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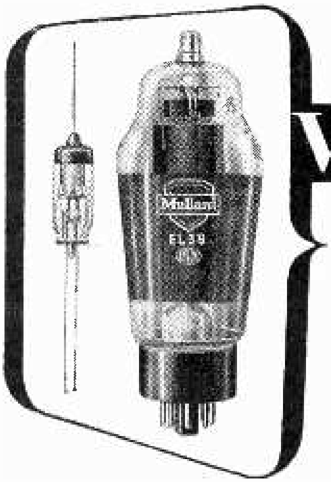

Valves and their applications

THE RINGING CHOKE CIRCUIT FOR E.H.T. GENERATION

When the current through a coil is suddenly interrupted, the oscillatory circuit formed by the coil (L) and its associated capacitance (C_S) will "ring" at a frequency determined by L and C_S and the resulting voltage waveform will be as shown in Fig. 1 (a). This principle is utilised in what is commonly called the Ringing Choke method of E.H.T. generation.

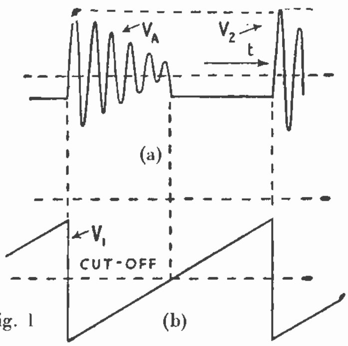

Fig. 1

Fig. 2 shows a practical circuit in which an EL38 operates as a switch which periodically interrupts the current through L. The switching voltage which is applied to the grid of the EL38 may be as shown in Fig. 1 (b).

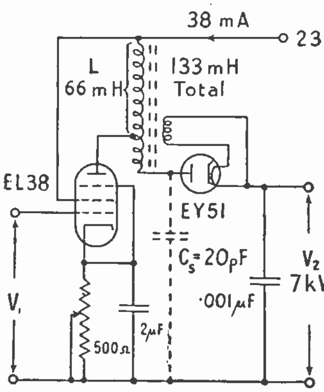

Fig. 2

In the choice of a valve for the circuit, two factors are of primary importance: the valve must be able (*a*) to supply large peak currents at low anode voltages and (*b*) to withstand large pulse voltages on its anode; the EL38 fulfils both these requirements adequately.

The mode of operation of the circuit is as follows:—during the period when the EL38 (V1) is conducting, magnetic energy is stored in L; when V1 is cut off, the oscillation which results may be regarded as an interchange of energy between L and C_S. At the end of the first quarter cycle, the energy stored in L (less the loss due to circuit resistance) has been transferred to C_S and the high voltage produced is rectified by the EY51 diode. The open circuit D.C. output voltage at the cathode of the EY51 will be approximately equal to the peak voltage and will leak away, at a rate determined by the time constant of the external circuit, as shown dotted in Fig. 1 (a). By connecting the anode of V1 to a tap on L, the output capacitance of V1 is transformed into a smaller equivalent capacitance, the contribution to C_S is reduced and the peak voltage will be increased (V^2_{peak} is proportional to $1/C_S$).

It will be noted that the EY51 heater supply is derived from a subsidiary winding coupled with L; the coupling should be adjusted until the colour of the EY51 heater is the same as that of a similar diode fed from a 6.3 V. 50 c/s supply.

The energy loss to the EY51 heater adds to the resistive losses associated with L and C_S and reduces the effective Q of the oscillatory circuit; with a circuit Q as low as 16, however, the peak voltage is reduced by only 5% below that voltage which would result from a loss-free circuit. Since a high Q is, therefore, not of great importance, the physical dimensions of L may be reduced considerably by the use of a high permeability iron-dust core.

The source impedance (R_S) of an E.H.T. supply of this type is approximately equal to $1/(C_S f)$ ohms where f is the repetition frequency of the waveform fed to the grid of V1 (10,125 c/s when this is derived from the line time base generator). The power (P) drawn from the H.T. line for both anode and screen supply may be estimated from the expression $P = V_O^2/R_S$ watts where V_O is the open-circuit E.H.T. voltage.

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Wireless World
RADIO AND ELECTRONICS
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Europe's New Broadcasting Frequencies

AFTER deliberations lasting some ten weeks the delegates of twenty-five of the thirty-two nations participating in the European Broadcasting Conference at Copenhagen have signed the Convention which provides for the re-allocation of frequencies to broadcasting stations in what is now known as the European Broadcasting Area.

