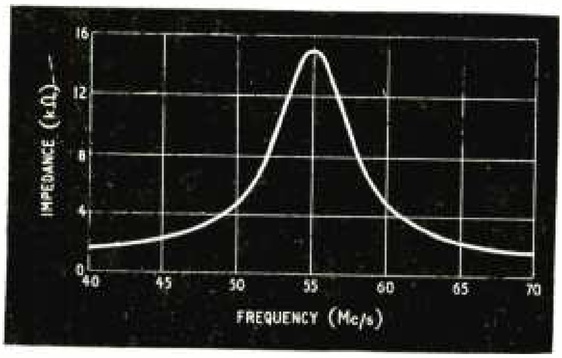


Fig. 2. Impedance characteristic of inductor suppressors over the television frequency band.

at v.h.f. when used in this particular manner. A suitable capacitor behaves as a short-circuit across the mains leads, so that the short length of cable between the appliance and the capacitor behaves as a loop energized from a low-impedance source. Thus, a a heavy r.f. current flows in this section of the mains lead. Radiation and induction fields are then produced and these can by-pass the suppressor and re-energize the remainder of the mains wiring.

Inductors are far less affected by the by-passing action of stray fields since their high-impedance limits the magnitude of r.f. current flowing in the section of the mains lead close to the appliance, and they separate the two sections of mains cable one from the other in the electrical sense.

The properties of an inductor suppressor are best described by reference to its impedance characteristic over the range of frequencies involved. This is controlled by the self-capacitance of the coil which, by design, is made to resonate at the mid-band frequency or near to it; at this point the impedance is high and the suppression is greatest. Fig. 2 provides this information for the inductors described. For the purpose of assessing the degree of suppression likely to be introduced it is convenient to regard the mains lead to the appliance as an r.f. feeder with an approximate characteristic impedance of 150 ohms. By dividing this value into the impedance of the inductor the ratio expressed in decibels gives a fair approximation of the degree of suppression introduced. The formula is:

$$N_{db} = 20 \log_{10} \frac{\text{Impedance of inductor}}{150}$$

If this is used in conjunction with the graph (Fig. 2) it will be seen that the suppression is in excess of 20db over the present five television channels and rises to about 40db at the mid-band frequency.

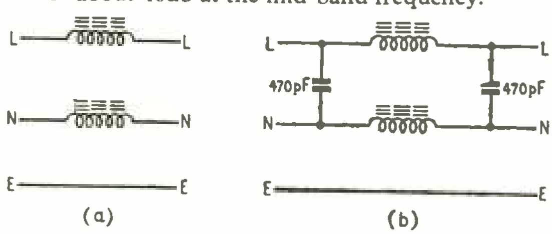


Fig. 3. Two types of suppressor tested, (a) inductor suppressor, (b) twin π suppressor.

Subjective tests which have been carried out in conjunction with laboratory experiments have confirmed that inductors should behave as efficient flex-lead suppressors. The tests were done on six typical domestic appliances which were chosen from a larger number and were known to produce severe television interference. Two suppressor circuits were tested as shown at (a) and (b) in Fig. 3. The inductors were single-layer solenoids wound on dust iron cores. They had an inductance of 8-9μH, a self-capacitance of about 1 pF, and were self-resonant at 55 Mc/s.

Five observers carried out tests at their homes. In each case they were done at as many different mains outlet points as possible. The receiver was kept in the same position throughout and no adjustments were made to the contrast and brilliance controls once they had been set for best reception when interference was not present.

The interference levels were compared with, and without, the suppressor in circuit in accordance with the following nine-division code.

(1) Picture obliterated—impossible to identify it.
(2) Picture identifiable but of no entertainment value.
(3) Very heavy interference.
(4) Heavy interference.
(5) Moderate interference.
(6) Annoying, if interference present for long periods.
(7) Perceptible but hardly ever annoying.
(8) Just perceptible—does not attract attention.
(9) No observable interference.

The table gives the results of the tests in terms of these interference levels, the figures being rounded-off averages for each appliance. It will be noted that the suppressor using inductors only is the better of the two. The effect of connecting and disconnecting an earth lead, where such provision existed, has also been taken into account. In general the effect of earthing a 3-core appliance was to increase slightly the general level of observed interference.

It is a general rule that a flex-lead suppressor should be fitted as close as possible to the source of interference. The reason for this is that the stray fields which radiate from that part of the mains lead connecting the appliance to the suppressor increase rapidly in magnitude as the filter is moved away from the appliance. It will be apparent from earlier remarks that the efficiency of inductor suppressors is much less dependent upon their accurate positioning than that of capacitors. However, it is good practice to insert the suppressor within 6in of the appliance.

TABLE OF AVERAGE INTERFERENCE LEVELS

Appliance	π Suppressor		Inductors only	
	Unsuppressed	Suppressed	Unsuppressed	Suppressed
Hair dryer (2-core) ..	3	6	3—4	8—9
Hair dryer (3-core) ..	2	5	4	7
Sewing machine	6	8	6	8
Vacuum cleaner	5—6	8	6—7	9
Fan	5	8	3	8
A.C./D.C. motor	3	6—7	4—5	9

LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents

"*Wireless Fifty Years Ago*"

ARTHUR MORSE'S comments in your October, 1953, issue on Maurice Child's delightful article (*Wireless World*, August, 1953) about early spark wireless days, raises a point on which I would like to comment. Mr. Morse refers to "the importance of carborundum, which was the preferred detector in commercial practice until the advent of de Forest's triode." Quite true, but one should add that carborundum was also the preferred detector in commercial practice for many years after the advent of de Forest's triode in 1906. This preference continued until after 1912, when the invention of the reaction or regenerative circuit brought on the era of modern radio.

It is worthwhile keeping this period of history straight because there is an important lesson to be learned from it. For six long years, the secret of modern radio lay obscured by de Forest's erroneous explanation of how the triode operated; i.e., that positive or negative voltages applied to the grid produced alike a reduction in the current through the tube. This theory was accepted as the explanation of the detection process that was observed. It precluded the idea of amplification, a thought which might have occurred to someone if the grid voltage/plate current relationship had been correctly stated, and it had the result that for years no one made a serious study to find out how the "audion" really worked. The use of the triode in commercial practice was confined to that of detection, perhaps 50 per cent more effective than the crystal, a point of so little importance that not a tenth of one per cent of the stations in operation were fitted with it. Seven leading textbooks, published before 1914, comprising in all over 3,000 pages, devoted less than one page of aggregate space to the "audion"!

The lesson is clear—anyone of us with a volt meter and potential divider to apply known voltages to the grid of a triode, and a galvanometer to measure the changes in its plate current, could have started unravelling the "audion's" mysteries long before we did start—*had we not known too many things that were not so*. The present generation is learning the same lesson over again from the advent of the transitor We had the crystal for a longer period of time than we had the triode without suspecting its major use could be anything other than a detector; until the man appeared who questioned what everyone else "knew."

Where could we find better examples of the wisdom of those immortal words set down four centuries ago?

"There are more things in heaven and earth,
Horatio, than are dreamt of in your philosophy."
(*Hamlet*, Act I, Scene 5).

EDWIN H. ARMSTRONG.

Columbia University, New York, U.S.A.

Television Aerials

MY first perusal of F. R. W. Strafford's article (your November issue) filled me with alarm and despondency. I could imagine the public reaction to the suggestion of erection of Christmas-tree-like structures upon their property.

Consequently, I read the article again with a view to finding a glimmer of hope. The result was not any more comforting than the first time. It was whilst pondering over the possibility of improving matters by the use of half rhombics and tilted wire aerials, etc., that I realized that although the pictorial representations implied a striving after gain, the mathematical considerations of the article were concerned in losses. This raised a further question, i.e., "Are we becoming slaves to the decibel?"

It would certainly appear so at the moment as the following example will show:

Assuming a frequency of 50 M/cs, a signal strength of 100 microvolts per metre, with H-type aerial and cable of 4 db loss per 100 feet we obtain at the receiver a signal of 137 microvolts for 50 feet run of cable.

Now suppose we double the loss by using a less efficient aerial or cable of 8 db per 100 feet. We now get a signal at the receiver of 108 microvolts. Nowadays it is a relatively poor receiver which will not produce peak white for 100 microvolt input, particularly the "fringe" type.

Thus it will be observed that the "alarming" loss that 2 db is generally supposed to cause is neither here nor there with a modern receiver.

The conclusions to be drawn from this are obvious. Free ourselves from the domination of the decibel and aerial installations, both present and future, can be less cumbersome and less expensive.

Scarborough, Yorks. H. WILLAN CRITCHLEY.

The author of the original article writes:

Mr. Critchley has drawn certain conclusions from my article and flattered me to the extent of reading it twice, but I will not be diverted from my avowed intention not to enter the political field.

On the second and technical issue concerning decibel fetishism, I am on safer ground and hasten to assure Mr. Critchley that, in certain circumstances, 2 db is a very useful increment when applied to vision reception, and 1 db is not to be sneezed at, either!

If Mr. Critchley will adjust his receiver for maximum sensitivity and insert an *accurately* calibrated step-by-step attenuator in series with the input connection from his aerial feeder, and furthermore adjust the attentuator so that the picture is just tolerable (that is, does not slip synchronism), he will find that the introduction of a further 2 db attenuation will result in an unstable, useless picture.

Repeating the experiment at a somewhat higher signal level, but in the presence of thermal and Schrott noise, he will find that an increase of 2 db will markedly improve the picture quality.

If an *aerial* gain of 2 db is achieved by the addition of parasitic or driven elements, it is axiomatic that the directional response of the aerial will improve, so that, apart from the 2 db increase in signal, there is a reduction in the ambient noise, man-made and terrestrial, and consequent improvement in signal-to-noise ratio which, after all, is a basic criterion of any communication system.

F. R. W. STRAFFORD.

Recording and the Law

YOUR leading article in the December issue raises an interesting point about the illegal recording of broadcast music. If a person is taken to court for pirating a broadcast of, say, a classical symphony, it will presumably be necessary to establish where he got it from, since the copyright applies to the performance and not the music, which is automatically "out of copyright." This is going to be difficult, to say the least. If I take my tape recorder to a Cup Final and put on Beethoven's Seventh Symphony, I may be taken to hospital, but I am not likely to be taken to law, at least not with any satisfaction to the prosecution. It may be years since I made the recording: there have been hundreds of performances of it since. Who is to say whether I got it from the B.B.C., from a foreign station, from some records a friend brought from the U.S.A., or merely synthesized it from the outputs of a number of oscillators?

I imagine there must be many music lovers who, like myself, use a tape recorder to transpose the excellent

music which the B.B.C. regards as fit background for lunch and tea to the evening hours when it is more concerned with improving my musical outlook. I play it back to an audience consisting of other cases of arrested musical development, refugees from television, and anyone else who happens to be interested. I invite the B.B.C. to prosecute me. E. G. HARRISON.
Nottingham.

MANY thanks for your clear exposition (December issue) about home recording and the law.

One wonders by whom the B.B.C. and *Radio Times* had been "asked to remind listeners" in the lop-sided way that ignored the protection of freedom given by Parliament in the proviso to Section 1, Dramatic and Musical Performers Act, 1925? And will they publish a correction to maintain fairness of presentation about a freedom?

Authority has demonstrated it is rather addicted to that kind of thing. Here is an example.

Television showed the "War on Pirates." The detector van went out searching. Did they catch a "pirate"? No. They "caught" licensed viewers and under suasion of a Post Office warrant demanded production of licences. A fine example of the use of authority to do an unnecessary thing, when a glance at the register of licences would have sufficed.
Mansfield, Notts. A. H. COUPE.

Reflex Push-pull Receivers

In his article in the November number, G. J. Pope has overlooked the shunting effect of the input resistance of V_1 across R.

In the absence of V_1, the voltage across R is about equal to that between grid and cathode of V_2, since the output impedance of V_2 ($\simeq \frac{1}{g_m}$) is about equal to R. The cathode of V_1, however, also presents a resistance $\simeq \frac{1}{g_m}$ across R. (The value of $\frac{1}{g_m}$ is that obtained when the screen current is included.)

Thus the input voltage will divide in the ratio of two-thirds to V_2 to one-third of V_1 and R in parallel. To put it another way, the signal current flowing in V_2 will divide equally between V_1 and R. It is clear that the full output power will not be available.

This circuit does, however, ensure that V_1 is not likely to be over-driven; so that one source of distortion peculiar to reflex circuits is avoided.

To improve the balance of the push-pull pair, R should be made large compared with $\frac{1}{g_m}$, or replaced by a suitable choke, appropriate arrangements being made for grid bias.

Since the detector circuit is transformer-coupled from the anode of V_1, it may be returned to the cathodes of V_2 and V_1 instead of to chassis. In this case the feed-back effect of the push-pull coupling is avoided, and increased sensitivity will be obtained. The output will, however, have the distortion characteristics of a single-ended stage.

Incidentally, in view of the high modulation depths frequently used by the B.B.C., it would be better to make the diode load the volume control, replacing the existing 2-MΩ one by a 1-MΩ fixed grid leak to reduce detector distortion.
Malvern, Worcs. G. F. JOHNSON.

Anode and Cathode

THE correctness or otherwise of the Oxford English Dictionary's definition of the anode of a cell depends upon how it defines an electric current and I have had no opportunity of verifying this. It is correct if the O.E.D. regards an electric current as a flow of electrons and disowns the regrettable "positive current." Should this indeed be so, Oxford is to be congratulated. One cannot, though, help feeling a little uneasy over such sponsoring of the electron current by the Home of Lost Causes.

As "Free Grid" implies (your December issue), this business of anodes and cathodes is apt to be rather confusing. Which pole is which depends upon whether one is referring to what goes on inside a generator or to what takes place in the circuit which it feeds. No bad way of obtaining a clear picture is to think of a diode rectifier as a generator of d.c., using the old (and possibly happier) names of filament and plate for its electrodes.

Inside the valve electrons flow from filament to plate: the former is here the cathode and the latter the anode. But in the external circuit the electron flow is from plate back to filament. The positions are now reversed, the plate being the cathode of the generator in the circuit—the departure point of electrons—and the filament, as their arrival point, the anode.

Replace the diode generator by a Leclanché cell. Matters are now a little more complicated, for, instead of a flow of electrons from the electrolyte to the can, there is a movement of positive zinc ions in the opposite direction. The result, however, is the same as if there were a flow of electrons to the can; and the can is the anode.

A further complication is that the cell is a two-part affair, the electrolyte being the cathode of Part 1. In Part 2, there is a similar flow of positive ions—hydrogen ions this time—to the manganese-dioxide element. Here, then, the electrolyte is the anode and the MnO_2 element the cathode. Since the two parts of the cell are effectively in series, its master cathode is the MnO_2 element and its master anode the zinc can. As in the case of the diode, the roles of these electrodes are reversed in the external circuit when the cell is under load.
Berkhamsted. R. W. HALLOWS.

Ignition Interference

I WAS interested in the opinion expressed by Malcom S. Morse of Rockville, U.S.A., in your October issue. This opinion called forth your Editorial article on page 445.

I believe that both Mr. Morse and your editorial miss the main point in discussing ignition interference to television, Mr. Morse believing that the interference is due to poorly designed British receivers, while your editorial suggests that the lack of ignition interference in America is due to the fact that the vehicles are effectively suppressed.

Surely one of the main reasons for bad ignition interference in Great Britain is due to the fact that, unlike America, the television transmissions are vertically polarized, and are in the main received on vertical antennas. The susceptibility of vertical antennas to reception of man-made and in particular, of ignition interference, is too well known to need any further elucidation. In the United States transmissions are horizontally polarized and horizontal antennas are not so prone to pick up this type of interference.

Secondly, it is a fact that the average British small car produces, for some undiscoverable reason, ten times as much interference as practically any American car. This point is well brought out in South Africa, where some 90 per cent of all cars in use are large American cars, practically all equipped with short- and medium-wave car radios, yet very few of the cars are equipped with anything except the most elementary form of suppression devices. On the other hand, any British car equipped with radio apparatus has to be lavishly equipped with every known suppression device.

In order to illustrate this, the writer's own vehicle, an

American car, is equipped with a receiver capable of covering 10-550 metres, with an average sensitivity of 1 mV. With this equipment it is possible to receive amateur and short-wave broadcasts of a low signal level even when travelling in normal suburban traffic, except when a small British car appears anywhere within 700-800 yards. In fact, over a period of time, I find it quite possible to state just what kind of British car is approaching me from the rear, without looking in the rear-view mirror, merely by listening to the racket which it generates in the receiver.

My own car is equipped with a noise suppressor only on the vibrating-reed type voltage regulator.

T. A. DINEEN (ZS6TP).

South African Philips (Pty.), Ltd
Johannesburg, South Africa.

Technical Qualifications

I WAS most interested to read the letter appearing in your November, 1953, issue from Mr. P. B. Hayes. In the penultimate paragraph of this letter Mr. Hayes states that the British Institution of Radio Engineers grants holders of the full Technological Certificate of the City and Guilds of London Institute complete exemption from the Technical and Mathematics sections of the Graduateship Examination.

This is not quite true. In actual fact, holders of the full Technological Certificate of the City and Guilds of London Institute in Telecommunications Engineering are exempted from all except Part I of the Graduateship Examination; that is, Physics.

London, W.C.1. A. J. KENWARD,
(Examinations Officer, Brit. I.R.E.)

IN a short time I shall be due for release from the forces after completing my National Service.

This year I obtained a full pass in the Radio Trades Examination Board examination and I felt that I would prefer a servicing post in industry rather than with a dealer.

In recent months I have had a number of interviews with large industrial concerns after applying for such posts, and have found without exception that the interviewer has never heard of the R.T.E.B. certificate. The most common method of selection I found was by extremely simple oral or written questions.

Since the R.T.E.B. is recognized by the British Institution of Radio Engineers and other important bodies, I think industry would do well to note the qualifications required for the R.T.E.B. certificate.

Street, Somerset. M. E. INGERFIELD.

AS a subscriber to *Wireless World* since 1927 and set back some distance from the British scene, I have followed through the medium of your publication the gradually increasing chaos in the radio engineering educational field in Great Britain, which must, in the long run, militate against the efficiency of the radio industry in your country.

There was a time when it seemed "Radio Engineer" would be a title of professional status similar to "Civil Engineer," etc., and that radio engineers would be acknowledged by the public as professional men and part of the engineering profession as a whole.

Such an outcome, instead of the present sorry state of affairs, would have rendered the profession attractive to a greater proportion of the best brains of the country and there would be less concern expressed about shortage of suitable material at I.E.E. and other meetings.

Viewed from this distance, there does not appear to be any justification for the increasing multitude of engineering qualifications and associations and the situation must confuse the public, the student and the industry. The I.E.E. has tried to introduce some semblance of order into this chaos by defining the province of the engineer, the technician and the craftsman, but your advertisers, for example, continue merrily to confuse the whole lot or reverse the roles, either out of ignorance or with a view to flattering their potential customers. Is there any hope that Great Britain will fall in line with the Commonwealth and most of the other English-speaking countries and use the title "engineer" in a consistent manner throughout the range of engineering endeavours?

The news writers are not hard pressed to find more glamorous titles for the professional engineer when he merits attention; all they have got to do is to pick at random from the confusion already created, a technologist, technician, boffin, technocrat, applied scientist, back-room boy, designer, research worker, radio executive, technical expert, inventor or whatever takes his fancy. They *would* be hard pressed, however, to pick out genuine professional engineering qualifications from amongst radio's growing alphabetic array. But does it matter much if students and employers are further befuddled—or could they be?

"ENGINEER ABROAD."

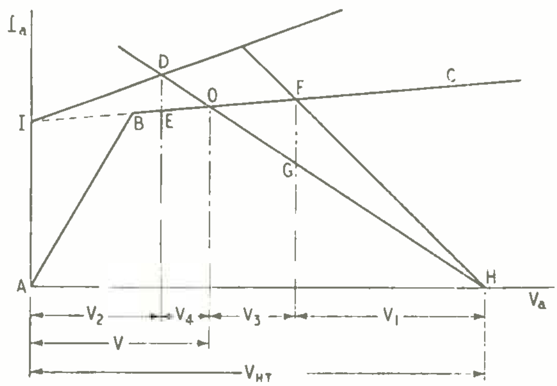
"Voltmeter Loading Again"

IN the October issue R. A. Wiersma stated in his article that the "one voltmeter three measurement" method cannot be applied to the case of non-ohmic resistance chains, and in particular cannot be used to measure the anode voltage of a pentode with resistive load. However, provided the voltage indicated by the meter when across the valve is higher than the "knee" voltage, the method is valid. This can be shown by considering the diagram.

ABC is an ideal pentode characteristic in which CB is assumed linear and is produced to cut the I_a axis at point I. From point H on the abscissa corresponding to h.t. voltage V_{HT}, load lines HD and HF are drawn. These correspond respectively to anode load R_L, and R_L shunted by meter resistance R_M. The line ID relates current and voltage when the meter is in parallel with the valve.

With R_L in series with the valve the working point is located at O and anode voltage is V.

When R_L is shunted by the meter the working point moves to F, the meter indicates V_1 and FG represents the meter current. When the meter shunts the valve the working point becomes D, the meter indicates V_2 and DE represents the meter current.



Triangles DOE and FOG are seen to be similar, so that

$$\frac{V_2}{V_1} = \frac{DE}{FG} = \frac{EO}{FO} = \frac{V_1}{V_3} = \frac{V - V_2}{V_{HT} - V_1 - V}$$

Hence

$$V_2V_{HT} - V_2V = V_1V$$

and

$$V = \frac{V_2V_{HT}}{V_1 + V_2}$$

Thus, so long as D, O, F lie above the "knee" point B, the formula will give a result whose accuracy depends only on the linearity of characteristic to the right of B.

With a valve biased by means of cathode resistance the method furnishes "anode to earth" volts since the relevant characteristic has the same shape as ABC.

Enfield, Middx. D. CHAPLIN

Home-Made Transistors

Inexpensive Conversion of Selected Germanium Diodes

By P. B. HELSDON, A.M.Brit.I.R.E.

IT is quite practicable to make point-contact transistors at home which compare quite well with those advertised by professional manufacturers. The electrical ratings and characteristics of the type 2N32 represent an attainable target for home-made units. The real difficulty is to make two units with reasonably similar characteristics. Consequently circuits must be tailored to suit the individual transistor if best results are to be obtained.

Even the best available point-contact units require careful handling, both electrically and mechanically; home-made transistors are no exception. If a bought unit dies, that's the end of it, but home-made units can be repaired by rotating the crystal to a new spot and re-forming. One unit has been resuscitated at least six times after circuit mishaps. It now has a current-gain "alpha" of 3 and a collector impedance of 50,000 ohms. Assuming an emitter impedance of 500 ohms, this represents an available power gain of 23.5 db. The alpha cut-off frequency is about 3 Mc/s.

The following materials are required to make one point-contact transistor:—

(a) 1 germanium diode (see below).
(b) 6in of 20 s.w.g. tinned copper wire.
(c) 1in of 36 s.w.g. phosphor-bronze wire.
(d) $\frac{1}{4}$in of $\frac{3}{8}$in diameter synthetic resin bonded paper (s.r.b.p.) rod.
(e) $\frac{1}{16}$in of $\frac{3}{8}$in diameter s.r.b.p. rod.
(f) $\frac{1}{2}$in of $\frac{3}{8}$in i.d. × $\frac{1}{2}$in o.d. s.r.b.p. tube.
(g) 9in insulated tinsel copper flex (hearing-aid cord).
(h) $\frac{1}{8}$in of 1 mm insulating sleeving.
(i) Bee's wax or impregnating wax.
(j) $\frac{3}{64}$ in × $\frac{1}{16}$in × 0.001in mica sheet.
(k) 8 B.A. brass grub screw $\frac{1}{8}$in long.

The tools required are those used generally for light instrument work. In addition, a pocket microscope of magnification 20 to 30 times is essential.

A simple ohmmeter in conjunction with a torch battery ($4\frac{1}{2}$ volts) and a 4.7 kΩ resistor is all the test equipment necessary. The ohmmeter should have an internal 9-volt battery and a half-scale reading of about 5,000 ohms. A Model 7 "Avometer" on the 1-megohm range is suitable. Assembly and forming jigs are described below.

The basis of the home-made transistor is a commercial high-reverse-voltage germanium diode. Diodes with a "turnover" voltage of 80 volts or more are usually necessary.

The basic physical phenomena which permits transistor action is "hole" storage. This is undesirable in diodes since it reduces the efficiency of rectification at high radio frequencies. Recently manufactured diodes appear to have been treated to minimize "hole" storage, consequently they make poor transistors. The best transistors are made from the glass-tube-enclosed type of diode made a year or two ago. The CG4-C and CG1-C with metal end caps and wire leads usually make good transistors. It is not necessary to use new diodes. Burnt out units are satisfactory as long as the crystal surface is unpitted and bright.

The first step is to clean the wax from the brass cap at the crystal (or red) end of the diode. The glass tube is gently broken and the cat's-whisker end of the diode discarded. Every precaution must be taken to avoid touching the face of the crystal since contamination from the fingers or tools may ruin it. The crystal is found soldered to a small brass mounting pin which is held in the brass cap by a set screw and a sealing compound. It is difficult to release the crystal by undoing the screw because the sealing compound holds it fast.

The crystal on its pin mount can be pushed out of the cap by means of a suitable jig and a vice. The jig consists of a metal plate at least $\frac{3}{8}$in thick containing a hole (No. 2 drill) larger than the diameter of the glass tube but too small to pass the brass cap, and the shank of an old twist drill about $\frac{1}{16}$in diameter. The cap containing the crystal is placed so that what remains of the glass tube is in the plate and the drill shank is then placed in the centre of the cap, behind the crystal. This assembly is squeezed in a vice until the crystal on its brass mount is ejected. The brass cap is discarded.

The crystal on its brass mount must be handled only by means of clean tweezers or small instrument pliers. Clean the remains of the sealing compound from the brass pin by scraping with a suitable tool. With a Morse No. 62 drill make a hole centrally in the base of the pin to a depth of $\frac{1}{16}$in. Cut a 1in length of the 20 s.w.g. copper wire and quickly solder it into the hole. This is best done with the wire held vertically in the vice. Only "radio" 60/40 resin-cored solder of low melting point should be used, as acid fumes or excessive heat would spoil the crystal. Test the joint for strength. Slip a $\frac{1}{8}$in length of the 1 mm sleeving up to the joint. Solder 3in of the tinsel flex to the end of the wire, using a heat shunt if necessary to protect the crystal. If the crystal should have been contaminated by dust or soldering smoke it may be possible to clean it on a silicone-impregnated lens tissue.

The collector and emitter contact points are made from flattened 36 s.w.g. phosphor-bronze wire. Cut the wire to two $\frac{3}{8}$in lengths. Straighten if necessary. Flatten the wires by hammering between two hard smooth steel blocks. The flattened wires should be about 0.002in thick. The points are ground with a hand-held carborundum stone.

The stone should be fine, clean and preferably new. Grind one end of each wire to an equilateral V-shaped point. Only a few light strokes are required. Examine the points under the microscope to see that they are clean and sharp. The radius at the tip should be less than 0.0005in and the angle of the V about 60 degrees. The points should be as alike as possible. Do not touch with the fingers.

The body of the unit consists of a ¼-in length of the ⅜-in diameter s.r.b.p. rod. The central hole in the body is drilled No. 44 or 45 to give a sliding fit for the crystal mounting pin. A radial hole is drilled and tapped 8 B.A. to meet the central hole about 3/32 in from the top face. Two holes symmetrical to the tapped hole are drilled No. 64, one on each side of, and parallel to, the central hole at a radius of 7/64 in. These holes must be a tight fit for the 20 s.w.g. copper wire. A ⅛in long brass grub screw is fitted to the tapped hole.

Cut the 20 s.w.g. copper wire to two 2-in lengths and clench each piece about ½in from one end firmly in a pair of point-nosed pliers. The deformation of the wires ensures the necessary very tight fit in the body. Draw the wires into their holes in the body, with the short ends at the top, until they are immovable. The short ends are then bent through a right-angle in opposite directions tangentially and parallel to each other. The bends should be ⅛in from the top face of the body. The bent ends are then cut to be within the projected circumference of the body. With a fine file make flats on top of the bent wires. These flats should be in one plane and parallel to the body face. Tin the flats with a soldering iron and remove excess resin. Cut the ends of the wires projecting below the body to a length of ¾in. Solder to each a 3in length of the tinsel flex.

A cap for the transistor is made from s.r.b.p. tube ⅜in inside diameter, ½in outside diameter and ½in long. A 1/16in slice of the ⅜in diameter rod glued into the top of the cap completes it. The cap should be a light push fit on to the body.

Each cat's-whisker must be bent to make an angle of just over 90 deg. The distance between the point and the bend should be 1/32in less than the distance between the flats on the support wires and the top of the body. The angle to which the cat's-whiskers are bent is important. It should be as close to 90 deg as possible without actually being 90 deg or less.

The cat's-whiskers are soldered in place on the support wires by means of a simple jig. This jig consists of a brass 8 B.A. screw 1½in long, eased down if necessary to be a sliding fit in the central hole. The end of the screw is drilled centrally with a hole 1/64in in diameter and 1/16in deep. The jig is placed in the central hole to project 1/32in above the top face of the body. Tighten the grub screw in the side of the body to hold the jig in place. The head of the jig screw projecting below the body can be held in a vice during the following soldering operation.

With tweezers lay one of the cat's-whiskers on a support wire so that the V-shaped point rests in the 1/64 in hole in the jig. Balance the whisker if necessary by cutting the unpointed end with a pair of scissors. The jig must be set so that the unpointed part of the whisker is parallel to the top face of the body. Solder by placing the iron for a few seconds in contact with the support wire a little distance away from the whisker. The whisker will settle down a little during this operation. The joint must be a strong one since it will be stressed after assembly. There must be no solder on the parts of the whisker not in direct contact with the support wire. This is to maintain the necessary springiness of the whisker.

The second whisker is placed on the other support

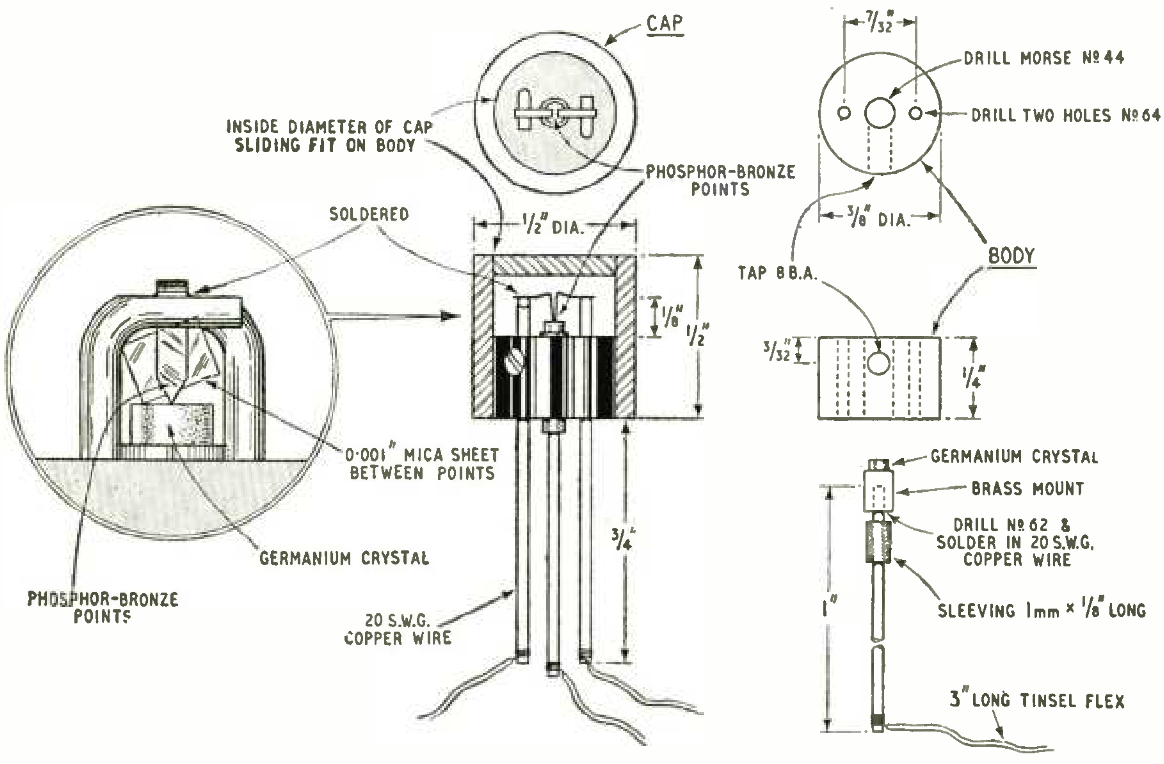


Fig. 1. Constructional details of home-made transistor.

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in line with the first whisker. The points should be in contact together in the $\frac{1}{64}$in hole. Solder as for the first whisker. Remove the jig from the body and cut the spare ends of the whiskers close to the support wires. Trim with a fine file any projections outside the circumference of the body.

The points examined under the microscope should be within about 0.002in of each other at the tips. The bends should be slightly farther apart. Looked at sideways the two Vs should appear coincident. If the points themselves are in contact it does not matter at this stage.

Cut a rectangle of 0.001in mica about $\frac{3}{64}$in × $\frac{1}{16}$in and carefully place it with tweezers between the whiskers. Friction will hold it in place. The mica should be positioned about 0.01in above the points.

The assembly of the crystal requires care. Insert the crystal on its mount into the central hole until the crystal comes into contact with the points. Increase the pressure until the top parts of the whiskers deflect about 0.01in. Tighten the grub screw. The insulated sleeving should also be inside the central hole as far as it will go. This is to give mechanical stability.

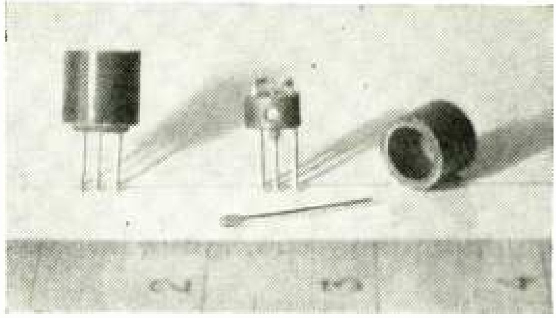
Examine the point spacing under the microscope. Any spacing between 0.0005in and 0.005in will make a transistor, but 0.002in is about optimum. If the points are found to be touching each other, release and partially withdraw the crystal and move the mica spacer down nearer the points. Readjust the crystal-point pressure as before. If the points skate about on the surface of the crystal it means that the angle at which the points meet the surface is incorrect. The angle must be as near normal as possible. Any latent instability of the points can be discovered by smartly tapping the body. The tapping procedure also helps to settle the points into the etched surface of the crystal. After tapping re-examine the point spacing. If satisfactory the cap should be fitted to protect the unit. Do not push the cap on too far or it will damage the points.

After forming and testing (described below) the unit is sealed by melting wax into the central hole and around the base of the cap. The wax must not penetrate as far as the crystal. The insulated sleeving helps to prevent this. The procedure is to place a small pellet of wax on the inverted unit and melt it quickly with a clean soldering iron. As soon as the wax melts, withdraw the iron.

All connections to the transistor must be made through the tinsel flex leads and not directly to the 20 s.w.g. wires. The reason is that the heat of soldering direct to the support wires would probably unsolder the internal joints. Also, if connection is made direct with crocodile clips, the shock of the spring-loaded clip slipping off is sufficient to break the cohesion developed at the points during forming.

The preliminary tests are to establish that a satisfactory double-diode exists. Check with the ohmmeter the resistance between the points, with the crystal lead (base connection) left floating. This is the unformed emitter-collector resistance and is usually about 1 megohm. A short-circuit requires readjustment of the points.

When the "Avometer" is used as an ohmmeter the normally positive (red) terminal has a negative potential. This will be described as the virtual negative terminal in the following text. With the virtual negative connected to the base, measure the resistance to each point. Each should be less than 1,000 ohms. Typical value is 500 ohms. Repeat with the virtual



Appearance of finished transistor, with and without sealing cap.

positive to the base. Each should be greater than 100,000 ohms. Typical value is 1 megohm. These readings should be fairly stable. If there is severe jitter the point pressure should be increased. The final forming process usually removes the last trace of jitter.

The next test is for transistor action. Connect the ohmmeter between one point and the base, with the virtual negative to this point (collector). Between the other point (emitter) and base, connect the 4½-volt battery in series with the 4,700-ohm resistor, making the emitter positive. The indicated collector-base resistance should fall about ten times, when the emitter bias is applied. Any observable drop in resistance is encouraging. If the drop is large, suspect an emitter-collector short-circuit. Repeat with the points interchanged. Choose the arrangement that gives the largest percentage drop in indicated resistance. Mark the collector wire with a spot of paint. If no transistor action can be detected, try a new spot on the crystal or change the crystal. Very few crystals tested by the author failed to give transistor action, and excellent results were obtained with about half of those tested.

The collector point must now be electrically formed to get the current gain (alpha) up to a useful value. The forming process also reduces the collector impedance. The increase in alpha, however, far outweighs the loss in collector impedance with successful forming. For example, forming can increase alpha from 0.1 to 2.5 while the collector impedance drops from 1 megohm to 25,000 ohms, giving an increase in power gain of nearly 16 times.

The theory of forming has been discussed by W. Shockley[3], J. Bardeen[1] and W. H. Brattain, W. G. Pfann[2,4], also by L. B. Valdes[5] and W. R. Sittner[6]. Methods of forming have been described by B. N. Slade[8] and R. W. Haegele[7]. The essence of these theories can be summarized as follows:—

The collector is formed by passing a short heavy pulse of current through it. The intense local heating changes the *n*-type germanium to *p*-type just under the point. In addition, thermal diffusion transfers some of the point material or surface impurities into this *p*-type area and changes an even smaller area in the immediate vicinity of the point back to *n*-type. The result is as if there were an *n-p-n* junction transistor with base input connection acting in cascade with the collector. The current gain is correspondingly high.

A theory that thermal traps are formed under the collector point also accounts for the very high alpha sometimes observed at low emitter currents. "Holes" caught in these traps form a positive space charge which attracts electrons from the collector. The average velocity of the electrons is much greater than that of the trapped "holes," consequently the current gain is that much greater. In practice the traps become saturated for emitter currents much above 50 μA. Consequently, the alpha falls to normal values of 2 or 3 at the more usual emitter current levels of 1 mA or so. In addition, this peak of alpha is very sensitive to temperature. This high alpha at low emitter current is not of much interest in transistors used as high-level amplifiers, but it is very important in the case of switching transistors. It greatly affects the triggering sensitivity in some switching circuits.

The purely thermal conversion to *p*-type material under the point can probably be provided by any short pulse, unidirectional or oscillatory; but better results are obtained when the collector is pulsed negatively, with suitable precautions to prevent the pulse becoming oscillatory. There is considerable scope for experiment in methods of forming.

A typical method of forming, given by B. N. Slade, is to discharge a capacitor of from 0.001 to 0.1 μF between the collector and base. The capacitor should have been previously charged to a voltage of from −75 to −300 volts. A charge/discharge switch is convenient. The emitter bias may be left connected, but the ohmmeter must be disconnected from the collector. Auxiliary contacts on the charge/discharge switch can do this.

Start pulsing at low voltage (80 volts) using the smallest capacitor. After each pulse measure the collector resistance (as before) with and without emitter bias. Increase the pulse in 20-volt steps and increase the capacitor at the end of each voltage cycle. Stop pulsing when the collector resistance, with emitter bias, has fallen to below 1,500 ohms, or when the collector resistance for zero bias has fallen below 10,000 ohms. A good transistor will be greater than 30,000 ohms for zero bias and less than 1,000 ohms with bias. When satisfactory results are obtained seal the unit with wax as described above.

More elaborate tests of the characteristics can be made point-by-point with suitable meters and current supplies.

The following tentative ratings are recommended for the home-made unit:—

Maximum collector voltage (d.c.)	−30 volts.
Maximum collector voltage (peak)	−80 volts.
Maximum collector current (d.c.)	−10 mA.
Maximum collector dissipation . .	50 mW.

These figures can, of course, be modified as experience is gained.

The application of the transistor in circuits requires care if a reasonable life is to be obtained. Inductive and capacitive surges are particularly to be avoided. Switching off a transistor circuit containing a transformer, for example, can easily produce an inductive kick which will "over-form" the collector, with disastrous results. In such circuits it is advisable to replace the usual on-off switch by a potentiometer plus switch, so that the current is slowly reduced to a low value before switching off. In circuits where the transistor is used to discharge a capacitor it is advisable to include a 1,000-ohm resistor in the collector lead to limit the peak current to a safe value. Oscillatory circuits which are liable to "squegg" are dangerous. For this reason one should not lightly attempt to obtain Class C operation by means of a C.R autobias network in the emitter circuit.

Home-made transistors have been applied to several different circuits, such as a saw-tooth generator, a sine-wave audio oscillator, an e.h.t. generator, a bistable multivibrator, a medium-wave straight receiver and an audio amplifier. The e.h.t. generator provides 860 volts d.c. for an input to the transistor oscillator of 2.2 mA at 16 volts. It forms part of a megohmmeter which measures up to 20,000 MΩ, and is contained in a box (complete with a hearing-aid type battery) measuring 6in × 4in × 3in.

The e.h.t. supply has also been used in conjunction with an image-convertor tube, and could be used to supply a small cathode-ray tube for oscillographic work.

The medium-wave receiver was, in fact, a crystal set (germanium diode) with one transistor stage of h.f. amplification, and used a loop aerial. A rough measurement of power gain gave a figure of 26 db. Part of this gain was due to positive feedback (reaction), but the circuit was quite as tame as any similar valve circuit. If one allows for the square law of the detector the effective gain was 52 db!

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[6] W. R. Sittner, "Current Multiplication in the Type-A Transistor," *Proc. I.R.E.*, Vol. 40, No. 4, p. 448; 1952.

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ESSAY COMPETITION

Scientific Research in Industry

PRIZES of £100 and £50 are being awarded for the best and second-best entries in an essay competition which is being run by the journal *Research*. The essay has to be about any recent scientific discovery and its applications in industry, or any item of industrial research work that the competitor thinks should be undertaken. Entries have to be about 3,500 words long and must be written without technical jargon so that they can be understood by a board of directors or management committee with no specialist knowledge. Competitors must be able to prove that they are engaged on scientific research, and their essays have to be sent in by 30th June, 1954.

In addition to the ordinary prizes, two special ones of £100 and £50 are to be awarded by the *Sunday Times* for entries which are suitable for publication in a general newspaper and which relate to one of the following subjects: applications of atomic energy; aerodynamics; conservation or utilization of fuel; electronics in business efficiency.

Further details can be obtained from the publishers of *Research*, Butterworths Scientific Publications, 88 Kingsway, London, W.C.2.

Band 4 Television Converter

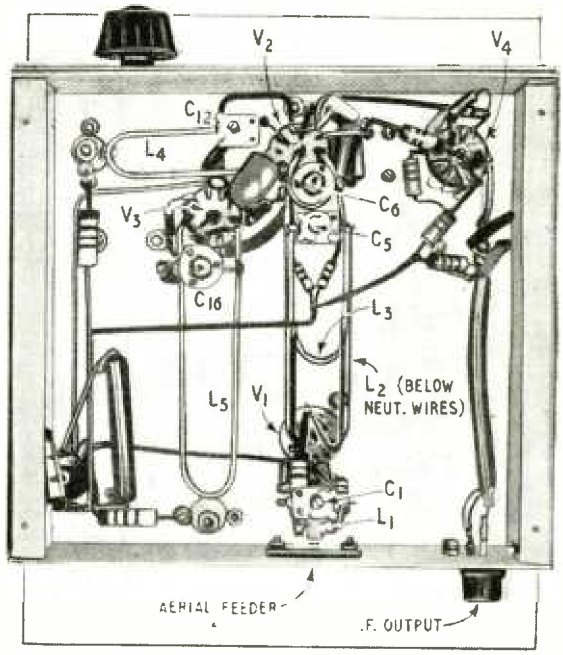
IN view of recent speculation on the use of Band 4 (470-585 Mc/s) for television, considerable interest has been focused on the experimental transmissions arranged by the Television Society. These will take place in the 70-cm amateur band with the vision on 427 Mc/s and the sound on 423.5 Mc/s.