The Copenhagen Plan, 1948, as it is called, is largely the work of a committee led by H. Faulkner, Deputy Engineer-in-Chief of the British Post Office. The committee, on which L. W. Hayes, B.B.C., also sat, is to be congratulated on producing a plan which, in spite of the prevailing international unrest and rivalry, proved acceptable to the majority of the delegates. The gargantuan task of accommodating in 139 channels some 340 stations and synchronized networks and in addition providing for numerous low-powered stations on two international common frequencies having been completed, it now remains for the governments of the countries concerned to ratify the Convention. Provided this is done the Copenhagen Plan will come into operation on March 15th, 1950—just ten years after the still-born Montreux Plan would have been implemented, had it not been for the outbreak of World War II.

In order to accommodate all the stations within the two bands (long and medium wave), both of which have been extended in accordance with the provisions of the recent Atlantic City Convention, it has again been necessary to allow only 9 kc/s for each channel. There will be general regret that it was found impracticable to increase channel width to 10 kc/s, as is done in the United States, but the alternative plan providing for this was rejected. Its introduction, with the resulting simplification of dial markings, would have been welcomed by both manufacturers and listeners. However, as will be seen from the full list of allocations printed elsewhere in this issue, channels have been numbered arbitrarily, but it seems doubtful in any case if the American practice of marking channel numbers on receiver dials will become general in Europe.

On paper the Plan appears to be perfectly satisfactory but its implementation bristles with difficulties. The major trouble is the appointment of an organization to supervise its continued operation. When the Lucerne Plan was introduced in 1933 there was one international organization—the Union Internationale de Radiodiffusion—which could and did undertake this formidable task. Since 1946, however, a second body—the Organisation Internationale de Radiodiffusion—set up originally under Belgian sponsorship has sought recognition. Both organizations were represented at Copenhagen, yet neither is in a position to act as the mouthpiece of all European countries; in fact, some countries, including Great Britain, are not members of either organization. It will be seen, therefore, that the provision of the Convention for the appointment of an international organization to "facilitate the entry into force of the Plan and to supervise its effective and regular implementation" is of paramount importance. The fact that the nomination of this organization by the International Telecommunication Union has to be approved by twenty-eight of the participating governments is likely to create an impasse.

Commenting on the Plan, Sir William Haley, B.B.C. Director General, recently told manufacturers: "It will need both statesmanship and technical skill to bring the Plan into operation. Then it should last five years. Whether at the end of that time the answer to Europe's wavelength problems will be F.M. no one can quite say. But at all events Europe by that time should be in a better state to put it into operation if F.M. does prove to be the answer. It is no answer to-day. Not a nation in Europe could face the vast change-over its adoption would demand." *Wireless World* is not at all sure that F.M. will be the answer, but we are certain that Europe will need some form of E.H.F. if it is to have high-quality broadcasting with a wide choice of local progammes.

SCALE DISTORTION —AGAIN

Clarifying Some Recent Misinterpretations

By "CATHODE RAY"

IT is notoriously difficult to find anybody who can repeat with perfect accuracy what Gladstone said in eighteen-hundred-and-whatever-it-was. So perhaps it is only to be expected that what the obscure "Cathode Ray" said about scale distortion in 1937[1] has, with the passage of time, become corrupted[2]. Seeing that my term "scale distortion" seems to have been widely adopted—in fact I have heard of no rival to it—perhaps I may be allowed a post-war say on the subject.

By scale distortion I mean the way in which adjusting the loudness of a sound programme alters the balance of tone. Its most noticeable feature is that when the loudness is reduced the bass diminishes much more than the higher tones. Various schemes of "bass compensation" have been devised for counteracting this effect. The whole subject seems to be a perpetual source of controversy among sound-quality enthusiasts, much of it springing from misunderstandings of one kind or another.

Definitions

First of all one has to be perfectly clear about the distinctions between sound power, intensity, and loudness. Haziness here has led to my being accused of wanting to get as many watts of sound out of my home loudspeaker as the B.B.C. Symphony Orchestra get out of their instruments. What I do claim is that in order to hear a programme reproduced with the same balance of high and low tone as in the original it is necessary that the sound entering the ears should have the same intensity as when listening to the original. How much sound *power* is necessary for this purpose depends on circumstances. If the reproducer is a pair of headphones a fraction of a milliwatt may be enough. A loudspeaker playing at the far end of a large well-upholstered hall may have to be emitting several watts of sound and need dozens or scores of electrical watts to drive it. The amount of water needed to flood a room to the same depth as a swimming bath is not necessarily as much as is in the swimming bath. It all depends on the size of the room.