If reasonable care is exercised a small converter using normal valves and established circuit technique can be employed at frequencies of this order. An example of this is a converter designed especially for receiving these experimental transmissions which was described by D. N. Corfield in the *Journal of the Television Society* for January-March, 1953. An orthodox power unit is used giving 250 V, 75 mA h.t. and 6.3 V, 1.2 A l.t. The oscillator (V_3) h.t. supply is stabilized by a Brimar VR150/30 voltage stabilizer, or its equivalent, at 150 V.

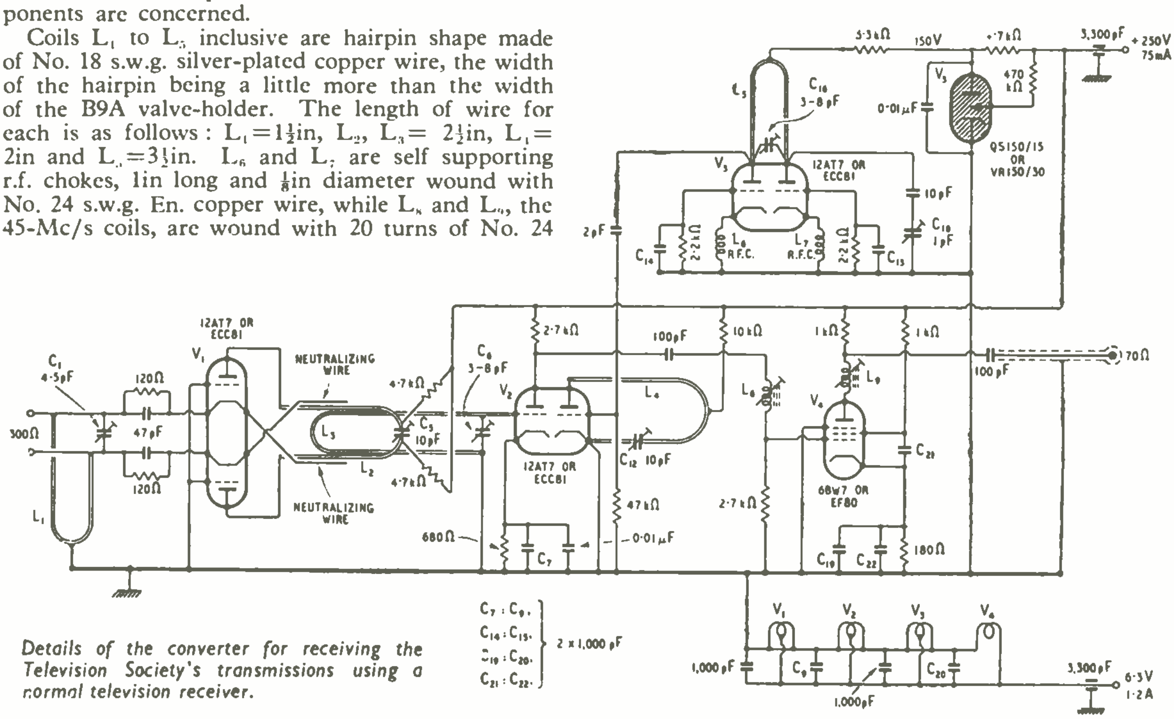
The converter is intended for use with a normal television receiver tuned to the London station (45 Mc/s). V_1 is a double triode (12AT7) employed as an earthed grid push-pull r.f. amplifier and is neutralized as shown. The left-hand section of V_2 (12AT7) is an anode-bend triode mixer and the right-hand section a frequency-doubler for the variable oscillator V_3 (12AT7) operating on 190 Mc/s. The internal coupling in V_2 suffices for mixing purposes, no other coupling being needed.

V_4 is an i.f. amplifier at 45 Mc/s using a 6BW7 or EF80 valve. Its grid and anode circuits are a little unusual but quite orthodox in so far as components are concerned.

Coils L_1 to L_5 inclusive are hairpin shape made of No. 18 s.w.g. silver-plated copper wire, the width of the hairpin being a little more than the width of the B9A valve-holder. The length of wire for each is as follows: $L_1 = 1\frac{1}{2}$in, L_2, $L_3 = 2\frac{1}{2}$in, $L_4 =$ 2in and $L_5 = 3\frac{1}{2}$in. L_6 and L_7 are self supporting r.f. chokes, 1in long and $\frac{1}{8}$in diameter wound with No. 24 s.w.g. En. copper wire, while L_8 and L_9, the 45-Mc/s coils, are wound with 20 turns of No. 24 s.w.g. En. copper wire on Aladdin No. PP5938 formers with dust cores and enclosed in Dale Type D/TV2 aluminium cans. It is essential that the receiver used with this converter does not pick up an unreasonable amount of 45-Mc/s signal with its aerial disconnected.



Underside of the converter showing layout of the parts. The principal components can be identified by the aid of the circuit references.



Details of the converter for receiving the Television Society's transmissions using a normal television receiver.

WORLD OF WIRELESS

Ionospheric Cross-modulation • Television Show • Mobile Radio Users • Amateur Emergency Network

"Luxembourg Effect" Again

LITTLE has been heard of the Luxembourg Effect* for some years, probably because of the general increase of power of medium-wave stations and of the tendency of listeners to avoid medium-wave reception by indirect-ray, since very few transmissions can now be received with anything approaching "programme-value" beyond the ground-ray range. However, since a very high-power transmitter radiating the "Voice of America" programmes on 173 kc/s opened near Munich, reports have been received from many parts of Europe that its modulation has been heard superimposed on medium-wave programmes.

The European Broadcasting Union is investigating the reports as it is thought that they may throw some light on the subject of cross-modulation and the Union would welcome reports from *Wireless World* readers who may observe the effect. The factors which influence the phenomenon include the range and bearing of the desired and interfering stations from the receiving point. Correspondents should also state the date, time and place of the observation, the name and frequency of the desired station, and give as full a description as possible of the severity and nature of the cross-modulation. Reports should be addressed to the Centre Technique, Union Européenne de Radiodiffusion, 32, Avenue Albert-Lancaster, Bruxelles-Uccle, Belgium.

* The superimposition of the modulation of a long-wave station on that of a medium-wave transmitter when the path of the m.w. station passes through a region of the ionosphere disturbed by the l.w. transmissions.

Isle of Man TV

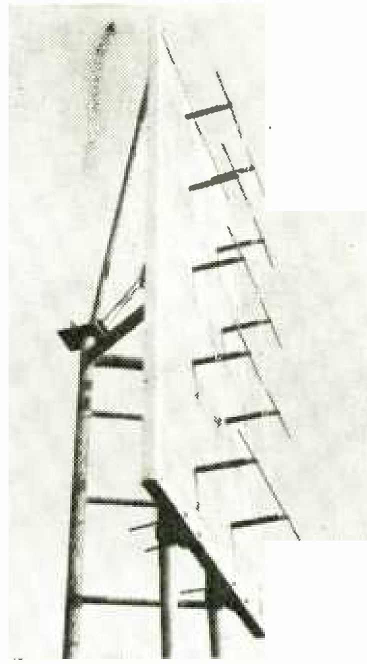
ANOTHER temporary low-power television station, installed near Douglas, Isle of Man, was brought into service by the B.B.C. on December 20th. Operating in Channel 5 (vision 66.75 Mc/s, sound 63.25 Mc/s), which it shares with Wenvoe and Pontop Pike, the transmitter employs the asymmetric side-band method of transmission with vertical polarization. The permanent station, for which a site has not yet been found, will operate on the same frequencies. The station will initially depend on the direct reception of Holme Moss for its programmes.

Radio Fuze Award

A TAX-FREE AWARD of £20,000 to Pye, Limited, for the development during the war of the proximity fuze and the No. 19 tank radio set has been made by the Government. The fuze, which was described in *Wireless World* of November, 1945, depended for its operation on an application of the Doppler effect. Radiation from a miniature transmitter, fitted inside an anti-aircraft shell, was reflected from the target and received back at a slightly different frequency. The beat note thus obtained was amplified and, on reaching a sufficient intensity, set off the fuze.

Television Show

NEARLY 40 EXHIBITORS are participating in the annual exhibition of the Television Society which opens at the Electrical Department of King's College, Strand, London, W.C.2, on January 7th. On the first day admission is restricted to members and the Press (6-9 p.m.). On subsequent days it will be open from 12 noon to 9.0 (8th) and 10.0-9.0 (9th) to holders of tickets obtainable from the Society at 164, Shaftesbury Avenue, W.C.2.



One of the two identical arrays for the Television Society's transmitter. Each array has 5 pairs of half-wave dipoles stacked in front of, and spaced a quarter wave length from, an expanded-metal reflector measuring 6ft 3ft.

In addition to the following organizations, some individual members of the Society will be exhibiting equipment. Avo, B.B.C., B.I.C.C., B.R.E.M.A., Belling & Lee, Bush, Balcombe, Sydney S. Bird, Cinema-Television, E. K. Cole, Central Equipment, Direct TV Replacements, Dubilier, E.M.I. Engineering, E.M.I. Institutes, Ediswan, Ferguson, Ferranti, G.E.C., A. H. Hunt, Hallam Sleigh & Cheston, Leland Instruments, Livingston Hogg, Mole Richardson, Mullard, Murphy, Nera, Norwood T.C., P.O. Research Station, S.T.C., 20th Century Electronics, T.C.C., Telequipment, Telcon, Wayne Kerr.

During the exhibition it is planned to start up the Society's 405-line experimental transmitter working on 427 Mc/s, which is installed at the Norwood Technical College. The sound and vision aerial arrays, designed by D. N. Corfield, have been made by Belling & Lee and presented to the Society for the transmitter.

Purchase Tax Concession

IT has been decided by the Customs and Excise Office that "pillow-phones"—used by hospital patients unable to wear the conventional headphones—will not be liable to purchase tax, even if they incorporate cone-type loudspeaker chassis.

It is pointed out that the matter will be reviewed if a market for domestic use develops.

Mobile Radio

WHEN announcing the formation of the Mobile Radio Users Association, Sir Robert Renwick said that its aims are briefly to represent those who operate mobile radio—the generic term for "business radio" and the like—who with the advent of competitive television are likely to be compelled to change their frequencies.

The Association contends that the present uncertainty of frequency allocation is hampering the development of mobile radio. It demands that mobile users be allowed to maintain their present position in Band 3 unless some satisfactory alternative can be offered; any user displaced should be compensated and, furthermore, security of tenure in the new channel should be guaranteed.

The technical adviser to the Association is J. R. Brinkley of Pye Telecommunications. The head office of the M.R.U.A. is at 199, Piccadilly, London, W.1, but the secretary, Ronald Simms, is at Buckingham Court, Buckingham Gate, London, S.W.1 (Tel.: Abbey 5763).

Emergency Communications

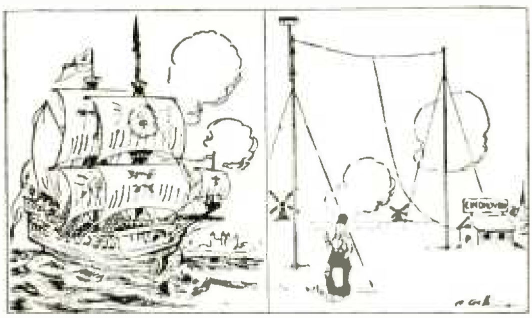
AN EMERGENCY SERVICE to provide communications in time of national disaster, such as the East Coast floods of last year, has been formed by the Radio Society of Great Britain. This Radio Amateur Emergency Network is open to all transmitting amateurs, who are asked to register their stations with the R.S.G.B. The Society envisages the formation of a nation-wide system of local networks operating in the 2-, 10- and 80-metre bands.

The new service will offer its facilities to such bodies as the Post Office, the Red Cross, W.V.S., hospital ambulance services, public utility undertakings, rescue services, the police and civil defence units. To maintain close liaison with these organizations a communications officer is to be appointed in all major cities and towns. The network will provide means of communication only when the normal Post Office telephone services are either out of commission or overloaded, and will feed its messages into the Post Office lines at the nearest suitable point.

Empire Broadcasting

WE ARE REMINDED by the celebrations of the 21st anniversary of the B.B.C. Overseas Service of the efforts made by *Wireless World* as far back as 1926 for the establishment of a short-wave overseas service and using this very title "Empire Broadcasting." It is interesting to recall that the idea was strongly criticized by Capt. P. P. Eckersley, then B.B.C. Chief Engineer, in a letter to *The Times*. He adopted the policy of "waiting for perfection" rather than introduce the experimental short-wave service for which we were pleading.

When the Dutch short-wave station PCJJ, at Eindhoven, was inaugurated early in 1927 (five years before the B.B.C. Empire station at Daventry started transmissions) we published the cartoon and caption reproduced below. Later that year experimental transmissions were started from the Marconi transmitter, G5SW, at Chelmsford.



"In 1652 Admiral Tromp, the courageous Dutch commander, defeated the British fleet under Admiral Blake at Dover, and, according to tradition, sailed up the Channel with a broom hoisted to his masthead to denote that he had 'swept the seas.' In 1927 the Dutch station of the Philips Company at Eindhoven 'sweeps the ether' on short waves and again scores off Britain, but this time in the friendliest spirit of rivalry."

PERSONALITIES

Norman C. Robertson, M.B.E., Assoc.I.E.E., M.Brit.I.R.E., has resumed his duties as deputy managing director of E. K. Cole, Ltd., having completed his two years' service with the Ministry of Supply as director-general of electronics production. While at the Ministry he was responsible for co-ordinating the production of electronic equipment for the defence programme. Mr. Robertson entered the radio industry in 1924 and joined Ekco in 1930, where he has been successively chief inspector, production manager, works manager and, since 1945, deputy managing director.

Peter E. M. Sharp, A.C.G.I., B.Sc., A.M.I.E.E., who, before joining the Telegraph Construction and Maintenance Co. in 1952, was for three years industrial officer (electronic equipment) with the Council of Industrial Design, is going to Malaya to join Telcon's agents in Singapore, the China Engineers, Ltd. Prior to joining the Council of Industrial Design, where he was responsible for the selection and organization of the communications and electronic exhibits for the Festival of Britain, he was with Standard Telephones and Cables.

Brigadier E. J. H. Moppett, M.I.E.E., has returned to this country after a tour of South America, the West Indies, U.S.A. and Canada on behalf of Pye Telecommunications, Ltd. He became a director of the company in 1952 on completing his tour of duty as Chief Inspector, Electrical and Mechanical Equipment, Ministry of Supply.

OUR AUTHORS

J. Moir, who contributes the article on stereophony in the cinema in this issue, is responsible for the design and development of sound reproducing equipment in the Electronic Engineering Department of the British Thomson-Houston Co., Rugby. He was co-author with C. A. Mason in 1940 of a paper to the Institution of Electrical Engineers which introduced pulse testing to the acoustic field. Mr. Moir has been responsible for the acoustic design of about one hundred cinemas and other buildings in Great Britain, including the Odeon Theatre, Leicester Square.

M. J. L. Pulling, M.A.(Cantab.), M.I.E.E., senior superintendent engineer of the B.B.C. Television Service, was among the members of the Corporation who, together with the Director-General, recently visited the United States to study television. He gives his impressions in an article on page 13. Mr. Pulling was at King's College, Cambridge, from 1925 to 1928, when he graduated as B.A. (Mechanical Sciences Tripos), after which he spent a year in the Cambridge University radio laboratory. Before joining the B.B.C. as assistant in the Engineering Information Department in 1934 he was for two years on the production testing of receivers at Murphy Radio. He was for nine years superintendent engineer (Sound Recording Department) before assuming his present position in 1949.

B. R. Bettridge, who describes an experimental transistor receiver on page 2, has been in the Osram Valve and Electronics Department of the General Electric Co. since 1950, working on semi-conductors. He joined the G.E.C. valve and c.r.t. works at Shaw, Lancs, during the war and was for a time after the war in the company's Process Heating Department in London, where he was concerned with r.f. heating. Before joining the G.E.C. he was with Ultra and the Marconiphone Co.

P. B. Helsdon, author of the article "Home-made Transistors," is employed as an engineer on the development of television camera equipment at Marconi's, Chelmsford, which he joined on leaving school in 1936. After his apprenticeship he worked in the Company's Test Department and in 1948 was transferred to the Development Division. His work on transistors is purely as a spare-time hobby.

Mr. H. N. Potok, contributor of the article on valve codes, graduated as B.Sc. (Electrical Engineering) at Glasgow University in 1941 and for the past two or three years has been a lecturer in electronics at the Royal Technical College, Glasgow. In the intervening years he was for some time with Partridge and Wilson, Leicester, on the development and design of rectifying equipment, in R.E.M.E. from 1944 to 1947 and was at Mullard's Valve Works, Mitcham, as development engineer in the Sub-Miniature Valve Department from his demobilization until he went to Glasgow in 1951.

IN BRIEF

Q.R.P.—In order to give notification that a television station is operating with reduced power, the B.B.C. has introduced identification signals for both sound and vision which will be used during the trade test transmissions or during B.B.C. tests outside broadcasting hours. The identification signal for vision consists of 50-c/s or 100-c/s frame bars and for sound 250-c/s tone at 40 per cent modulation. When required the signals will be radiated for one minute out of every five during the transmissions.

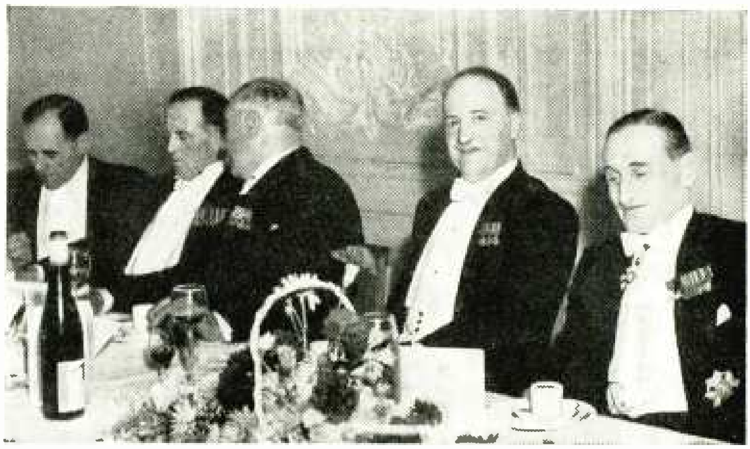
G3AAT/OX, the radio station of the British North Greenland Expedition, of which Lt. Cdr. Brett Knowles is signal officer, has been received on 14 Mc/s by J. S. Bell, GM3WO, of Falkirk, Stirlingshire.

Eiffel Tower.—Recording the 50th anniversary of the opening of the wireless station in the Eiffel Tower, a French correspondent claims that but for radio this Parisian landmark would long ago have disappeared. The first station was installed for the army in 1903 by General Ferrié. The tower now supports the Paris television aerials.

A series of 11 lectures on "**Powder Metallurgy**" will be given at 7.0 on Tuesdays, commencing January 12th, at the Battersea Polytechnic, Battersea Park Road, London, S.W.11, for which the fee is 25s.

Anglo-German Trade.—Television apparatus figures among the exports to Germany allowed under the bilateral trade agreement concluded in December.

AT THE TOP TABLE at the Radio Industry Council Dinner on November 18th are (reading from the right) the president, Lord Burghley; the principal guest, the Rt. Hon. R. A. Butler; G. Darnley Smith (R.I.C. chairman); the Postmaster General (Lord De La Warr); and P. H. Spagnoletti (chairman of B.R.E.M.A.)



Colour Television. — The Fleming Memorial Lectures of the Television Society by G. G. Gouriet on "Colour Television" will be given at 7.0 on February 10th and 24th (not 12th and 25th as previously announced) at the Royal Institution, Albemarle Street, London, W.1. A limited number of tickets for non-members, costing 5s for the two lectures, are obtainable from the Society at 164, Shaftesbury Avenue, London, W.C.2.

Manchester Electronics Show.—The ninth annual electronics exhibition organized by the North-Western Branch of the Institution of Electronics will be held at the College of Technology, Manchester, from July 14th to 20th. It will include a scientific and industrial research section and a commercial section in which manufacturers will be participating. A programme of lectures is also being arranged.

A new trophy, to be known as the **Calcutta Key**, has been presented to the Radio Society of Great Britain by a past president, W. A. Scarr, who is at present in Calcutta as representative of the British Council. The trophy is to be presented annually to the member who, during the year, has "given the most outstanding service to the cause of international friendship through the medium of amateur radio." The first recipient is A. O. Milne, G2MI, the Society's new president.

Illegal Recording.—In the Blackpool Magistrates Court on December 4th, Jack Michaels, of Jack Michaels' Mobile Recording Studios, pleaded guilty to charges of having recorded illegally a broadcast performance and also to having sold records so produced. Fines totalling £8 were imposed. Under the Dramatic and Musical Performers' Protection Act, 1925, it is an offence to record directly or "indirectly" (e.g., through broadcasting) or to sell, hire or use *for public performance* any recording made without authority.

"Electronic Aids to Production" is the revised title of the Convention being organized by the British Institution of Radio Engineers to be held at Christ Church, Oxford, from July 9th to 12th.

Technical Writing.—The preparation of reports, collection of data and practical advice on the submission of papers for publication will be covered by Geoffrey Parr in a course of six lectures on the writing of technical reports he is giving at the Borough Polytechnic, London, S.E.1, on Thursdays at 6.30 p.m. commencing on January 21st. The fee is 15s.

Technical Publications Association.—An attempt is being made to form an organization which will aim at improving the standard of production of technical handbooks and obtaining a recognized status for people engaged in this type of work. Lectures and discussions are being planned and it is proposed to establish a formal system of graded membership. Further details can be obtained from C. E. Cunliffe, 33, Great North Way, Hendon, London, N.W.4.

Scottish Home Service Transmitter.—A new 2-kilowatt station at Mousewald, near Dumfries, replacing the temporary transmitter which has been in use in the area for some time, was brought into service by the B.B.C. on December 13th. It operates on 809 kc/s (370.8 metres).

Industrial Directory.—Among the seven main sections of the 26th edition of the "F.B.I. Register of British Manufacturers, 1954," is a buyer's guide classifying over 6,500 member firms of the Federation of British Industries under some 5,000 alphabetical trade headings. Other sections of this 952-page directory, which is produced by Kelly's Directories and our Publishers (price 42s), give information about trade association, proprietary names, trade marks, etc.

"The Year that Made the Day" is the strange title of an excellently produced book published by the B.B.C. giving a well-illustrated description of how the Coronation Day broadcasts were planned and carried through. As an appendix to this 80-page book a selection of 36 photographs taken from the screen of a television receiver on June 2nd is given. It costs 6s.

1955 Plastics Exhibition.—The third biennial British Plastics Exhibition and Convention is to be held at Olympia, London, from June 1st to 11th, 1955. Both the exhibition and convention are being organized as previously by *British Plastics*.

NEWS FROM ABROAD

Canadian Audio.—During his visit to New York for the Audio Fair in October, G. A. Briggs, of Wharfedale Wireless, crossed into Canada and addressed a joint meeting of the Acoustical Institute and the Toronto Chapter of the Society of Music Enthusiasts. At a subsequent meeting of the S.M.E., F. A. Towler, Tannoy's Canadian representative, demonstrated the Tannoy dual concentric speaker using a Williamson amplifier. P. G. A. H. Voigt, from whom we received this news, recently lectured to the Wireless Association of Ontario using the Voigt pre-war corner horn and a Williamson amplifier.

International Exchange of Manufacturing Rights.—The recently formed Porter International Company of 1025 Connecticut Avenue N.W., Washington 6, D.C., is interested in sponsoring in the United States the manufacture or use of British products or processes in various fields, including electronics. The company also arranges for the licensing of foreign manufacture of American products.

U.S. Magnetic Recording.—The growth of magnetic recording in America—"now a $100 million industry"—is evidenced by the formation of the Magnetic Recording Industry Association and the publication of a new bi-monthly journal *Tape and Film Recording* devoted to all aspects of magnetic recording.

International Congress on Sound Recording.—It has been decided to hold a public exhibition of equipment to run concurrently with this Congress, which, as announced in last October's issue, will be held from April 5th to 10th, in Paris. The organizers are the Société des Radioélectriciens, 10, Avenue Pierre Larousse, Malakoff (Seine).

INDUSTRIAL NEWS

"Tape Deck."—We are informed by Truvox, Ltd., that the Patent Office has advised them of the cancellation from the Register of Trade Marks of the name "Tape Deck" registered by Wright and Weaire.

New Magnetic Tape.—Special equipment has been developed by the M.S.S. Recording Company at their laboratories at Hythe End, Bucks, for the production of high-grade, medium-coercivity tape suitable for 3¾ and 7½ in/sec speeds. The work has been carried out in conjunction with B.I. Callender's Cables and special attention has been given to the production of surface finish which will reduce wear of the magnetic heads to a minimum. The price of the new tape (Type AM15) is 37s 6d per 1,200-ft spool.

Exporting Magnetic Recorders.—A £30,000 order for 32 E.M.I. tape recorders and a large quantity of recording tape has been placed with the E.M.I. subsidiary company in the Argentine by the Argentinian Ministry of Communications. The equipment will be used by the country's broadcasting authorities.

Canadian Market.—John W. McCaslin, Jr., of 1021 Second Avenue N.W., Moose Jaw, Saskatchewan, would like to hear from manufacturers of radio and electronic equipment interested in the distribution of their products in Saskatchewan, Western Canada.

Presidential Radio.—A modified H.M.V. export receiver (Model 5321) covering 10 wavebands has been supplied by E.M.I. Sales and Service to the Indian Railways for installation in the new presidential coach. The order was received through Racal, Ltd. radio and aeronautical consultants of Kingsway, London.

Sonar (SOund NAvigation and Ranging), the American device employing supersonic radiations for underwater navigation, has been produced in this country by R.C.A. Photophone, Ltd., under the U.S. off-shore procurement programme. The first delivery of equipment was made to the Norwegian navy.

"C.R.T. Insurance."—Apropos of our note in the December issue on television maintenance insurance schemes, Whizards, Ltd., of Baker Street, London, W.1, have notified us that they have had such a scheme in operation since September, 1948.

Compact Portables.—A range of remarkably compact battery-mains portables, made by the German firm of Akkord-Radio, is available to retailers and selected wholesalers in this country through G-A Distributors, 29 Whitehall, London, S.W.1. There are three models, each fitted with internal ferrite-rod aerials, and British valves. A supply of spare parts will be available.

Coming of Age.—Two well-known radio companies have recently celebrated their 21st anniversaries: Roberts Radio of East Molesey, Surrey, who throughout the 21 years have concentrated on the production of portable receivers, and Aerialite of Stalybridge, Cheshire, specialists in cables and aerials. Aerialite has allocated £10,000 as a birthday bonus to the staff.

Decca Radar is now installed in, or ordered for, over 3,000 vessels—from ocean-going liners to police launches—throughout the world. In addition to the merchant ships of many nationalities nineteen of the world's navies use Decca radar.

Three new P. & O. cargo vessels—Patonga, Ballarat and Bendigo—are to be equipped with **Marconi Marine** radio communication and navigation gear.

NEW ADDRESSES

W. Edwards & Co. (London), Ltd., specialists in high vacuum techniques, have moved to new premises at Manor Royal, Crawley, Sussex. (Tel.: Crawley 1500.) The new factory covers an area of approximately 100,000 square feet.

The offices, stores and despatch departments of **Osmor Radio Products, Ltd.**, have been moved from Bridge View Works, Borough Hill, Croydon (which is being retained as a factory), to 418, Brighton Road, South Croydon, Surrey. (Tel. Croydon 5148-9).

Hifi, Ltd., of Stourbridge, Worcs, have moved to Derry Works, Derry Street, Brierley Hill, Staffs. (Tel.: Brierley Hill 7604.)

MEETINGS

Institution of Electrical Engineers

Radio Section.—"A Single-Sideband Controlled-Carrier System for Aircraft Communication" by G. W. Barnes, B.Sc., on January 13th.

Discussion on "Should Sound Broadcasting of the Future be Entirely in the V.H.F. Band?" Opener A. J. Biggs, Ph.D., B.Sc., on January 25th.

Both the above meetings will be held at 5.30 at Savoy Place, London, W.C.2.

East Midland Centre.—"Technical Colleges and Education for the Electrical Industry" by H. L. Haslegrave, M.A., Ph.D., M.Sc.(Eng.), at 6.30 on January 19th at Loughborough College.

North-Eastern Radio and Measurements Group.—Discussion on "Will Transistors Oust Receiving Valves?" Opener E. H. Cooke-Yarborough, at 6.15 on January 18th at King's College, Newcastle-upon-Tyne.

Sheffield Sub-Centre.—"Colour Television" by L. C. Jesty, B.Sc., at 6.30 on January 20th at the Grand Hotel, Sheffield.

North-Western Radio Group.—"A Simple Connection between Closed-Loop Transient Response and Open-Loop Frequency Response" by J. C. West, Ph.D., B.Sc., and J. Potts, B.Sc., at 6.30 on January 6th at the Engineers' Club, Albert Square, Manchester.

North Lancashire Sub-Centre.—"The History of Television" by G. R. M. Garratt, M.A., and A. H. Mumford, O.B.E., B.Sc., at 7.15 on January 13th at the N.W. Electricity Board Demonstration Theatre, Darwen Street, Blackburn.

South Midland Centre.—"Transmission of Pictures by Radio" by A. W. Cole at 7.15 on January 14th at the Winter Gardens Restaurant, Malvern.

South Midland Radio Group.—"A Method for the Synthesis of Speech" by W. Lawrence, M.A., at 6.0 on January 25th at the James Watt Memorial Institute, Great Charles Street, Birmingham.

Southern Centre.—"Electronic Speed Control of Motors" by J. C. Rankin at 7.30 on January 13th at the R.A.E. Technical College, Farnborough.

"Radar Echoes from the Moon and Aurora" by I. A. Gatenby, M.Sc., at 6.30 on January 22nd at the South Dorset Technical College, Weymouth.

South-Western Sub-Centre.—"Electronic Telephone Exchanges" by T. H. Flowers, M.B.E., B.Sc., at 3.0 on January 27th at the Electric Hall, Torquay.

Reading District.—"Training in Electronic Fire Control in R.E.M.E." by Capt. R. A. Middleton, R.E.M.E., at 7.15 on January 25th at the George Hotel, Reading.

London Students' Section.—Film evening at 7.0 on January 11th at Savoy Place, London, W.C.2.

British Institution of Radio Engineers

London Section.—"Engineering Design of V.H.F. Multi-Channel Telephone Equipment" by W. T. Brown (British Telecommunications Research) at 6.30 on January 6th at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

Scottish Section.—"Radio Astronomy" by H. Seddon (Edinburgh University) at 7.0 on January 7th in the Department of Natural Philosophy, The University, Edinburgh.

Programme of technical films at 7.0 on January 20th in the Department of Natural Philosophy, The University, Edinburgh, and at 7.0 on January 21st at the Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2.

North-Western Section.—"The Manchester University Computer" by D. B. G. Edwards (Manchester University) at 7.0 on January 7th at the College of Technology, Manchester.

Merseyside Section.—"Interlacing Problems in Television Receivers" by Dr. G. N. Patchett, B.Sc. (Bradford Technical College), at 7.0 on January 7th at the Electricity Service Centre, Whitechapel, Liverpool, 1.

North-Eastern Section.—Short papers by students at 6.0 on January 13th at the Neville Hall, Westgate Road, Newcastle-upon-Tyne.

West Midlands Section.—"Microwave Measuring Instruments" by P. M. Ratcliffe (Marconi Instruments) at 7.15 on January 26th at the Wolverhampton and Staffordshire Technical College, Wulfruna Street, Wolverhampton.

British Sound Recording Association

London.—"The Violin: its Tonal Variations and Peculiarities" by D. J. W. Seagrove at 7.0 on January 15th at the Royal Society of Arts, John Adam Street, London, W.C.2.

Manchester Centre.—"The Problems of Hearing" by J. E. J. John (Manchester University) at 7.30 on January 18th at the Engineers' Club, Albert Square, Manchester.

Television Society

London.—"The Marconi Television O.B. Unit" by K. E. Owens and P. R. Berkeley at 6.45 on January 6th at Film House, Wardour Street, London, W.1. (Joint meeting with the British Kinematograph Society.)

"American Television" by J. Sieger at 7.0 on January 21st at the Cinematograph Exhibitors' Association, 164, Shaftesbury Avenue, London, W.C.2.

Institute of Practical Radio Engineers

Berks, Bucks and Oxon Section.—"Television Service" by J. Barton (English Electric) at 7.30 on January 13th at the White Hart Hotel, Reading, Berks.

Society of Instrument Technology

Birmingham.—"Supervisory Control and Telemetering" by R. W. Field and E. Norton at 7.0 on January 8th at Regent House, St. Philip's Place, Colmore Row, Birmingham, 3.

Radio Society of Great Britain

"Art and Science in Sound Reproduction" by F. H. Brittain, D.F.H. (G.E.C. Research Laboratories), at 6.30 on January 29th at the I.E.E., Savoy Place, London, W.C.2.

Institute of Navigation

"Methods of Air and Surface Navigation" by Wing Commander E. W. Anderson, D. H. Sadler, Lt. Commander R. B. Michell, R.N., and Group Capt. E. Fennessy at 5.0 on January 15th at the Royal Geographical Society, 1, Kensington Gore, London, S.W.7.

Institution of Production Engineers

Yorkshire.—"Electronics as an Aid to Productivity" by R. McKennell at 7.0 on January 11th at the Hotel Metropole, Leeds.

R.S.G.B. Exhibition

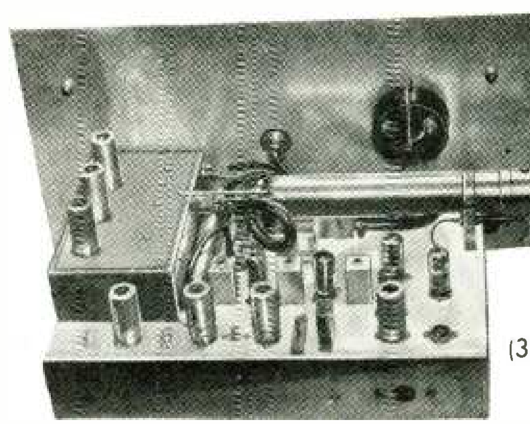
Equipment Shown by the Royal Corps of Signals, the R.A.F. and by Amateurs

THE announcement that the recent amateur radio exhibition was to be opened by Mr. Rene Klein, one of the founder members, calls to mind the fact that this event marked the 40th year of the Society's existence. Unfortunately, Mr. Klein was prevented by reasons of health from performing the opening ceremony and his place was taken by Brigadier Eric Cole, Chief Signals Officer, Southern Command.

The Royal Air Force showed a replica of a repair line assembly as used in the central repair depot for servicing v.h.f. aircraft sets. It showed the procedure from the initial inspection and recording of defects, through the repair stages to the final test and inspection. One could not fail to be impressed by the way in which a highly complicated 10-channel remotely-controlled transmitter-receiver is broken down into a few functional units with every component easily accessible for test and replacement. One corner of this stand was given over to the R.A.F. Amateur Radio Society, a wall-map showing the world-wide nature of the organization as most overseas stations have one or more members among their personnel. On view also were some examples of v.h.f. equipment constructed in their spare time by servicing members of the Society.

Some of the latest radio equipment in use, or about to be used, by the Army was shown by the Royal Corps of Signals. A new communications receiver, the GFR562, attracted much interest in view of its unusual design. The set is tall and narrow but of considerable depth and is housed in a sturdy, sealed case provided with forced air ventilation. The valves fit in sealed sockets in a narrow vertical channel at the back of the set. There are band-switched rotatable scales calibrated in frequency and an optical projection system for expanding each scale to about 120 in. It is a double superheterodyne and in six ranges covers 640 kc/s to 26 Mc/s.

Single-sideband operation of telephony transmitters is gaining popularity among the more advanced amateurs, as it has several advantages over the double-sideband system in very crowded wavebands. The bandwidth required for a station is very much less and less power can be used for the same signal strength at the receiving end, or alternatively a much larger effective signal output is obtainable from the transmitter for a given power input. Some simplification of equipment is possible as modulation is applied at a low level. The various exhibits in this section well exemplified the general reduction that can be effected in the size of a transmitter of a given power output, and elsewhere in the exhibition were



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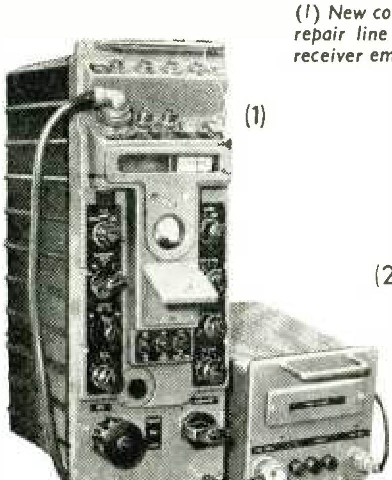
(1) New communications receiver, Type GFR562, shown by the Royal Corps of Signals. (2) Replica repair line used in the R.A.F. for servicing v.h.f. aircraft equipment. (3) Seventy-centimetre receiver employing linear circuits (plumbing).



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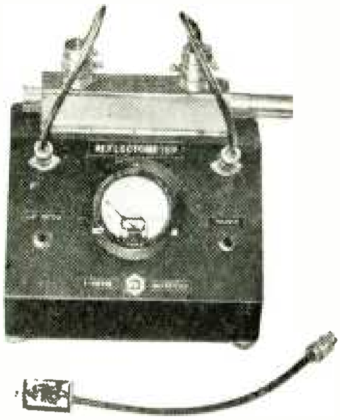


The "Reflectometer" standing-wave and aerial matching bridge, with one of the two probes in the foreground, and (right) corner of the stand devoted to amateur-built single-sideband equipment.

a number of orthodox type transmitters of comparable output for comparison.

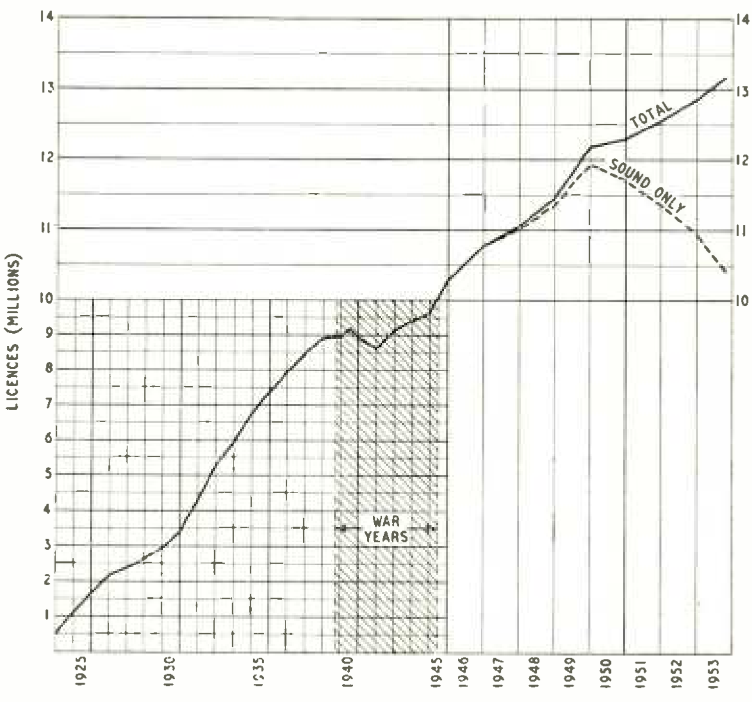
In the v.h.f. section the most interesting sets were those designed for use in the 70-cm band. "Plumbing" and orthodox circuitry sat side by side, but in general the former is used for reception and the latter for transmission.

Trial and error methods of doing things do not obtain in many amateur stations, if the wide variety of home constructed test and measuring equipment at the Show is any guide. These included precision frequency meters, valve-voltmeters, noise generators, grid-dip meters, oscilloscopes, field-strength and aerial impedance measuring sets. One of the last mentioned, described as the "Reflectometer," was particularly interesting as it employs bridge technique to balance the forward and reflected r.f. voltages on a short length of coaxial line, using two probes spaced a few inches apart. Each contained a crystal diode and the unit covered 144 to 420 Mc/s.

The British Amateur Television Club was well in evidence, but adopted a more static rôle than usual, no demonstrations being staged this year. Their activities have already been described at some length under the heading "Amateur Television Progress" in last month's *Wireless World.*

Some last-minute changes in the exhibit of Cosmocord resulted in the HGP40 pick-up (mentioned in our December issue) not being on view, but in its place was a new pick-up head of the same design, but for use with the GP20 pick-up arm. Separate heads are required for standard and long-playing records although there was an implication in our pre-view that the one head served for both purposes.

BROADCAST RECEIVING LICENCES



WITH broadcast receiving licences in Great Britain and Northern Ireland now well over thirteen million—the last available figure (October) was 13,153,314—it is interesting to see from this graph the steady growth in the number of licensed receivers from the beginning of 1924 to October 1953; that is, if we ignore the temporary decrease during the early part of the war—from August 1940, when the total was 9,153,380, until the end of 1941, when it had dropped to 8,625,580.

The peak in "sound" licences was reached at the end of 1949 when the total was 11.941,600. The continued growth in the number of television licences—now totalling 2,727,070—is shown by the divergence of the two curves since 1946 when separate licences were introduced. This section of the graph has been enlarged in order to show more clearly this divergence. The graph is plotted from figures supplied by the Post Office.

The number of licences for receivers installed in cars has now reached 200,286.

Compatible Colour Television

Views on the Sideband Interference Problem

By D. A. BELL,* M.A., B.Sc., Ph.D.

ON page 523 of the November, 1953, issue it is suggested that the American system of frequency interlacing sidebands is not foolproof, because the occurrence of ordinary picture sidebands of substantial intensity on the frequencies allocated to the colour sub-carrier and its sidebands would cause interference between black-and-white and colour signals; but I think the chief difficulties in applying the system in Britain lie in a different direction.

The interference from the monochrome sidebands to the colour signal would, in principle, cause false colour rendering, but it appears from the N.T.S.C. specification that the colour sub-carrier will, in fact, be at a considerably higher level than any probable monochrome sideband at this frequency. If an exceptional monochrome sideband is generated by putting on a pattern related to the well-known chequer-board, will anyone mind its having a gentle rainbow hue? In the reverse direction, interference from the colour sub-carrier to the black-and-white picture always exists, though partially concealed by the alternate-frame reversals. This interference will not interact with any steady pattern of the same frequency which may be present unless the non-linear response either of the eye or of some part of the television system prevents the two components from operating separately.

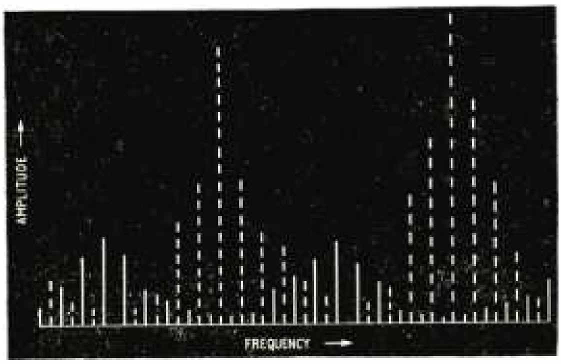


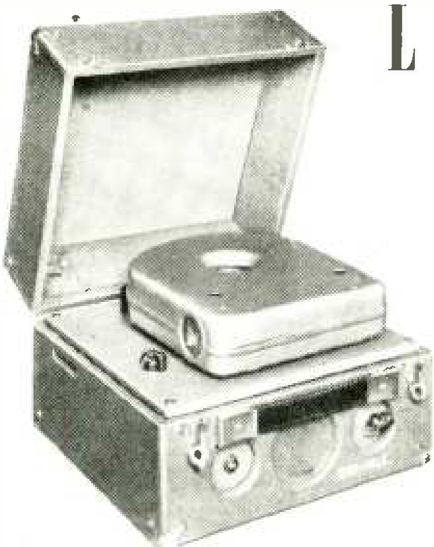
Fig. 1. Interlaced sidebands of the colour and monochrome signals in the N.T.S.C. colour television system. The full lines represent the monochrome sidebands and the broken lines the colour sidebands.