How about loudness? Some people speak as if an intense sound and a loud sound were the same thing. That may be all right in ordinary conversation, where "intense" seems a bit pedantic and "loud" is generally used instead. But this must never be done in a technical or scientific context. Intensity refers to the sound itself; loudness to the effect on the listener. To a literally stone-deaf person no sound, however intense, has any loudness whatever. To people who can hear, however, sound faithfully reproduced at the same intensity at the ear as the original is equally loud. But it is a great mistake to conclude that loudness is directly proportional to intensity. It is surprising that the Americans, who have studied acoustics more than anybody, should have practically guaranteed this particular confusion by reckoning both intensity and loudness in terms of the same unit, already a somewhat overworked one—the decibel. It is just about as muddling as it would be to specify the speed of a car in horse-power.

For one thing, although sound intensity can be measured fairly accurately, nobody can tell precisely when one sound is twice as loud as another. My estimate might be quite different from yours, and who could prove which was right? By averaging many people's estimates of how much the intensity of a sound has to be increased to make it twice as loud, a result in the region of eight times has been obtained; but individual figures differ widely. Even if everyone could agree on the same figure, it wouldn't hold good at every level of sound. For suppose the intensity of a sound that is just too weak to be heard at all is increased eight times (or whatever the agreed ratio might be). Assuming the sound is thereby made audible, the increase in loudness (i.e. from nothing to something) is not twofold, because twice zero is zero.

Another thing; experiments show that whereas a sound that is strong enough to seem very loud at one frequency is about equally loud at all audio frequencies, one that sounds soft at high frequencies is entirely inaudible at low frequencies. So when they do become audible, low notes must increase in loudness more steeply than high notes.

Practical Measurements

Evidently there is no hope of any simple formula for connecting intensity and loudness. What has been done is to take as a starting point the intensity of sound that is on the "threshold of audibility"; that is to say, the dividing line between being heard and not heard by people with normal hearing in perfectly quiet surroundings. And since the intensity at this point depends so much on frequency, 1,000 c/s has been chosen, being a good round

[1] "Scale Distortion," *Wireless World*, September 24th, 1937.

[2] H. S. Casey. "Quality in the Home," *Wireless World*, August, 1948; and letter, September, 1948, p. 346.

number somewhere near the middle of the scale. Intensity is reckoned on a decibel scale, because the zero can be put anywhere that is convenient—in this case at the threshold of audibility at 1,000 c/s. Every 10 db above this represents a 10-fold increase in intensity (20 db is 100-fold, 30 db is 1,000-fold and so on).

Loudness is reckoned in phons. The threshold of audibility is the obvious starting point for a loudness scale, so is marked 0 phons—at all frequencies. Zero phons coincides with 0 db at 1,000 c/s, because 0 db was defined in such a way as to make it so; but sounds of lower frequency have to be made much stronger than 0 db to be heard. That experimental fact is shown by the lowest curve in Fig. 1. A 36 c/s sound has to be about 60 db—a million times—stronger than 1,000 c/s to make itself just heard.

We already know that it appears futile to try to make a distance on the phon scale mean any definite number of times louder. So the whole problem of "How much louder?" has been bypassed by an arbitrary decision to make the phon scale coincide with the decibel scale at 1,000 c/s. Note that although a 60 db sound is 10 times stronger (i.e. more intense) than a 50 db sound, a 60 phon sound is not necessarily 10 times (or any other definite number of times) louder than a 50 phon sound. Nor is the increase from 50 to 60 phons necessarily the same amount of loudness increase as one from 20 to 30 or 100 to 110. In other words, whereas a decibel is a certain definite intensity ratio anywhere on the diagram, a phon has no exact meaning by itself. So nothing could be more confusing than to call these loudness units decibels. Saying that the loudness of a sound is, for example, 60 phons means no more than that it is the same loudness as that experienced by a person with normal hearing when a 1,000 c/s sound is raised 60 db in intensity from the threshold of audibility.

By noting the intensities of sounds of other frequencies that are judged to be equal in loudness to the 60 phon 1,000 c/s sound, the 60 phon curve in Fig. 1 was plotted and similarly for the others. These curves are known, after the investigators who compiled them, as the Fletcher-Munson curves.

Suppose, then, that a certain programme includes (in succession) sounds of 100 c/s, 1,000 c/s and 6,000 c/s, all at 100 db at the listener's ear. According to Fig. 1 they should all sound, as nearly as he can tell, equally loud, that loudness being denoted by 100 phons. Incidentally, that is about the loudest sound likely to be heard when listening to a large symphony orchestra. Now suppose that the intensity of the whole programme is reduced by 60 db. The loudness of the 1,000 c/s note is now, by definition, what is called 40 phons. But the curves indicate that the 100 c/s will have faded out almost entirely, while the 6,000 c/s is 36 phons. Instead of the loudnesses of all the sounds being reduced equally, as were the intensities, the balance of tone has been radically altered.