There is, however, a difference between the British and American monochrome systems in their probable abilities to eliminate the interference pattern due to the colour sub-carrier. First, we should be at a slight disadvantage relative to the U.S.A. because our 25-c/s picture frequency would show more residual flicker of the interference pattern than would occur with the American 30 c/s. More serious, however, is the fact that we endeavour to resolve a 3-Mc/s pattern with a system in which the nominal video band does not much exceed this frequency. The American video band, on the other hand, goes up to a full 4 Mc/s, but there is some evidence that the overall resolving power of typical receivers does not do justice to this band and a 3.5-Mc/s flicker pattern is not serious degradation. Neither would a 3.5-Mc/s pattern be serious to us—we usually stop at 3 Mc/s anyway—but to get the video sub-carrier of a frequency-interlace system adequately within the British video band would result in an interference pattern of the order of 2 Mc/s only, which would be far more serious than the 3.5-Mc/s pattern.

It seems that the American system does not, after all, get three pints into a pint pot, but only one and a half pints. (I am tempted to say one pint and some froth, but it is really a little better than this.) First of all, the physiology of the eye allows the bandwidths of the colour signals to be less than that of the luminance (brightness) signal, so that without any overlapping of sidebands one needs only twice the bandwidth of monochrome in order to transmit adequate three-colour pictures. Then by judicious interleaving one can compress the two channels into a little less than one and a half times the channel which has generally been effectively utilized hitherto.

I would also like to point out that the diagram of frequency-interlaced sidebands on page 526 of the November issue is very diagrammatic: there are actually more than 200 sidebands between adjacent harmonics of the line frequency, so that the decrease in amplitude as the frequency departs from a line harmonic is likely to be more gradual than is suggested by this diagram, which has been traditional since the 1934 paper of Mertz and Gray (*B.S.T.J.*, Vol. 13, p. 464). Also, each colour group is likely to be practically as wide as a monochrome group, the bandwith limitation on the colour affecting the number of groups (number of line harmonics) which are associated with the colour sub-carrier. Fig. 1 is probably a more realistic representation of the frequency-interlaced sidebands, though it still shows only a fraction of the real number between line harmonics, and no great significance can be attached to the relative amplitudes of the various components in the sketch. It will be noticed that the individual sidebands still interlace when the groups overlap. It appears to be implicit in the N.T.S.C. specification that all scanning frequencies are to be developed from the frequency of the colour sub-carrier, so as to ensure accuracy of interlace between the two groups of sidebands to this degree.

* University of Birmingham.



Each cassette gives a reading duration of 12 hours. There are 24 tracks on ½-in tape.

Long-Playing Magnetic Tape

Experimental Equipment for Speech, Using 48 Tracks per Inch

FOR many years the Royal National Institute for the Blind and St. Dunstan's have maintained a library of "talking books" recorded on 24-r.p.m. discs. Many of the books, which are recorded by experienced readers, run to 12 hours or more in duration, with an average of six to eight hours for popular short novels. The playing time of discs is 24½ minutes per side and 10 double-sided records, packed in a special fibre container, is the standard unit for transmission through the parcels post.

Against this background of established service, the research section of the Sound Recording Department is continuously exploring alternative methods of recording with the object of giving better service to the blind, and of expending economically the funds at its disposal. For several years magnetic tape recording has been under investigation and a prototype machine, suitable for manipulation by the blind, has been produced and is now undergoing tests in the field.

The advantages offered by magnetic recording can be realized only by using much narrower tracks than are usual, and by adopting single cassette loading for both supply and take-up spools. In the machine illustrated the track width is only 10 mils (0.01 inch) and with spacing between track centres equal to twice this distance, up to 24 tracks can be accommodated, without "crosstalk," on ½-inch wide tape. Each track gives 30 to 35 minutes duration, so that a total of 12 hours can be recorded on each cassette—a 50 per cent increase over the equivalent 10-record disc unit. There is also the advantage that only a single unit is involved and there is no possibility of getting the recordings mixed up in the wrong order. Yet another advantage is that new books can be recorded and issued quickly, since the time taken for processing and pressing discs is eliminated.

In a general-purpose magnetic tape recorder/reproducer, designed for music as well as speech, it is necessary to provide equalizing networks to give a level overall frequency characteristic. Since clear articulation is of greater importance in a talking book than exact fidelity to the spectrum of the original speaker's voice, it is permissible to omit the equalization and allow the response curve to rise. This greatly simplifies the circuit, minimizes hum troubles and generally conduces to reliability.

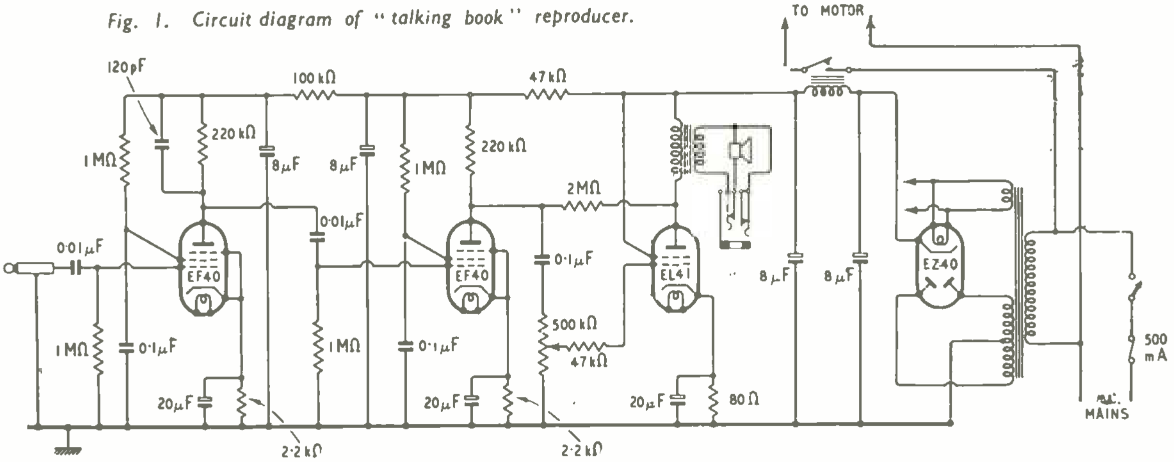
The amplifier, shown in Fig. 1, has a "flat" characteristic and a voltage amplification to the grid of the output valve of 10^4. Negative feedback is applied by a 2-MΩ resistance between the anodes of the last two stages. A relay in the h.t. circuit controls the tape motor and ensures that this cannot be started until the valves have warmed up and the amplifier is ready to function. The winding of the relay serves also as the h.t. smoothing choke. A three-position switch first switches on the amplifier and then mechanically engages the friction drive to the motor.

The driving mechanism for the tape spool spindle is also of simple and reliable design and consists of a large-diameter rubber-tyred wheel driven through a double-stepped idler reduction gear from the motor spindle. The driven spool therefore revolves at constant speed (actually π (3.14) seconds per revolution). Consequently the tape speed varies according to the diameter of the tape on the take-up spool from 3¾ to 7½ in/sec. This is no disadvantage since, at any point on the tape, the linear speeds for recording and reproduction are the same. With a short gap in the pickup head and modern tape coatings, the high-frequency response at 3¾ in/sec is more than sufficient for speech, while at the higher speeds the h.f. response is progressively curtailed during recording.

The essential simplicity of the reproducer unit is preserved by incorporating the rest of the tape winding mechanism, together with the playback head, in the cassette. The cassette unit is necessarily more complicated, but as it automatically returns to the library at frequent intervals, an eye can be kept on it for incipient troubles.

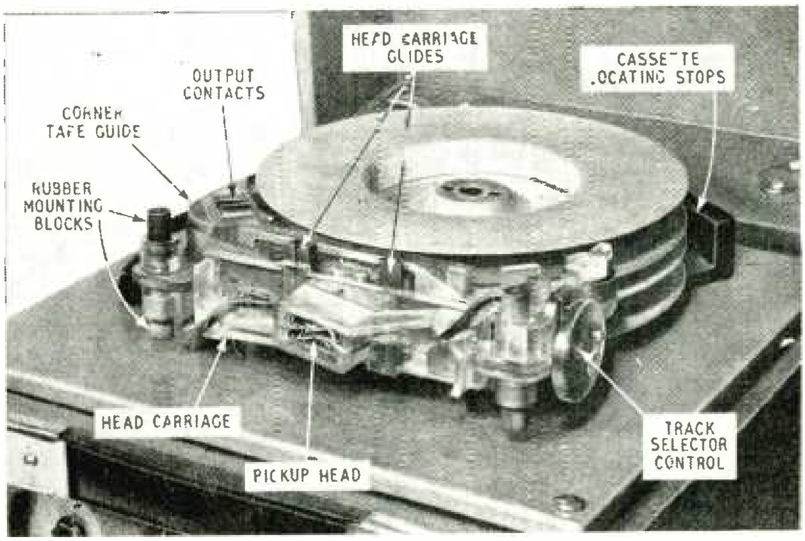
Two aluminium spools are mounted, concentrically and independently, on each end of a spindle bolted to a fixed central web plate with resilient rubber mounting blocks which locate it between the two halves of the cassette. A limited amount of movement is allowed at the centre so that the lower (take-up) spool falls by gravity on to the centre spindle

Fig. 1. *Circuit diagram of "talking book" reproducer.*

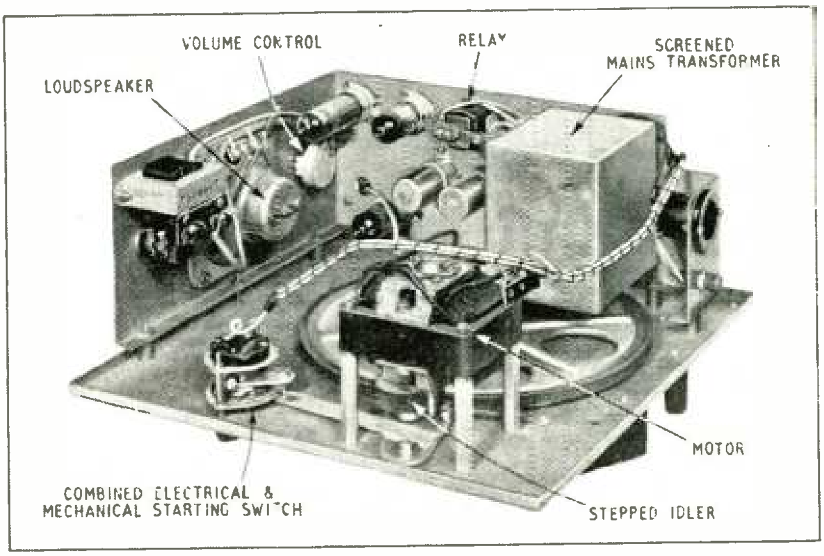


and picks up the drive when the holes in the drum engage two spigots on the spindle. The tape passes over corner guides and under the pick-up head, which is housed in a carriage mounted on guides running approximately at right angles to the length of the tape. The carriage is located by stops at each end which slide on wedges formed by a plate of the approximate shape shown in Fig. 2. This plate is constrained to move in a line parallel with the fixed baseplate and is under the control of a lead screw, the thread of which (in conjunction with the degree of taper on the wedges) gives 20 mils lateral movement to the head carriage for each complete revolution of the control knob. The latter is provided with a detent for each revolution so that the blind person can feel as well as hear when the next track has been engaged. The cassette is, of course, turned over manually between tracks and what was the take-up spool then becomes the supply pool. Electrical contact between the play-back head and the amplifier is effected by a cut-down telephone plug and springs forming a socket in the cassette.

The tape is graphited to reduce friction and, incidentally, to reduce static charge effects. The head carriage and baseplate, which in the model illus-



Tape winding mechanism and track-locating device for pickup head and (below) underside of reproducer chassis showing friction-driven reduction gear.



trated have both been hand-made from Perspex sheet, will in future machines be made as graphite loaded Bakelite mouldings. Spring-loaded phosphor bronze annular tapes are fitted to each spool to control tape spilling which might result from inadvertent hand winding of the spools in the wrong direction. These tapes also help in reducing static charges, which might otherwise build up under some conditions.

Recording is made with the same head and track-shifting mechanism as is used for reproduction, so that the relationship between head and tape is fixed for each cassette assembly.

Details of the head are given in Fig. 3. It is of the high-impedance type with two bobbins each carrying 6,000 turns. The gap is formed by two 0.01-in laminations, copper-plated 0.00015-in thick at the tips, butted together and soldered into a slot in a hard nickel-chrome alloy tape bearer plate. Two pairs of 0.015-in laminations complete the magnetic circuit. A split Mumetal shield surrounds the windings, and an additional guard plate (not shown) is mounted facing the air gap.

The narrowness of the track is not, theoretically, a disadvantage from the point of view of signal/noise ratio, though the available total output is, of course, reduced. In practice, however, the narrow track is very sensitive to blemishes in the coating of the tape and very quickly sorts the sheep from the goats among commercially available tapes.

With a good tape, however, a side-by-side comparison would be necessary to say whether the speech quality from the experimental "talking book" was in any way inferior to that from a conventional portable twin-track magnetic recorder. Certainly the hum and surface noise are quite unobtrusive, and the clarity of diction is impeccable.

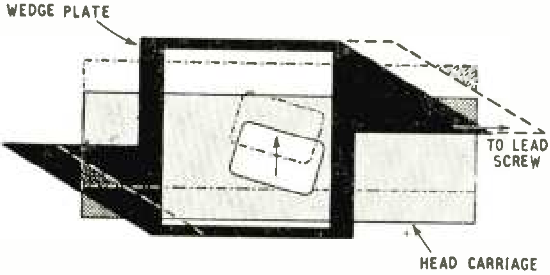


Fig. 2. Illustrating the principle of the track-locating mechanism.

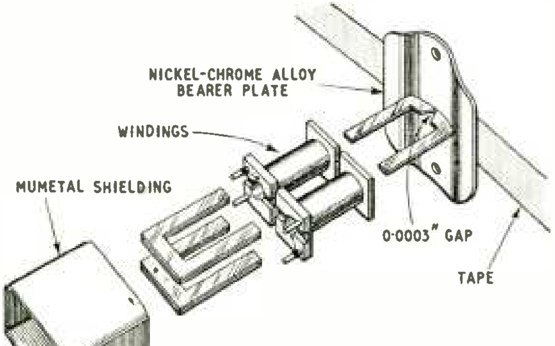


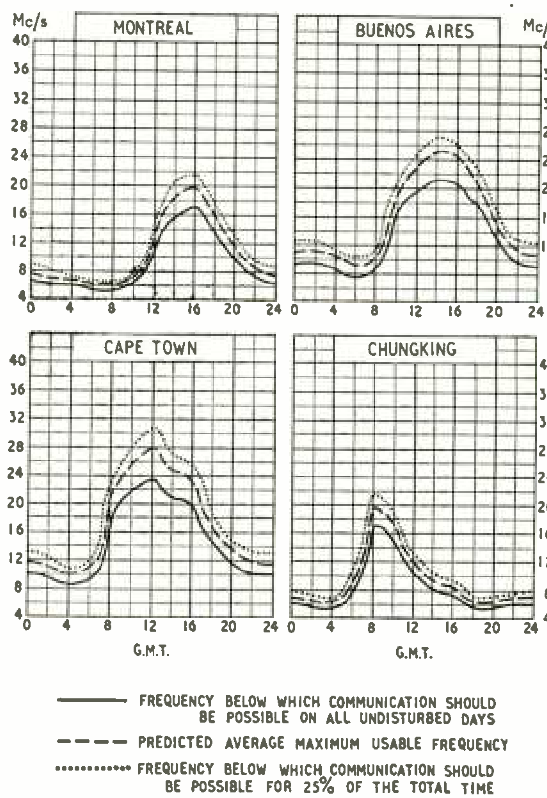
Fig. 3. Component parts of the magnetic head used in the "talking book".

Short-wave Conditions

Predictions for January

THE full-line curves given here indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during January.

Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.



THE "IONOPHONE" DEMONSTRATED

AN informal lecture on "Loudspeaker Systems—Recent Trends in Design," given recently by A. E. Falkus, B.Sc.(Eng.), to the Radio Section of the Institution of Electrical Engineers, included a demonstration of the "Ionophone,"* a diaphragm-less loudspeaker depending on the heating effect of a current through ionized air. The driving element was a quartz tube about 3in long, closed by an electrode at one end, working into a small horn with throat and mouth areas of $1cm^2$ and $50cm^2$ respectively.

The lecturer said that the element was truly aperiodic, tests and delay response experiments on the combined horn and element showing linearity from 600 to 20,000 c/s. For the lower frequencies a 15-in cone unit was employed, with a cross-over network designed for 800 c/s.

A source of radio-frequency power is necessary for the "Ionophone," and the lecturer stated that suitable frequencies lay between 14 and 40 Mc/s. In the model demonstrated the r.f. power was 60 watts at 20 Mc/s. Possible interference had been forestalled by the use of screening and mains filters.

* See *Wireless World*, January 1952.

Making a Universal Shunt

By A. L. CHISHOLM

IN the July issue of *Wireless World*, an ingenious way of adjusting an ammeter shunt was described. This method is ideal for single-range ammeters, but cannot be used for making the much more useful Universal Shunt. This is the type which is used in most commercial multi-range meters and its virtues are too well known to need elaboration here. Cazally and Roddam describe it in detail in "AC/DC Test Meters" (Pitman) but the method of construction they give is cumbersome and is really beyond the scope of the amateur. The method of construction given here is quite simple to carry out and requires only the ordinary workshop equipment.

Let us assume we have a meter of full-scale deflection 1 mA and resistance about 50 Ω—we do not need to know the exact value of the latter. We desire to make a shunt to give us ranges of 5 mA, 50 mA, and 500 mA. Then the arrangement is as shown in Fig. 1.

For the 500-mA range, 499 mA flows through R_1 when 1 mA flows through the other resistances in series.

$$\therefore 499 \times R_1 = 1 \times (R_2 + R_3 + r)$$

where r is the sum of the meter resistance r_m and the series resistance r_s.

$$\text{Then } \frac{499}{1} = \frac{R_2 + R_3 + r}{R_1}$$

Add 1 to both sides

$$\therefore \frac{500}{1} = \frac{R_1 + R_2 + R_3 + r}{R_1} \quad \ldots \ldots (1)$$

In the same way, for the 50-mA range

$$\frac{49}{1} = \frac{R_3 + r}{R_1 + R_2}$$

$$\text{or} \quad \frac{50}{1} = \frac{R_1 + R_2 + R_3 + r}{R_1 + R_2} \quad \ldots \ldots (2)$$

For the 5-mA range, we get

$$\frac{4}{1} = \frac{r}{R_1 + R_2 + R_3}$$

$$\text{or} \quad \frac{5}{1} = \frac{R_1 + R_2 + R_3 + r}{R_1 + R_2 + R_3} \quad \ldots \ldots (3)$$

Dividing (1) by (2) we find

$$\frac{R_1 + R_2}{R_1} = \frac{500}{50} = \frac{10}{1}$$

Dividing (2) by (3)

$$\frac{R_1 + R_2 + R_3}{R_1 + R_2} = \frac{50}{5} = \frac{10}{1}$$

If we put R_1 = 1 Ω, solution of these equations gives R_2 = 9 Ω, R_3 = 90 Ω and r comes out at 400 Ω. This value of r is unnecessarily high and the meter would be more efficiently used by making r one-fifth of this value — that is 80 Ω. This gives R_1 = 0.2 Ω, R_2 = 1.8 Ω and R_3 = 18 Ω.

Now the difficulty of construction centres round the resistance R_1. It is not easy to make a resistance accurately 0.2 Ω. Contact resistances and resistance of connecting wires all become important making accuracy difficult to achieve. However the exact size of R_1 is not important, as shown above, provided the various resistances are in the correct ratio. Fortunately, this is much easier to attain.

The author has found the following method of construction very successful. A former is first made of Paxolin strip, as shown in Fig. 2, and No. 22 gauge tinned-copper wire threaded through holes acts as anchorage points. R_1 is made as nearly as possible to size by measuring off the length of wire, calculated from resistance wire tables—it is better to make the resistance too high than too low. The wire is wound in the R_1 space and the ends are securely soldered to C and D. Then R_2 is measured off by length so that it is a little greater than the calculated value (1.8 Ω). One end of the wire is soldered to C and the other end is cut until the ratio of R_1 to $R_1 + R_2$ is exactly 1 to 10. There are many ways of measuring this ratio but the author used an ordinary school metre bridge, a single dry cell in series with a flash lamp bulb (to limit the current), and the 1-mA meter as indicator, with complete success. If a metre bridge is not available, one can readily be improvised with a metre stick and a length of resistance wire. The final adjustment should be made with the free end of R_2 soldered to B.

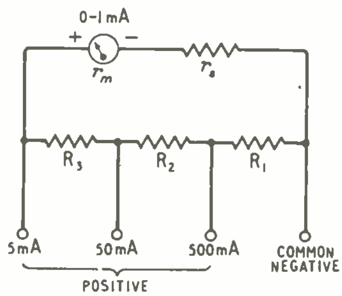
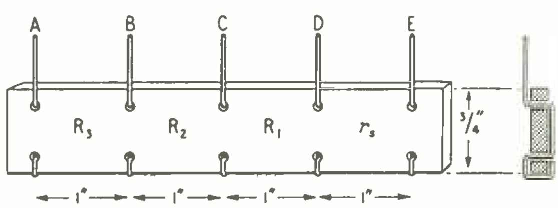


Fig. 1. Connections for universal shunt.

Below: Fig. 2. Paxolin former with wire connectors.



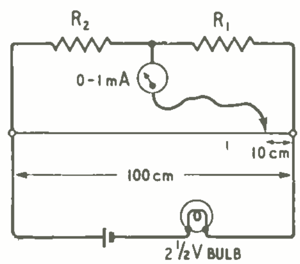


Fig. 3. Simple bridge for measuring the ratio of R_1 to $R_1 + R_2$.

In the same way, R_3 is measured off and adjusted until the ratio of $R_1 + R_2$ to $R_1 + R_2 + R_3$ is exactly 1 to 10.

The adjustment of r_s (about 30 Ω) is made most easily by using another meter which can indicate a current of 5 mA. The 1-mA meter is joined between A and E and an external circuit consisting of a battery, variable resistance and the 5-mA meter is joined to A and D. Then r_s is adjusted so that when 5 mA is flowing through the external circuit, the 1-mA meter shows full-scale deflection.

If it is desired to have the original 1-mA range still available, a switch must be fitted to open one of the leads connecting the meter to the Universal Shunt. This must be done also if the meter has to be used as a voltmeter or ohmmeter.

Simple Linearity-Measuring Instrument

By K. G. BEAUCHAMP, A.M.Brit.I.R.E.*

For Checking Television Scanning

ONE of the most important criteria of television scanning circuits is the linearity of the display on the cathode-ray-tube screen.

As a check on the linearity of these scanning circuits a pattern generator of a type previously described elsewhere[1] is often employed or alternatively the B.B.C. test pattern is utilized. In either case measurements are taken of the distance between pairs of parallel vertical or horizontal bars over different portions of the screen face. The linearity can then be expressed as a percentage increase or decrease of this distance about the mean spacing of the bars.

When this information has been obtained it may be presented in several forms. A complete picture of the performance of a scanning circuit in this respect is given by a linearity graph of the form shown in Fig. 1. Alternatively, a figure can be given of the greatest departure from correct linearity as a percentage of the mean bar spacing, e.g.,

$$\text{Non-linearity} = \frac{200\,(a - b)}{(a + b)}\ \%$$

where,

a = width of widest bar spacing.
b = width of narrowest bar spacing.

In order to facilitate the measurement of scanning circuit linearity the author has constructed a simple device which will enable the required measurements to be obtained quickly and accurately.

To avoid parallex error the instrument has been designed on the lines of a travelling microscope, and consists of two parts; a graduated scale 44 cm in length mounted on a rectangular section of Paxolin tubing for rigidity and lightness, and a movable brass sleeve carrying the eyepiece.

This latter is constructed from a short length of ½-inch diameter Paxolin tubing closed at each end by a Perspex cheek. Upon the Perspex at the far end are scribed crossed hair-lines, and a small diameter hole at the near end to enable the instrument to be accurately aligned and so avoid the parallex error previously mentioned.

In order that the device may be brought into use quickly and to dispense with cumbersome mounting arrangements, two rubber "suckers" are fitted 8 inches apart on the back of the graduated scale.

Due to this method of attachment, coupled with the method of alignment, measurements may be taken from completed receivers enclosed in their cabinets by "sticking" the instrument on to the implosion guard covering the tube face.

A photograph of the completed instrument is shown

* General Electric Company, Coventry

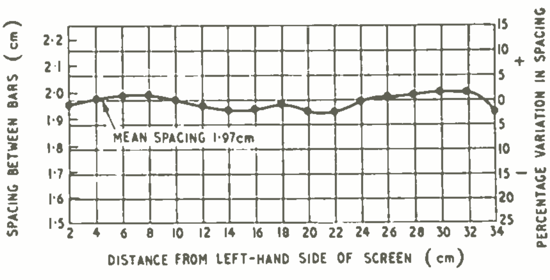


Fig. 1. Linearity graph for a line-scanning circuit.

Fig. 2. The complete instrument standing on the rubber suckers. The optical system is housed in the vertical tube.

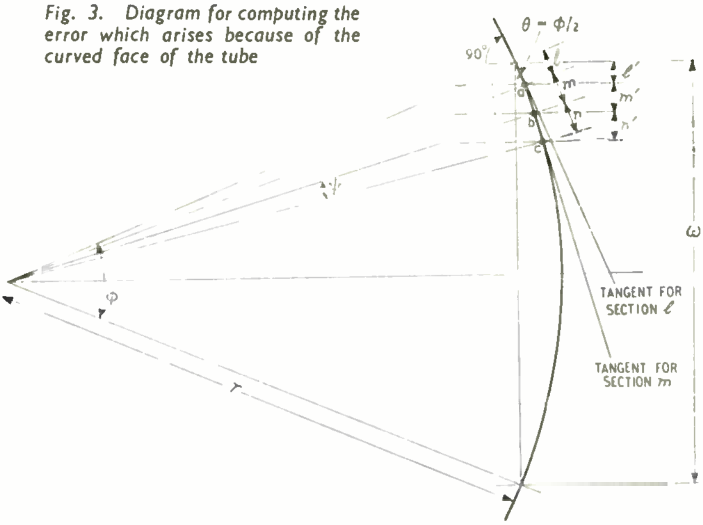
[1] "A Transmitter for Production Testing of Television Receivers," by J. M. Siberstein, *Electronic Engineering*, June 1953.

in Fig. 2 from which the construction can be clearly seen. To ensure rigidity and prevent the scale from vibrating on its rubber supports, a stabilizing lug has been soldered to the brass sleeve. This can be seen beneath the sleeve in the photograph of Fig. 2.

When using this instrument, however, we must bear in mind that when viewing a picture displayed on a cathode-ray tube we are really looking at a projection of a flat picture on to the curved surface of the screen face, and some distortion is bound to occur if an ideal flat picture is displayed upon it.

The form of projection used is therefore important if distortion is not to be experienced. This has already been considered by Jacob[2] who suggests that minimum distortion is apparent when a form of stereographic projection is employed for this makes it possible to reproduce shapes accurately over the entire screen face.

Fig. 3. Diagram for computing the error which arises because of the curved face of the tube



As a consequence, unless the instrument is used with a flat screen projection-type receiver some correction of the measured results is necessary. This arises because the instrument is used effectively to measure a flat picture projected from the curved surface of the tube face, giving rise to the distortion referred to above. This may be quite small and for many types of cathode-ray tubes in current use can be neglected unless extreme accuracy is required.

The exact extent of the correction will be seen to be dependent on two factors:

(a) The radius of curvature of the tube face (r).

(b) The maximum picture width (w).

From the diagram of Fig. 3 the aperture ϕ can be expressed as:

$$\phi = 2 \sin^{-1} \frac{w}{2r} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

In order to estimate the extent of this error over the screen face let us divide this angle into a number of small increments ψ radians as shown and assume that a number of linearity bars are produced at points a, b, c, etc. Then the distance between these bars l, m, n, etc., will be small equal sections of the screen face of length:

$$l = m = n = r\psi \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

Now the apparent distance between the bars, such as would be measured by the instrument, can be found by assuming the screen to be flat over these small segments and following a tangent to the radius r at the centre of the section being measured, i.e.:

$$l' = l \cos \theta = l \cos \frac{\phi}{2} \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

$$m' = m \cos \left(\frac{\phi}{2} - \psi\right) \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

$$n' = n \cos \left(\frac{\phi}{2} - 2\psi\right) \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

etc.

Giving rise to a maximum subjective error of:

$$\frac{l - l'}{l} \cdot 100\% = \left(1 - \cos\frac{\phi}{2}\right) \cdot 100\% \quad \ldots \quad (6)$$

Knowing r and w for the cathode-ray tube in the receiver being measured, then a correction graph can be constructed and used in interpreting the results obtained by measurement. A typical graph of this nature is shown in Fig. 4 for a 14-inch rectangular tube, and it will be seen that a maximum error of 2.7% is obtained at the extreme edges of the picture. This is for the line scan and in the frame direction the correction will be smaller and amount to only 1.5%.

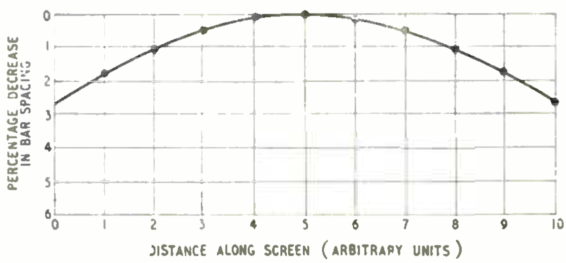


Fig. 4. Correction curve for a G.E.C. 7201A tube of the 14-inch rectangular type

When measurements of linearity are taken from tubes having a greater radius of curvature, such as the earlier blown bulbs, then the correction factor assumes some importance and may be as high as 8–10% which is comparable to the maximum scanning distortion that can be tolerated in a domestic television receiver.

[2] "Television Monitors," by J. E. B. Jacob, *Wireless World*, June, 1950.

Two-Band Transmitter Receiver

DETAILS of coils L_3 and L_6 (Fig. 2, p. 595, December, 1953, issue) were unfortunately omitted. They are the same as the corresponding coils L_2 and L_5, with the addition of a tapping 3 turns from the earth end on L_3 and 6 turns on L_6. Theoretically, R_7 in Fig. 1 should be 400 ohms when 6AM5 valves are used, but the 100 ohms should hold the cathode currents at a safe value. Also in Fig. 1 a 0.01-μF capacitor ought to be joined from the g_2 end of AFC_1 to earth. In the list of components for the receiver R_{11} was omitted; it should be 33 kΩ, 1W. P_2 should be 50 kΩ potentiometer.

In the list for the transmitter the tapping on L_2 should be 20 turns from the *anode* end. At the top of the right-hand column on page 594 capacitor values in the "pi" network should read: 500 and 300 pF for the variables in this order and 330 and 680 pF fixed respectively.

VALVE CODES *Problems of Devising a Useful and*

By M. H. N. POTOK,* B.Sc., A.R.T.C., A.M.I.E.E., A.M.Brit.I.R.E.

THE large number of radio and industrial valves in use to-day emphasizes the desirability of evolving some method of designation which will serve not only to distinguish valves which are not interchangeable, but also to give some information about the characteristics and potentialities of individual types.

A sequential numbering system fulfils the first of these requirements admirably, but does not give the vital information about the valve which is the essential function of a code. One of the chief difficulties in devising a code is to ensure that it shall be flexible enough to cope with unforeseen developments; this is never a problem with sequential numbering.

The arguments for having a code are, that it places the valves in suitable categories. Looking at the valve code number, the user may know without further reference whether it is a diode or a pentode or even whether it is an a.f. or an r.f. pentode, what is the heater voltage, what type of base it has, its size, type of envelope, etc. He may find all those or only some of them. The more information the code will contain, the longer it will be. But even the simplest is likely to eliminate at least one source of error and exasperation in selecting valves. It will also speed up the process of choosing a series of different valves to be used in a single piece of equipment. It will simplify redesigning, using modern valves as they appear. It may help the user to assimilate new developments by referring to types known to him under the code.

Let us take a few examples. Originally each branch of the Armed Services had its own designation system for valves. This has now been unified under a common valve (CV) system, which is strictly sequential. In it CV 138 is a well-known miniature, high g_m, 6.3-V heater, pentode; CV 129 is a 3-cm klystron. CV 2000 may be anything or nothing. The system covers virtually all electronic devices. It is ideal for stores.

In the Mullard code, EF 37 stands for a 6.3-V heater, voltage pentode amplifier on octal base (the last figure denotes a particular development of this type). PL 80 should be a 300-mA series heater, power output pentode with Noval 9-pin base. When EF 81 is advertised as a new product the user will subconsciously add this to the list of valves he knows something about.

In the R.T.M.A. American code 6J5 stands for a 6.3-V heater with five independent useful elements. It turns out to be a low-μ triode. 6J6 is a double triode while 6J7 is a pentode. All have 6.3-V heaters but give no information about anything else and no clue as to what, say, 6J8, would be.

On the whole it would appear that a code is preferable to a sequential system, but before giving a final judgment, let us examine what we want from a code.

It should be fairly clear that a good code should give the maximum amount of information, and yet be short and easy to memorize and to reproduce. Let us examine what sort of information can be given by a code. There is, of course, no limit to that, but the most essential data are possibly :—(*a*) Heater voltage or current; (*b*) Type of base; (*c*) Type of envelope; (*d*) Electrode structure; (*e*) Power-handling capacity; (*f*) Special features; (*g*) Applications.

Obviously if each one of these were to be given by a figure or a letter, the code would be unwieldy and therefore useless. Let us look at some of them in detail.

Heater voltage or current: This is probably the safest information to be given about hot-cathode valves, and the simplest code would be a figure giving the nearest integral voltage. The difficulty arises with series-connected heaters operating at constant heater current. At present the heater voltage is not likely to exceed 100 V, while current is almost always 100 mA or more, thus one could say that one or two figures denote the voltage but three figures will denote current. The danger is that with miniaturization of valves low heater currents may become more common, upsetting the system. It might therefore be safer to use figures for both, but precede current by some pre-arranged letter such as O, so that 20 would stand for 20 volts but O20 would mean 20 mA.

Type of base and envelope: This is very useful information to have in a code, and is also safe in the sense that new developments or requirements are not likely to call for a change of designation of existing types. As long as one chooses symbols which allow for expansion no trouble should be experienced. The present multitude of bases, not only as far as number of pins is concerned, but also their distribution, sizes and material of the base itself, creates a serious problem. No limitation is possible, because new developments will lay stress on new base characteristics, demanding ever new types and structures. A number giving the number of pins is useless if one thinks of, say, B8A, B8G, International Octal, Mazda Octal—all 8-pin bases. It seems that it would be necessary to sacrifice a self-explanatory code and use a two-letter or two-figure group to describe the base and envelope.

Electrode structure.—It is difficult to foresee future developments, but possibly, as far as the present types are concerned, a simple system giving the number of electrodes could be adopted for the conventional types, with the code letter or figure doubled for twin valves. Letters would be preferred here allowing for a larger number of twin-valve types. Thus B would stand for a diode, E for pentode, CC for double triode, BBC for double diode triode, etc. Letters following K might be used for other types of valves more or less arbitrarily.

Applications.—While this information is very useful it is also one that may cause confusion when it is found, say, that a valve originally designated as a general purpose voltage amplifier turns out to be particularly useful for a very definite application. It is possible that recoding should be allowed then. An arbitrary choice would have to be made to codify the

★ Dept. of Electrical Engineering, Royal Technical College, Glasgow.

various applications by a two-figure or two-letter group. This code might also cover any special features, such as secondary emission, exceptional reliability, etc.

Power-handling capacity.—This information could be dispensed with as the power could be judged quite closely from the other information given. It is also in this field that most changes occur as experience is gathered and new circuits developed.

The code would already be probably so long as to be useless and yet it is not even complete, because some allowance must be made in it for relatively small variations within one general type. Makers and users each have different ideas about the best valve characteristics of a particular type, and that is bound to result in there being at any time several, say, r.f. pentodes with 6.3-V heaters on octal bases in glass envelopes, and they could probably be differentiated only by a serial number. As it is unlikely that more than twenty such varieties will be found on the market, a simple letter might be used here. Even so, the code might consist by now of nine figures and letters mixed, say, BG12CC18K, which might be interpreted as miniature 7-pin base, 12-V heater, double triode, low-μ, serial letter K, if only it could be memorized together with several dozen other valves one constantly uses.

Having arrived so far we have now to consider dropping some information. Heater designation is possibly the first one could omit. After all most valves operate at fairly standard voltages. The application might also be omitted as somewhat artificial. In the new code BE17P would then stand for, say, diode pentode, Noval base, serial letter P. (The serial letter or number, while not common from type to type, would in itself give some information.)

One should also consider the possibility of having a short and a full code, the short code giving valve structure, application and serial number, while an additional code would give heater voltage or current and base type, thus: CC18K/BG12. One would then normally use the short code only.

Should There be One Code or More?

The advantages of a code which ties a valve type to a particular manufacturer are primarily connected with the sales aspect. Since manufacturers enter the valve business to sell their products, this aspect must not be minimized.

It may be said that a code system which is so different from any other that it ties in the user's mind the valve type to its maker, adds to the prestige of a good firm. It may also be argued that a less knowledgeable user may buy a replacement which bears the same code, and therefore comes from the same maker, as the valve which has just died on him, even if other makers make an identical valve under a different code. This, however, cuts both ways, and therefore may not be as important as it would appear.

One important aspect of the individual maker's code is that it simplifies the code to the manufacturer, who himself is not likely to make as many types and variations of one type as may actually be on the market. Also any small improvement or selection may easily be distinguished by the user (as for example EF37 and EF37A, or 715A, 715B, and 715C, etc.). This is very useful as long as the various codes in existence at one time do not confuse the user. Simplicity is also a great advertising asset.

On the whole, however, even at the cost of somewhat complicating the code, it would appear—and current American practice supports this view—that one code is preferable to many, with a central registration board allotting the code.

Current Codes

Let us now look at the codes used by the leading manufacturers and comment on them individually.

Mullard.—First letter stands for type of heating and voltage or current. Second letter and following denote the electrode system.

The first figure denotes type of base. Second figure stands for a serial number of a development.

The following table gives details of the meaning of letters and figures as placed:

	If first letter	If second or following letters
A	4 V, a.c., parallel	Diode
B		Double diode
C	200 mA, a.c./d.c., series	Triode
D	Battery 0.5–1.4 V	Power triode
E	6.3 V series or parallel	Tetrode voltage amplifier
F		Pentode voltage amplifier
G	5 V	
H	150 mA, a.c./d.c.	Hexode
K	Battery 2 V	Heptode or Octode
L		Output tetrode or pentode
M		Beam indicator
N		Gas triode
P	300 mA, a.c./d.c.	Secondary emission (if third letter)
Q		Nonode
U	100 mA, a.c. d.c.	
X		Gas filled full-wave rectifier
Y		Half-wave rectifier
Z		Full-wave rectifier

Figures:

1–19 various	50–59 B9G
20–29 B8G Loctal	60–70 sub-miniature
30–39 Octal	80–89 B9A Noval
40–49 B8A Rimlock	90–99 B7G miniature

This system was very good indeed, and largely self-explanatory, but it now shows sign of breaking down, especially in the miniature and sub-miniature ranges, because of numerous new developments. It certainly could not cope with all possible variations already on the market. In spite of that it remains the only code in use anywhere which is strictly logical.

Marconi, E.M.I., G.E.C., Osram, M.O.V.—The code consists of a letter or letters and a serial number. The letters stand for :

A—Special industrial applications	M—Metalizing (when used later in code)
D—Diode or double diode	N—Output pentode
GU—Gas-filled rectifier	U—Rectifier
GT—Thyratron	W—Var. μ screened pentode.
H—High-impedance triode	X—Frequency changer
KT—Kinkless tetrode	Y—Tuning indicator
L—Low-impedance triode	Z—Sharp cut-off screened pentode

This system is very simple and flexible. As types and applications multiply so, presumably, the list will grow longer and longer until it will be impossible to remember anything useful. No information is given about heater or base, but that could be added easily.

Ediswan, Mazda.—The first figure or figures give heater voltages or current, thus :

1 = 1.4 V	10 = 100 mA
6 = 6.3 V	20 = 200 mA

followed by a letter or letters :—

C = Frequency changer
D = Diode or double diode
F = Voltage amplifier, tetrode or pentode
K = Small gas triode or tetrode
L = Voltage amplifier triode or double triode
M = Tuning indicator
P = Power amplifier
U = Half-wave rectifier } without first figure
UU = Full-wave rectifier }

followed by a serial number.

This system is similar to the previous one, but with heater information which is only useful in the very limited range used.

Brimar (S.T.C.).—Three codes are used :

(1) If the valve is for export, the American RTMA code is adopted sometimes with a prefix SV.

(2) If for home market the code consists of a figure or figures, such as :

1—Half-wave rectifier	9—Var. μ pentode
8—R.F. pentode	20—Triode hexode

followed by a letter
A for 4-V heater
B for 2-V heater
D for indirectly heated, other than 2- or 4-V cathode
followed by a serial number.

(3) If special valves, the code consists of a number, such as :

2 Diode	5 Pentode
3 = Triode	22 Double diode, etc.
4 = Tetrode	

followed by a letter giving maximum anode dissipation and type,
followed by a serial number,
followed by one or two letters to indicate base type and special features.

The above systems provide the remaining variations of figures and letters although it will be noted that, say, 20D1 may mean 200mA. heater, diode (Mazda), or 6-V indirectly heated triode hexode (Brimar).

The last mentioned is the most elaborate of all, for example, 33A/158M is a double triode, anode dissipation under 10W., 158 is serial number, M stands for B8G base. It would be interesting to find the reaction of users to this code. It fails in not being flexible enough in describing the electrode system unless a new structure such as a klystron will be classed under a completely different code.

Continental makers such as Philips, Tungsram, Siemens Halske, use a code common with Mullard (given above).

American (R.T.M.A.) Code. All American leading manufacturers register any new valve they produce with this organization (Radio Television Manufacturers' Association) which allots it a code unless the difference between it and any existing valve is such that no knowledge of the difference is recognized to replace one by the other. This code consists of a first number symbol indicating rated filament or heater voltage within −0.4 to +0.6V, a first letter symbol consisting of one or two letters which in themselves are of no apparent significance, a second number symbol indicating the number of independent useful elements for which terminals are provided, without consideration of their function, heater or filament counting as one, as do combinations of one or more elements connected to one terminal.

A second letter or letters indicating distinguishing features, such as :—

G = Glass tube on octal base
GT = Above in a T-9 bulb
X = Low-loss base
Y = Intermediate-loss base
M = Metal-coated glass envelope on octal base
W = Military type assigned on behalf of armed forces.
A, B, C, D, E, F = a modified version of a type without the suffix.

Valves used specifically for industrial purposes have a sequential designation beginning with the number 5500.

Several manufacturers still use their own codes for special valve types but these are not common.

The main R.T.M.A. code, described above, gives only the heater voltage as a definite information, all the others being, more or less, differentiation marks or serial numbers. Some of the symbols such as G, GT appear to be vestigial and no equivalent symbols have come into use for other types of base and bulb. If one has to remember the difference between CJ5, 6J6, and 6J7, one might as well call them CV1933, CV858, and CV1936, respectively, as in the British Armed Services System.

Conclusions

While it does appear that a valve type code is preferable to a sequential system, there are very serious difficulties in deciding on a suitable and lasting code. Apart from those mentioned, one has to remember that other electronic devices will require codes as well and these must be such as not to be confused with the valve codes proper.

Possibly the best first step towards a solution would be for one of the professional institutions to organize a series of discussion meetings leading to the setting up of a committee representing manufacturers, users, Services, institutions, and the British Standards Institution, which should then give the findings of the committee its full sanction.

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How Fast is Electricity?

"CATHODE RAY" Makes Us Think Again About Currents

IT is a great pity that we are not all together so that we could hear one another's answers to this question. I am sure they would be most interesting. Probably those who are young enough to have been brought up on the "electronic approach" to electrical theory would be cautious and seek further information on what was meant by "electricity" before committing themselves to a firm answer; but not so long ago I heard a professional electrical engineer express surprise when someone cast doubt on his clear-cut idea that electricity travelled at the speed of light or thereabouts.