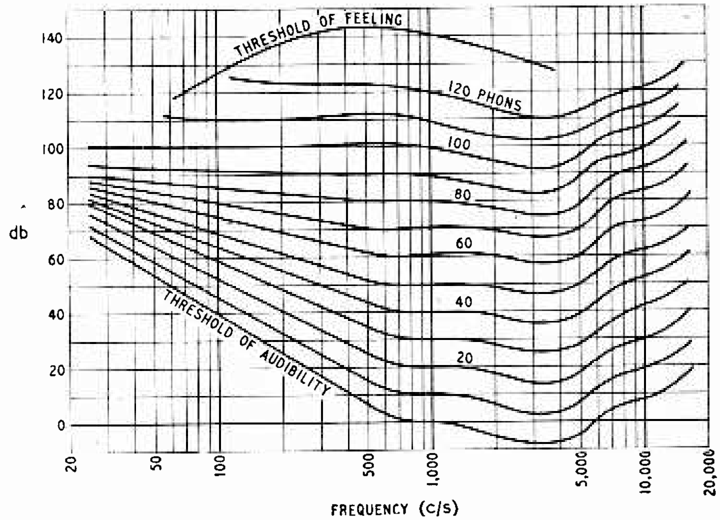


Fig. 1. Equal loudness curves. (After Fletcher and Munson.)

The truth of this is borne out by experience. When the volume control is turned down, the bass more or less disappears. If the original programme were at a low level, enlarging it would cause the loudness of low notes to increase much more than the middle and top. This effect is painfully noticeable when the voice of an announcer speaking quietly in the News studio is, by turning up the volume control, literally made to shout from the housetops. His crisp tones become throaty and bellowing.

Unless sound is reproduced at the same level as the original, the balance of tone cannot be the same as in the original, no matter how "high-fidelity" the equipment. Altering the scale of the reproduction does more than merely making it louder or softer.

It has been pointed out to me that as this effect is not necessarily connected with reproduced sound, but occurs just the same when one moves towards or away from the orchestra itself, it is wrong to call it distortion. If distortion of a sound is taken to mean some change that cannot occur naturally, in direct listening, that is fair enough. It raises an interesting question, too; one that sound-quality enthusiasts always come round to sooner or later—should the aim be the most natural sound or the most pleasing sound?

I am not going to be drawn off into a general argument on that question just now; I have only raised it to point out that one's attitude to scale distortion—and even whether one calls it distortion at all—depends on how one answers it. If you consider the quality of any natural sound, however unattractive or badly heard, to be sacred, and any modification of that sound by a

Scale Distortion—

reproducer, however pleasing, to be a sin, then "distortion" is not the right word. But if you hold that the job of the sound reproducer is to reproduce the original *as heard at the optimum position* (and still more if you are so heretical as to believe that the object is to emit the most pleasing sound, regardless of what the original is like) then you will probably accept the term "scale *distortion*."

Another thing I have been accused of doing is advocating "bass compensation" as a remedy for scale distortion. If the charge had been one of taking every opportunity to discredit bass compensation it would have been nearer the truth. By bass compensation I mean any attempt to counteract the relative loss of low tones when the volume is turned down, especially when such a device is linked with the volume control. From Fig. 1 it is an easy matter to draw a curve showing how the frequency characteristic is modified by a given change of intensity. Suppose, for example, that normal listening loudness is assumed to be 80 phons at all frequencies. The sound intensities required to produce this loudness at various frequencies have been entered on line *a* of the Table. Now suppose that the volume control is adjusted successively to −20 db, −40 db, and +20 db relative to the original setting. The resulting loudnesses are tabulated on lines *b*, *c*, and *d* respectively, and when plotted, as in Fig. 2, indicate a striking amount of scale distortion. On lines *e* to *g* are entered the volume control adjustments that would be necessary at each separate frequency if the original uniformity of loudness were to be preserved at levels of 60, 40, and 100 phons respectively. These are plotted as Fig. 3, and show the combined volume and tone control characteristics required for the specified conditions, according to the calculations of bass compensation exponents.

The first comment is that programmes in which sounds of all frequencies continue at constant strength all the time are fortunately rare. If the original loudness, although *averaging* 80 phons, had not been level over the frequency band, the required compensation characteristics, as calculated above, would have been different. Still, their general trend would have been similar, and that is probably the most that reasonably pessimistic bass-compensation designers hope to achieve.