Nature of Electricity

Well of course the question is nearly as vague as "How long is a piece of string?" so we shall have to heed the cautious young men and say what we mean by "electricity." It is not enough just to substitute the words "an electric current." What is an electric current? It can be several different things, and perhaps more than one of these things at the same time. I suppose we couldn't go far wrong in defining it as a movement of electric charge. But that raises one complication right at the start: there are positive and negative charges. I have no intention of our becoming deeply involved in nuclear physics, so, firmly ignoring the boys from Harwell and all the special effects that to them may be normal, let us stick to the simple broad picture showing all matter as made up of atoms each having at the centre an electrically positive "sun" or nucleus, with electrically negative electrons circulating around it like planets, the number of such electrons depending on the element concerned—one for hydrogen, six for carbon, twenty-nine for copper, and so on. The positive charge carried by the nucleus is normally cancelled out by the negative charge of the satellite electrons, but if by any means one or more of the electrons become detached, what is left has a positive balance and is called a positive ion, or often just an ion. A current of electricity from A to B, then, consists of electrons moving from B to A and/or positive ions moving from A to B.

If the current is flowing in solid material, the ions are the fixed material itself, so cannot move, and the current consists wholly of electrons. In gases the ions too can move, but as they are thousands of times heavier than the electrons the general effect is rather like rowing boats streaming one way and Atlantic liners the other, both kinds of craft being propelled by identical outboard motors. In a vacuum, all matter is, by definition, absent. No vacuum is perfect, however, and the best pumping arrangements leave behind about a thousand million molecules, (i.e., small groups of atoms) in every cubic inch. But for most practical purposes this number is quite negligible—like the same number of flies in a space as big as the world.

Our simple picture (unobscured by all the quantum theory, Fermi-Dirac statistics, uncertainty principle and suchlike filled in by modern scientists) shows insulating materials to be built of molecules with electrons firmly attached, so that nothing can move and hence there is no current. In metals, by contrast, the electrons are free to move. And they do; not only when there is any organized inducement, but all the time, like a random crowd milling around, or a swarm of angry wasps in a box. These random movements are uncontrollable, except by temperature—the hotter the material the livelier the movement. Nevertheless, according to our definition *any* movement of an electron must be an electric current. But because the movements are random there is no tendency to move in any one direction more than another. At any given time, for every million electrons moving up a wire there are likely to be almost exactly a million moving down. So the tendency is for these tiny currents to cancel one another out. If you were to toss up a coin millions of times, for every thousand heads there would usually be just about a thousand tails. Occasionally—not very often—it would be exactly one thousand. Usually it would be a little more (positive) or a little less (negative). Taken over millions, the positives and negatives would average out to practically zero, but individual batches would fluctuate above and below. In the same way the vastly greater number of random electron movements in metal averages out to nothing—in other words, they do not result in any d.c.—but they fluctuate a little, up and down. The result is a.c. of no particular frequency, or, if you prefer, of every frequency.

Movement of Electrons

Is there any reason why, just for a moment, this fluctuation current might not be quite large, as a result of most of the random movements happening to move in one direction? No, there is no reason. Neither is there any reason why, if you are a football pool addict, you should not win £75,000. But it has been calculated that you would have to persevere for 300,000 years to have an even chance of doing so. The chance of heavy current as a result of a large proportion of random movements coinciding is even more remote. In practice they maintain a fairly steady average, enough to have considerable nuisance value in high-gain amplifiers, as "noise," but not perceptible otherwise. The speed of the electrons while they engage in this ceaseless activity, although no doubt of interest to physicists, does not have much bearing on our work. It is believed that at ordinary room temperature it is of the order of 100,000 metres (say 60 miles) per second. If electrons were like the lady who, when accused by the police of doing 50 miles per hour in a built-up area, replied indignantly that she couldn't have because she hadn't driven more than 10 miles in her life—if electrons I say, were like her, they would complain even more bitterly, for they seldom move more than about 10^{-8} cm without colliding with something, so the inside of a piece of metal must be like a night-club dance floor.

Organized Currents

Let us turn now from these dubious activities to consider something much more to the point—the organized movements of electrons under the influence of an e.m.f. or potential difference. These are what are most usually understood by the term "electric current." As we are still dealing with solid materials—in particular, metals—ion movements are impossible, so there are only electrons to consider. One principle at work here is the attractive force between opposite charges. If by any means a lot of electrons are removed from one end of a wire, that end has a corresponding number of un-neutralized nuclei, and is therefore positively charged. This offers an attraction to the neighbouring electrons, which start moving towards it. In doing so they leave behind a positive charge, and this attracts the electrons immediately behind. And so on, until electrons throughout the wire are on the march towards the end from which some have been removed. This would soon create a positive charge at the other end, which would then offer a counter-attraction that would tend to bring the column to a standstill again (apart, of course, from the random movement which goes on all the time, over and above any definite drift one way or the other). But if the agent that removed the electrons from one end conveys them by a different route to the other end to fill up the gaps left by the retreating column, the movement—the electric current—can be kept going indefinitely.

Such an agent is what we call an e.m.f. By making one end of the wire more positive and the other end more negative it creates a difference of potential between the two ends. If, for example, this p.d. were 5 volts, and the length of the wire were 10 metres, the wire and all its electrons would be in an electric field of 0.5 volt per metre. The nature of electrons when they are in an electric field is to move (if they can) through it positive-wards. In metals they can move, but are greatly hindered by the vast numbers of molecules, with which they keep on colliding. In other words, even a metal has resistance. Supposing our wire has a total resistance of 1 ohm, the number of electrons that the 5 volt p.d. will cause to pass any fixed point per second will be 31.2×10^{18}. The electron-per-second is rather an inconveniently small unit of current, and moreover does not fit in well with volts and ohms; the practical unit—the ampere—is equal to 6.25×10^{18} electrons per second, so the current in our example is of course 5 amps. But for the purpose of calculating the speed of the electron current it is necessary to reckon it in electrons per second. It is also necessary to know how many electrons there normally are in a given amount of metal. The speed at which troops would have to move in order to pass a fixed point at the rate of 10 soldiers per second would obviously be greater if they were in single file than if they were marching in close ranks 20 abreast. I have never actually counted the number of free electrons per cubic centimetre of copper, so I have to take the physicists' word for it that it is not far short of 10^{23}. Since our copper wire has a resistance of 0.1 ohm per metre it is probably 26 s.w.g., whose cross-sectional area is 0.00164 sq. cm., so the number of free electrons in each centimetre length is about 1.6×10^{20}. This is about 5 times the number that pass every second when the current is 5 amps, so the marching speed must be about 0.2 cm per sec. Hardly competitive with the speed of light! And that is with a current sufficient to make the wire decidedly warm, so it is a speed that in practice would seldom be exceeded, or even reached. In power stations and places where thousands of amps are flowing, they have much thicker conductors to flow in, so the electron speeds are generally less.

Another thing: we have been assuming that our current is d.c., so that its movement is in the same direction all the time. But most currents are alternating. Even at the relatively low frequency of 50 c/s the electrons have only one hundredth of a second at a time in which to move forwards. So if the average value of current in a 26-gauge wire were 5 A (r.m.s., 5.5 A; peak, 7.8 A) the total extent of any electron's movement would be only 0.002 cm. Even that minute promenade is liberal compared with the allowance at radio frequencies. Suppose you have a 50 Mc/s television dipole, and being fairly near the transmitter it has induced in it an average current of as much as 0.1 mA. The diameter of the dipole is, say, ½in, but owing to skin effect the current would be confined mainly to the outermost 0.0005in, so the effective cross-sectional area would be 0.005 sq. cm (equivalent to a 21-gauge wire) and the current density would be 20 mA per sq. cm. In our previous example the current density was 3,000 A per sq. cm—150,000 times as much—so the electron speed in the skin of the dipole is 0.2 150,000 or 0.0000013 cm/sec. But here the motoring lady intervenes to point out that the poor electrons never get anything like a whole second in which to keep right on at this fabulous speed; and she is quite right, for in point of fact each half-cycle of 50 Mc/s oscillation allows only one hundred-millionth of a second for each journey. The extreme distance travelled is therefore about 10^{14} cm! I am not sure what is the diameter of an electron or even whether it can be said to have a diameter, but one authority says it is somewhat greater than this. In which case, the Ancient Mariner has the best description of its activity—"Backwards and forwards half a length, with a short, uneasy motion."

Electricity in Aerials

All this must come as rather a shock to those who have pictured electrons dashing up and down aerials, let alone to any who still think in terms of the speed of light. To anybody at all, it must be difficult to imagine how such incredibly small movements—even in the aerial of a powerful transmitter they are sub-microscopic—can affect things many miles away. Seeing that 0.1 mA is far from being the smallest significant current, and 50 Mc/s far from being the highest known frequency, one begins to wonder if there may not be something wrong with data that lead to conclusions so hard to believe. Some physicists now say that not all the "free" electrons take part in currents, and if this is so the speed of those that do would be greater; but at most it would seem to be much less than we used to imagine.

So much for electric currents in solids. I don't propose to discuss currents through gasses, because they are complicated by the electrons bumping into the gas molecules and ionizing them by knocking out electrons, not only augmenting the electronic current but starting a relatively slow ion current in the opposite direction. Let us go straight on to vacuum. Here there are no electrons—or anything else—in significant quantity, so they have to be brought in. The most usual way of doing this is to heat a metal surface coated with barium oxide or some such material, which causes electrons to boil off in vast numbers. If there is no electric field, however, they tend to hang around, as in Fig. 1, and by forming a negative charge close to the emitter they prevent others from coming away. So let us place another piece of metal some distance off (Fig. 2) and make it positive relative to the first. This creates an electric field between what are now two electrodes, and the electrons are attracted away from the first electrode, the emitter or cathode, towards the anode, as in Fig. 2. By this time, of course, everybody has recognized that we are in Lesson One on the two-electrode valve. But perhaps not everyone who has taken even a whole course on valves could say right off how fast the electronic current travels through them, or how one finds out.

Acceleration in Valves

This is where a little knowledge of elementary mechanics is a great help ; in particular, what happens to freely movable things when a steady force is exerted on them. If you were unfortunate enough to fall out of a space-ship in level flight a few hundred miles from the earth you would be freely movable, because there would be no appreciable air to hinder you ; and the force of gravity would be acting downwards on you. The result would be that you would move downwards with steadily increasing speed. In other words, the constant force would cause a constant acceleration.* In this case the acceleration would be approximately what is now widely know as g, which is an increase in speed of 32 ft sec per second, usually abbreviated to 32 ft sec^2. It is easy to find how fast you would be falling n seconds after you had started (provided it was not long enough to bring you into the atmosphere) ; it would be $32n$ ft/sec. What is not quite so easy is to find how fast you would be falling after having fallen m feet, but a little elementary calculus shows it to be $\sqrt{2gm}$, or $8\sqrt{m}$ ft sec. The important fact is that the speed is proportional to the square root of force × distance.

Now each electron in a valve is "falling" towards the anode. The "force of gravitation" in this case is the electric field, which is reckoned in volts per centimetre or per metre. If you multiply this force by the distance through which it acts, the product is in volts. By analogy with mechanics one would expect the velocity imparted to an electron by V volts to be proportional to $\sqrt{V}$. It is quite a simple problem in basic theory to confirm this. At the start—assuming it is a standing start—the speed of an electron is zero, so it has no kinetic energy (energy of movement). But is has potential energy by virtue of the potential difference between it and the anode. This potential energy is equal to its charge multiplied by the potential difference ; in symbols, eV. At the end of the journey this potential energy has been entirely converted into kinetic energy, which mechanics teaches us is half the mass multiplied by the square of the speed (or velocity)—$\frac{1}{2}mv^2$. Since this must (according to the law of conservation of energy) be equal to eV, we have

$$v^2 = 2\frac{e}{m}V$$

The ratio of charge to mass of an electron, e/m, has been found by experiment ; it is 1.76×10^{11} coulomb kg, so

$$v = \sqrt{2 \times 1.76 \times 10^{11} V} = 5.93 \times 10^5 \sqrt{V} \text{ metres sec}$$

or $593\sqrt{V}$ kilometres per sec. or $368\sqrt{V}$ miles per sec.

One interesting thing about this is that the speed of the space current driven through a valve by ordinary anode voltages is of an altogether different order from that of the same current flowing through the connecting wires. At 100 volts it is 3,680 miles per second, which makes Duke and Lithgow look slow ; but its 5 mA (say) in a 26-gauge anode lead is only doing about 0.002 *millimetre* per second ! Another interesting thing is that the final speed depends only on the potential difference it has fallen through from rest, and not at all on the route it has taken or the uniformity or otherwise of the field accelerating it. So in Fig. 2, even if a negative grid were interposed, or the "space charge" of the relatively dense crowd of comparatively slow electrons near the cathode caused an appreciable local reduction of the anode's attraction, the speed of those ultimately reaching the anode would be just the same.

Although the speed developed by 100 V is still well below that of light, voltages of a million or more are commonplace in high-tension laboratories, and one can buy over the counter "linear accelerators" urging electrons on with the equivalent of several million volts. Suppose we are content with one million, and use the formula to calculate the final velocity ; it is $593 \times \sqrt{10^6} = 593{,}000$ km/sec. But what have we here ? A speed nearly twice that of light (299,792 km sec) ! According to Einstein and all modern physicists, that is impossible. The fault is in the formula, which does not allow for the fact that mass increases with speed. Up to about one sixth of the speed of light the increase is not more than 1%, so the formula is good enough up to 7,000 volts—perhaps even 15,000. But when the electron begins to compete seriously with the speed of light its mass increases very rapidly, and this ensures that it will never succeed in breaking the "light barrier." The

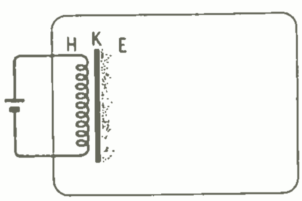


Fig. 1. Vacuum tube with a heater (H) which raises the temperature of a prepared surface (K) to the point where it emits electrons. These hang around in a cloud (E), their negative potential (space charge) tending to repel later emissions back to K.

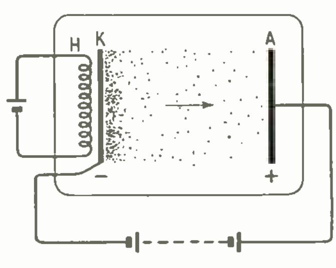


Fig. 2. When the negative space charge (E in Fig. 1) is neutralized by the high positive potential of the electrode A, a continuous current of electrons is set up from K to A.

* Actually, of course, the gravitational force would increase as the earth was approached ; but not very much in 100 miles or so.

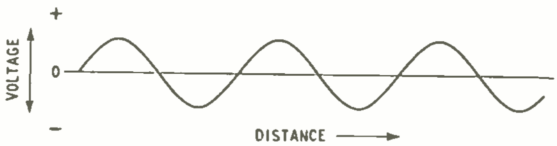


Fig. 3. Instantaneous graph of the voltage along a line carrying electromagnetic waves.

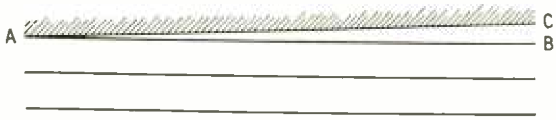


Fig. 4. The line AB represents an ocean wave rolling in towards a sea wall AC. During the time the wave takes to cover the distance from B to C, the splash on the wall has travelled from A to C.

voltage required would be more than infinitely great!

Whence, then, came the idea that electricity is as fast as light? Surely not from the fact that nowadays one can accelerate electrons to within 1% of that speed, but from the discovery that signals sent by electrical means—wire or wireless—go as fast. Now that we know that radio waves and light waves are the same thing except for frequency, and that frequency does not affect their speed, the idea that electricity is as fast as light is obviously correct if "electricity" is understood to mean "radio waves" or, more generally, "electromagnetic waves." If you connect a source of e.m.f. to the end of a pair of wires, it starts electrons moving in those wires. We have seen that (according to the data supplied by the physicists) this movement is incredibly slow, but that does not apply to the speed at which the *start* of the movement is passed along. One microsecond after you have made the connection, electrons nearly 330 yards along the line are starting to move. Assuming that the wires are insulated entirely by air—which in this particular respect is practically the same as nothing—the signal travels along the line at the speed of light. Solid insulating material increases the capacitance without any corresponding decrease of inductance, so the parts of line affected take longer to charge and the average speed is less. Along an ordinary r.f. coaxial cable it may be half the speed of light. But it is still enormous compared with the speeds of the individual electrons. You may start waving a suspended rope from side to side very slowly, but waves travel along the rope quite fast. With electrical signals the contrast is vastly greater.

Note that it is only a *change* in the electrical condition that goes at the high speed. If water is flowing very slowly and steadily through a pipe, nothing can be said to be travelling along the pipe any faster. But if the water is turned on and off, the effects are felt at the other end almost immediately, whereas the actual drops of water made to enter the pipe will not emerge until much later.

Now that we have progressed in stages from speeds of millionths of a millimetre per second up to the speed of light, 300,000 kilometres per second in round figures, it might well seem that there are no more worlds to conquer. Is it not basic to modern science that no speed can be faster than that of light? True; yet even so it may in a kind of way be possible for electrical signals to have a faster speed. When they are being sent as r.f. waves along an air-spaced line, the signals travel along it at practically the speed of light. If they could be "frozen" long enough for a graph to be drawn of voltage against distance along the line, it would be something like Fig. 3. Actually this voltage pattern would be travelling at the same speed as any group of waves forming (say) a Morse dot, so if it were possible to keep an eye fixed on a particular voltage peak its speed (the *phase velocity*) would be that of light. The group velocity and phase velocity in this case are the same. But if the signals were being sent along a waveguide this would not be so. It is too late to start explaining exactly how waves travel along a guide, but the nearer the wavelength is to a certain critical length the more they zigzag from side to side and the slower they travel directly along it. The group velocity, which is truly the speed of the actual signals, is therefore less than that of light—possibly much less. But the lower this speed, the longer the distance between successive voltage peaks along the axis of the guide, and the faster these peaks (or any other phases) travel. If the group velocity is half that of light, the phase velocity is double that of light. This may seem to contradict the laws of nature, but of course it only seems to do so. In actual fact it does not, because all that travels at this super-high speed is a phase pattern, not any actual energy or information. It is impossible, by doing anything at one end of the guide, to exert any influence on what takes place at the other end in a shorter time than light would take to do the distance. If waves are rolling in towards a sea-front very nearly at right angles to the coast, the splash of a wave arriving at one end A (Fig. 4) will travel very much faster along the front to C than the wave itself, which has only moved from B to C. No energy—still less any water—has travelled from A along with the splash.

What is the speed of electricity? Well, now you know!

Bigger and Bigger Tubes

THE trend towards bigger and bigger television screens, mentioned by our contributor "Diallist" in this issue, is confirmed by figures recently issued by the British Radio Equipment Manufacturers' Association. It will be seen from the following table that, whereas in 1950 40 per cent of the sets sold had either 9- or 10-inch tubes and only 2 per cent had screens of 14 inches or larger, the figures for the July/September quarter this year show that 72 per cent of the receivers sold had tubes of 14 inches or more.

	9in. and 10in.	12in.	14in.	15in.	16in.	17in.	Projection
1950	40%	56%	2%		—		2%
1951	13%	80%	4%		—		3%
1952	4%	71%	9%	14%			2%
Jan.-June 1953	3%	47%	24%	11%	3%	11%	1%
July-Sept. 1953	*	25%	36%	14%	2%	20%	*

* Combined sales of small-tube and projection sets totalled 3 per cent.

We understand that the combining of the sales figures in some cases is done to avoid disclosing information regarding the sales of individual firms where only one manufacturer is supplying a specific type of set.

C.R. Tube Safety

By W. TUSTING

Transient Conditions When Switching On and Off

IT is now the usual practice to use direct coupling between the video stage of a television receiver and the cathode of the c.r. tube. The grid of the tube is then connected to a potential divider across the h.t. supply, the grid potential being thus negative to the cathode potential and adjustable as a brightness control. A by-pass capacitor is usually connected between grid and negative h.t., as shown by C_1 in the figure, but sometimes it is joined between grid and positive h.t., as in the case of C_2. In the figure, C_1 and C_2 are to be regarded as alternative positions for the capacitor; the two are not normally present simultaneously.

If the effect of any ripple on the h.t. line is ignored, the capacitor is equally effective in either position. When the receiver is switched on or off, however, a transient condition exists during which the position of the capacitor appears, at first sight, to have a considerable effect; it appears, in fact, that it could influence the life of the cathode-ray tube.

It is argued that, because the charge on the bypass capacitor cannot change instantly, the grid is left behind when any sudden change of h.t. voltage, and hence of cathode potential, occurs. With the capacitor at C_1, for instance, a sudden drop to zero in the h.t. voltage would take the tube cathode to earth but leave the grid at its normal potential to earth. The grid would then be positive to cathode. Similarly, if C_2 is the capacitor, a sudden jump in the h.t. voltage from zero to its normal value would take the cathode up to its normal value, but, since C_2 would be uncharged, the grid would be carried right up to positive h.t. Again, the grid would be positive to cathode.

There is, in fact, nothing wrong with the argument; it is the premises that are at fault. If the h.t. voltage did, in fact, come on or go off instantly, the effects on tube life could be serious. But, in reality, the voltage cannot change quickly in normal switching on or off and so nothing to endanger the tube does occur. It is, however, worth while to examine the conditions in some detail.

First of all, consider what happens when a normally operating receiver is switched off. The h.t. voltage drops to zero, but not instantaneously, for the capacitors in the h.t. circuit take some small time to discharge. The time will vary quite a lot between different receivers because of the various forms of circuit employed and is, in any case, quite difficult to calculate accurately. As a rough approximation to it, however, we may consider the discharge of a capacitor equal in value to the total h.t. supply capacitance, through a resistor equal to the h.t. voltage divided by the total h.t. current. In a typical modern set the capacitance may be 200 μF and the resistance 250/160 $= 1.56\ \text{k}\Omega$. The time constant is $200 \times 10^{-6} \times 1.56 \times 10^3 = 3.12 \times 10^{-1} = 0.3$ second. The voltage will have fallen to a negligible value in about four times this period or 1.2 sec. This agrees with practical experience, which is that a receiver goes on functioning to a decreasing extent for at least one second after it is switched off; sometimes it does so for appreciably longer.

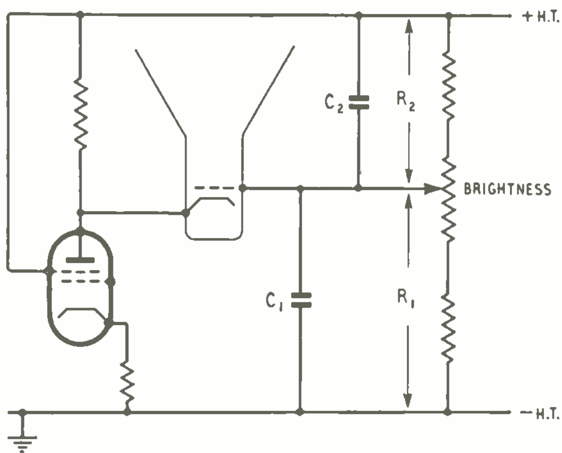
In the figure, therefore, the cathode of the tube falls to earth potential in not less than one second after the set is switched off. If C_1 only is present, the grid voltage cannot fall to earth as quickly because it is taken from the h.t. supply through a circuit of time constant $T = C_1R_1R_2/(R_1+R_2)$. If this time constant is comparable in value with, or larger than, the time constant of the h.t. supply, the grid voltage will lag behind the cathode voltage by a considerable amount, with the result that the grid-cathode voltage will be less negative than during normal operation. Theoretically, the grid might become positive to the cathode, with quite bad effects on the life of the tube. If it were possible for the h.t. voltage to drop instantly to zero, this would always happen, for the cathode would drop to earth while the grid would be held at its normal value by the charge on C_1.

It is because of this that it is often recommended that the brightness control should be turned right down before switching off. It is not, however, always a necessary safety precaution because there is still no risk if the time constant T is small compared with the h.t. time constant. The two voltages will then fall with substantially the same time constant, and the grid-circuit time constant will have negligible effect.

The grid is often at about 50 V above earth in normal operation. For a 250-V supply R_1 might be 10 kΩ and R_2 40 kΩ. With 0.1 μF for C_1, the time constant is

$$T = 10^{-7} \times 8000 = 8 \times 10^{-4}\ \text{sec}$$

This is very small compared with the 0.3 sec of the h.t. supply and would still be small even if it were ten times as great. There is thus very little risk with



The bypass capacitors C_1 and C_2 are not usually both employed together. One of them only is used.

the normal values of components, and it is not usually necessary to turn down brightness before switching off.

In the alternative position for the capacitor, using C_2 instead of C_1, there is no possibility of the grid becoming positive to the cathode whatever the values of the time constants. If the h.t. voltage could drop instantaneously to zero, so that the cathode could drop at once to earth, the grid voltage would change negatively by an equal amount and the grid-cathode voltage would be unchanged. The charge on C_2 would be unaltered and so the grid voltage relative to plus h.t. would be unaltered but, as plus h.t. would have dropped to earth, the grid would have dropped below earth.

The use of C_2 is inherently safe under all conditions on switching off. The use of C_1 is, in normal practice, also safe, but could be unsafe if the relevant time constants were very unusual.

It is now necessary to consider what happens when switching on. There are two distinct possibilities to take into account. What happens depends on whether the video stage and tube become operative before or after the h.t. voltage is applied.

The first condition is obtained when an indirectly-heated rectifier is used and its warming-up period is, as it should be, longer than that of the valve and tube. The rise of h.t. voltage depends not only on the electrical time constant of the h.t. supply circuits but also on the rectifier valve itself. The rise usually takes several seconds, as anyone may see for himself, by watching a voltmeter connected across the h.t. supply. The needle takes several seconds to reach its final value. The tube cathode rises with the h.t. and at the same rate.

Using C_1 only, the grid potential rises also, but, because of the time constant T, it lags somewhat on the h.t. voltage. The grid is more negative to cathode than normal, and this is a completely safe condition whatever the time constants.

With C_2 only, the conditions are reversed; C_2 charges from the rising h.t. voltage and the voltage across it lags on the h.t. voltage. The grid voltage relative to cathode is thus somewhat less negative than it should be. It is necessary, therefore, to have the time constant small compared with that of the h.t. supply for the condition to be a safe one. The conditions are much the same as on switching off using C_1, and so normal component values are safe ones.

The second h.t. condition occurs when a directly-heated rectifier or a metal rectifier is used. The h.t. voltage is then at its normal value, or somewhat above it, before the valve and tube are operative. No harm will come to the tube even if, while its cathode is cold, its grid is momentarily carried positive to its cathode. Before valve and tube function, the grid voltage will have its normal value determined by the setting of the brightness control and the tube cathode will be at positive h.t., so that the grid will be more negative than usual to cathode. There is no harm in this, even if the tube warms up before the valve. When the valve draws current the cathode voltage drops to its normal value. This condition is consequently a completely safe one.

There are two conditions only when there is a theoretical possibility of the grid of the tube becoming positive to its cathode. The first is on switching off when C_1 is used, and this can be obviated completely by turning down the brightness control before switching off. The second is on switching on when C_2 is used and the h.t. supply contains an indirectly-heated rectifier.

However, provided that the time constant of the grid circuit of the tube is much smaller than that of the h.t. supply, all the conditions are adequately safe in practice. It is not necessary even to turn down the brightness control before switching off; that is, as far as the grid-cathode conditions are concerned. If the e.h.t. circuit has a time constant long compared with that of the h.t. supply, it may be advisable to do so to minimize any risk of the screen being burnt.

One other thing: if the set is switched off and then on again within a few seconds a dangerous condition can occur, for all valve heaters will still be hot and the switching-on conditions will not be the normal ones. There is no risk with C_1 but there is a slight one with C_2. With the h.t. rectifier hot, the rise of h.t. voltage will be more rapid than the decay on switching off and the effective h.t.-circuit time constant may no longer be large enough compared with the time constant of the grid circuit of the tube for the conditions to be completely safe.

It will be clear, therefore, that it is normally safe to use the grid bypass capacitor in either position. There is a slight preference for using it in the C_1 position, which is the usual one, but it is very slight.

Manufacturers' Literature

Underwater Television Equipment with image orthicon camera capable of operating at a depth of 1,200ft and with remotely controlled optical focusing. Descriptive leaflet from Pye, Ltd., Radio Works, Cambridge.

Negative-resistance Elements ("Brimistors") for suppressing surges and compensating resistance variations. Data booklet with list of types and characteristic curves from Standard Telephones and Cables, Footscray, Kent.

Wire-wound Potentiometers in values up to 25kΩ linear and rated at 2 watts Leaflet from A.B. Metal Products, 16, Berkeley Street, London, W.1.

Precision Castings and Fine Tubing in nickel alloys. Manufacturing processes and applications described in an illustrated booklet from Henry Wiggin and Company, Wiggin Street, Birmingham, 16.

Vitreous Enamelled Resistors, using nickel alloy wire, with values from 9kΩ to 100Ω, ratings up to 180 watts and tolerances of ±5%. Data booklet from the distributors, Radelec, Ltd., 63, High Street, Cheltenham.

Flat Twin Transmission Lines with impedances from 75Ω to 300Ω. Leaflet giving characteristics at 1 and 100 Mc/s and at amateur transmission frequencies. From The Telegraph Construction and Maintenance Company, Telcon Works, Greenwich, London, S.E.10.

Helical and Toroidal Potentiometers; a comprehensive illustrated catalogue giving specifications and constructional details from P. X. Fox, Hawksworth Road, Horsforth, Yorks.

Amplifying Telephone Sets with m.c. microphone in handset and battery-powered amplifiers for transmission and reception in the base of the instrument. Technical description on a leaflet from Lustraphone, St. George's Works, Regents Park Road, London, N.W.1.

Sub-miniature Electrolytics measuring ¾in long by ¼in diameter with values up to 8μF and working voltages up to 50V. Technical bulletin from The Telegraph Condenser Company (Radio Division), North Acton, London, W.3.

"Ferroxcube," an informative booklet on this material, including an historical survey, details of physical structure, electrical and magnetic properties, mechanical features, application data and standard core dimensions. From Mullard, Ltd., Century House, Shaftesbury Avenue, London, W.C.2.

Components and Accessories, a comprehensive illustrated catalogue for mail orders from the Radio Servicing Company, 82, South Ealing Road, London, W.5.

F. M. Feeder Unit, a leaflet describing a unit (or kit of parts) made according to the design by Amos and Johnstone in our September and October, 1952, issues. From Bel Sound Products Co., Marlborough Yard, London, N.19.

Manufacturers' Products

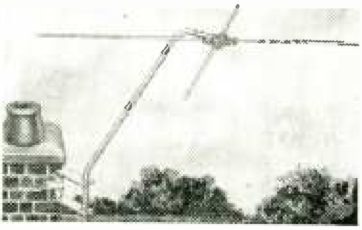
NEW EQUIPMENT AND ACCESSORIES FOR RADIO AND ELECTRONICS

New Television Aerials

TWO new models and a refinement to an existing one comprise the latest additions to the range of television aerials made by Antiference, Ltd., 67, Bryanston Street, London, W.1.

One new model is a wall-mounting dipole incorporating the quick-assembly feature described as "snapacitor" fitting. It is pre-assembled at the factory, but its main feature is that the feeder is capacitance-coupled, not directly connected, to the dipole. It is an addition to the existing wall-dipole and can be used either vertical or horizontal. The price is 27s 6d complete.

The other new model is a horizontal "Antex," or "X," aerial fitted on a swan-neck mast. It is available with chimney stack lashings, Model X4L/H costing 70s, or for wall-mounting, Model X4W/H, at 61s 6d.



Antiference horizontal "Antex" television aerial now available on a swan-neck mast for chimney or wall mounting.

The refinement is incorporated in the new "Univex" indoor aerial, the two telescopic tube sections now being enclosed in cream coloured PVC to tone with the centre insulator. Known as Model U2RC, it costs 21s with 15 ft of cream coloured coaxial cable, or 15s without.

Pickup Arm

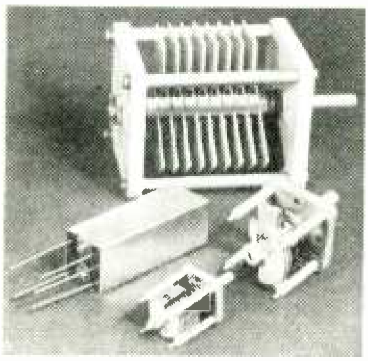
A KIT of parts is now available for a tone arm to match the moving-coil pickup designed by A. M. Pollock for home construction. The outfit comprises a simple, but effective, pivot post with hardened bearing point, a box-section laminated plastic arm, a bearing spindle for the vertical motion and a lead counterweight. The user is called upon to drill and file out a slot in the arm, drill and tap the lead weight and mark out, drill and reamer the holes for the horizontal bearing, operations which call for reasonable skill in the use of hand tools. The price of this kit, which is obtainable from A. M. Pollock, 14, Broomfield Lane, Hale, Cheshire, is 26s by post.

H.F. and V.H.F. Components

A NUMBER of new Eddystone components for short- and very short-wave receivers and transmitters have been introduced by Stratton and Co., Ltd., Alvechurch Road, West Heath, Birmingham, and, together with existing items, will be included in a new catalogue shortly to be issued.

Among the new items is a series of transmitting capacitors in split-stator, differential and plain types ranging from 25 + 25 pF to 250 pF. The specimen shown here is a 100-pF size with vane spacing of 0.08 in and it will stand up to the highest r.f. voltages likely to be encountered in small transmitters provided the d.c. is applied through a parallel path. End plates are ceramic $2\frac{1}{2}$ in square.

In contrast to the above is a new miniature Microdenser in butterfly, split-stator and plain types. A single ceramic back plate measuring $\frac{3}{4}$ in square is used. The capacitances are 25 + 25 pF or 50 pF according to type. For comparison of sizes we include in the illustration one of the normal Microdensers of 15 + 15 pF in split-stator style mounted on a ceramic end-plate 1.3 in square. All metal parts in Eddystone capacitors are heavily silver plated.



Selection of new Eddystone components, comprising 100-pF transmitting capacitor, standard and new miniature Microdensers and 5.2-Mc/s discriminator transformer.

Of interest to builders of f.m. receivers is a range of 5.2-Mc/s i.f. units in small metal cans 0.8 in square and 2.4 in high. Included are discriminator and plain i.f. transformers and a BFO unit.

RANDOM RADIATIONS

By "DIALLIST"

Taxi!

MY RECENT mention of the intrusion into a tape recording of a message from a radio-taxi to its headquarters brought me a large number of letters from readers, to whom I am most grateful. They gave instances of break-through from taxis, police cars, walkie-talkies, fire brigade radio-links and amateur transmitting stations into not only tape recorders, but p.a. systems, TV sound stages and even baby alarms! As many of my correspondents point out, there must be pick-up by some lead, which happens to be of just the right length, and rectification. The latter process could take place in a variety of ways; a "dry" soldered joint or a poor switch contact are examples of possible adventitious metal rectifiers. And an amplifying valve will function as a rectifier of sorts if it is overloaded by a signal of large amplitude. I gather there have been some rather embarrassing incidents with p.a. systems when the loudspeakers blared forth for all and sundry to hear remarks very definitely not intended for public consumption.

Shooting a Line

ONE HEARS various explanations offered for the occurrence of a narrow white vertical line near the left edge of the television screen when some cameras are in use. Well, here's the truth straight from the horse's mouth—though I hope my B.B.C. informant won't think I'm calling him a horse! There is an overshoot in the trailing edge of the line sync pulse; rising from blacker-than-black, it doesn't stop at the black level, but goes up as a little "pip" well into the greys. The effect is more marked in some cameras than in others and it is apt to be accentuated when the signal travels over a long network. The B.B.C. is doing its utmost to reduce the overshoot; but some of the receivers of to-day don't make things too easy for them. If the line flyback is rapid, the overshoot has no visible effect, for the white line that would be due to it is pushed right off the screen. With slow flyback it is apt to come in as an unwelcome addition to what is otherwise a good picture. And so, for the time being, at any rate, those whose receivers are designed in that way must regard the white line as just one of those things.

Counsels of Perfection?

IT IS, I suppose, to the demand for cheaper and cheaper television receivers that the present trend towards the live-chassis design for sets of all kinds is mainly due. Strict as the B.S.I. requirements are, I can't say that I'm altogether easy about the position. BS415 lays down that all openings in a television cabinet must be of such size and shape that the "standard finger" can't be pushed through any of them dangerously near to any live part. This gadget has joints, which can be locked or left free to move, and represents a long, thin human finger. In other words, everything seems perfectly safe, so long as the back stays put. But, the television receiver has become so much a part of domestic equipment that it is not unusual for quite small children to be left by themselves watching Muffin the Mule or the Flowerpot Men. The B.S. test equipment doesn't, so far as I know, include a standard metal knitting needle—and that was the prodder used by one youngster, of whose exploit I heard recently. At his age, I'd have been very tempted to do the same. He was not hurt, but his dropping the needle into the set and his mamma's subsequent stout work with the fire extinguisher made a pretty expensive mess of things. My suggestion, for what it is worth, is that all six walls of the cabinet of a live-chassis receiver should be lined with metal gauze, bonded and earthed. I'd like, too, to see an arrangement which switched off the set when the back was removed. I'm all for having two capacitors in series (and not just a single capacitor) between set and dipole. And, lastly, I *would* like to see a complete prohibition of the use of eighth-watt resistors in most parts of a TV receiver.

Fitting 'Em In

THE URGE felt by so many to buy television sets with larger and larger c.r. tubes is a curious one, considering the small living rooms of modern houses. You murmur the expected words of polite admiration when friends proudly show you their umpteen-inch set; but when the monster is switched on you may find that, even if you jam the back of your head tight against the opposite wall, you can't get far enough from the screen to see the picture properly. I'm speaking, needless to say, of receivers that do not employ either spot-wobble or spot-elongation. Given either of those—spot-wobble for choice—a big-tube receiver can give a good account of itself in a small room. Without them you must in such circumstances strain your eyes by looking at a liney picture, in which every small imperfection is all too obvious. A good rule of thumb is that the room must be at least as many feet one way as there are inches across the receiver screen.

That Awkward Question

MANY READERS must suffer as often as I do from one of the most embarrassing of all requests for advice: "I want to buy a television set, but I don't know the first thing about them. Be a good chap and tell me which is the best to get." Years ago I made a firm resolution that I'd never again recommend anything to anybody! There's always the risk, for one thing, that if you do recommend a particular this or that, the man who takes your advice may be landed with the one and only dud in the history of the firm that made it. But when it comes to television sets there's a much more important consideration than that: when a man buys one of them he also, so to speak, buys the dealer with it. The best of sets can be badly handicapped, if it is installed and maintained by a not very skilled, and perhaps not very enthusiastic, serviceman. Most of the dealers whom I know are good; but there is the odd black sheep.

At It Even Then

A FRIEND SENT ME the other day a copy of a now almost forgotten wireless periodical, which he had found while rummaging amongst some old papers. The issue bore a date early in 1936 and I was interested to find that it contained an article from my pen, forecasting the havoc that motor-car ignition interference would play with television, unless something were done quickly about it. What a difference there would be to-day, had an act been passed those eighteen years ago to compel manufacturers to provide all new cars with suppressors! Interfering vehicles would now be few and far between; and when a "snowstorm" did break out on the screen we'd have the comforting thought that the veteran causing it wouldn't be on the road much longer. I believe that the only country which did outlaw interference radiators of all kinds was Germany. It was not television that its then rulers had in mind: they were out to ensure that the working of v.h.f. apparatus used by their army and air force should not be upset. If, though, the law has remained in force, German viewers must be reaping the benefit.

UNBIASED | By FREE GRID

Æsthetics and Anæsthetics

JUST LATELY the newspapers seem to be full of the wonders that we are to see on our TV screens in a few years' time when the B.B.C. and the proposed rival corporation are locked together in the fierce struggle of competition. One thing that I am glad to see is that programmes from the proposed new corporation's transmitters are to be strictly controlled and there will be no need to send the children out of the room when we switch on the TV set, a thing which I have frequently had occasion to do when carrying out experimental work on the reception of a certain Continental station.

"Peeping at his pancreas."

Despite the promise of strict programme control, there is some danger that in years to come something not suitable for children—nor yet for adults—may be televised; this was brought home to me very forcibly recently when talking with a country doctor living in a remote district amid the Cymric Hills. He pointed out to me that, by comparison with medicos living on the doorstep of a hospital, he and others similarly situated had fewer facilities for keeping in active touch with the latest surgical developments. Yet, of course, they really had more need of them, for they frequently had to cope with sudden surgical emergencies themselves as there was no nearby hospital to which they can send the patient.

He is, therefore, eagerly hoping that the Ministry of Health will buy time from the proposed corporation and give TV broadcasts, straight from the operating theatre, of front-rank surgeons employing the latest techniques. Now this seems at first sight to be a very desirable development, but, to say the least, these anæsthetic presentations would be unæsthetic. Speaking personally, I have no desire at some future date for my midriff to be exposed to the morbid-minded mob or my ribs to the ribaldry of the rabble.

Surely, no man in his right senses wants to have the public peeping at his pancreas or leering at his liver; I hope, therefore, you will all join with me in demanding, before it is too late that such "programmes," if televised, should be thoroughly scrambled and the necessary de-scrambling apparatus supplied only to doctors and medical students.

Coherers in 1908?

LIKE THOSE of you who have been readers from the first number of *W.W.* and experimenters for a long time before that, I have during the course of years accumulated a considerable amount of wireless apparatus. From time to time Mrs. Free Grid has made an onslaught upon it and made a bonfire of all that she could lay hands on. There has, however, always been a considerable residue in the hinterland of the loft which she has been unable to reach owing to the suspected presence of woman's natural enemy, the mouse.

It is more years than I care to remember since I previously penetrated the jungle of disused household paraphernalia up there, but I recently did so in an endeavour to find an old newspaper to settle an argument as to the precise date of the relief of Mafeking.

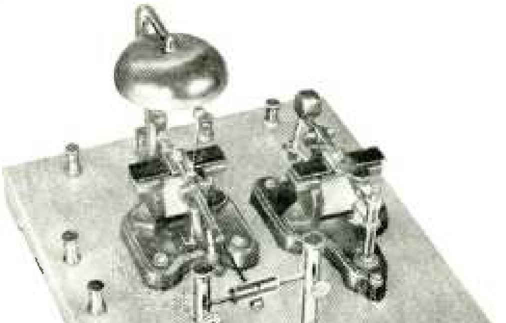
I was astonished at the wealth of early and primitive wireless gear I found, but the most interesting was a coherer-decoherer unit in a remarkably good state of preservation. I have not the slightest recollection of acquiring the instrument and I find it very difficult to assign a date to it. I am hoping that some of you with long memories will be able to help me from the few details I give.

It is not an experimental instrument made by an amateur, nor yet a commercial one of the type used by ship and shore stations in the early days of wireless. The familiar D.R.G.M. marking on it leaves me in no doubt of its origin and I should say it was imported from Germany for sale to amateurs.

At first I thought it might have been sold by one of the big departmental stores, but I find that none of them started a wireless department until 1908 and surely that was too late for coherers? These primitive receivers started to disappear from commercial W/T stations soon after the arrival in 1902 of the magnetic detector, but these were expensive and massive devices and maybe coherers did linger on in amateur circles until the close of the Edwardian era. If so, possibly some of you will recognize the unit from my photograph. The instrument by the side of the coherer is a relay, presumably for working a morse inker for which two terminals marked M are provided. There are terminals at each end of the coherer for aerial and earth and two pairs marked + and − for batteries.

"That's Champion!"

DESPITE all the propaganda I don't think the majority of motorists fit suppressors to their plugs to stop interference to TV. In the early days of television we used to hear about the detrimental effect which suppressors were supposed to have on engine performance. This was disproved so thoroughly that the argument is seldom heard now. I am afraid that nowadays offenders simply take the couldn't-care-less attitude. A move in the right direction has, however, been made by a well-known maker of sparking plugs who supplies them with built-in suppressors. "That's champion!" as a Lancashire man might say, and I only hope the other plug-makers will follow suit and that eventually no maker will produce a plug without a built-in suppressor.



Primitive wireless receiver.