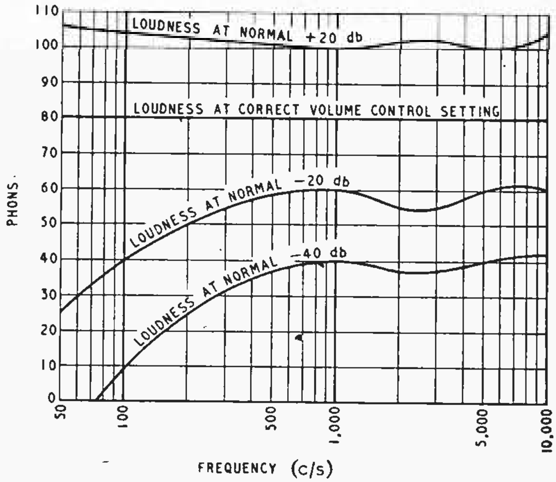


Fig. 2. Scale distortion when 80-phon sound is reproduced at various volume-control settings, derived from Fig. 1.

The next objection is, I think, more serious. The Fig. 1 curves apply only to comparisons between steady pure tones heard one at a time. Programmes of that character are also rare; unaccompanied flute solos are about the only ones I can think of that come anywhere near qualifying. When two or more sounds are heard together, each tends to "mask" or suppress the other, and the extent to which they do so depends on frequency and intensity in an even more complicated way than loudness in Fig. 1. So with most programmes, which contain many constantly changing sounds, it is impossible to tell theoretically how far Fig. 1 is a guide to scale distortion. Listening tests indicate that even in complex sound patterns the broad result is something like what one would expect if Fig. 1 were valid. But it is a shaky proceeding to base design figures on Fig. 1.

Granting, however, that one is justified in boosting the bass whenever it is necessary for any reason to reproduce sound programmes much below their normal intensity, what is one to say about bass compensation as usually understood, which links the boosting device with the volume control so that the job is done automatically?

It is founded on the assumption that the amount of bass correction required is a function of the

TABLE

Line		Frequency (c/s) 50	100	200	500	1,000	2,000	5,000	10,000
a	db for 80 phons	88	85	83	81	**80**	76	80	93
b	Phons at (original db − 20)	25	40	50	59	**60**	55	60	60
c	Phons at (original db − 40)	—	9	25	37	**40**	37	40	42
d	Phons at (original db + 20)	106	104	103	101	**100**	102	100	105
e	db difference for 60 phons	-7	-10	-13	-19	**-20**	-17	-20	-20
f	db difference for 40 phons	-14	-20	-27	-36	**-40**	-37	-40	-43
g	db difference for 100 phons	12	15	17	21	**20**	18	20	16
h	db for 60 phons	81	75	70	63	**60**	59	60	72
i	Compensation at 60 phon setting (from *e*)	13	10	7	1	**0**	3	0	0
j	Phons with (*h* + *i*) db	91	79	70	61	**60**	63	60	60

volume control setting. But the amount of correction required is actually, as we have seen, a function of the amount of enlargement or reduction in scale of the original sound (presumably at the best position for listening). So, for automatic bass compensation to do what it is meant to do, this change in scale must be a function of the volume control setting.

But is it? Consider an evening's broadcasting. When first switched on we hear, shall we say, a band concert, with announcements between. If we are good neighbours, or the children are trying to get to sleep, we may decide that a "life-size" reproduction is slightly too much. At our setting of the volume control, then, any compensation ought to consist of bass boost. The announcements, when they come on, will probably be broadcast nearly if not quite as loudly as the band, and even at the slightly reduced volume may well be an acoustical *enlargement* of the announcer's original quiet tones. So compensation *at the same volume control setting* should be bass cut.

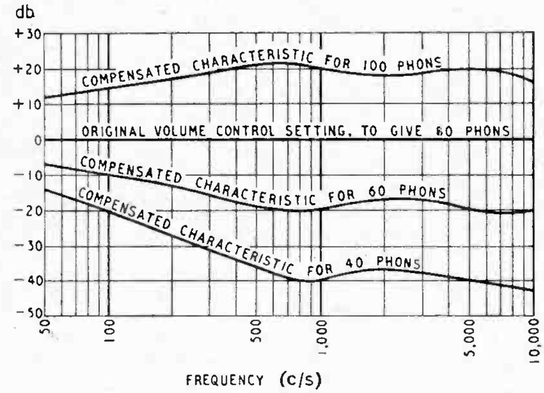


Fig. 3. Modified frequency characteristics necessary to level out the curves of Fig. 2; also derived from Fig. 1.

As I said in 1937, even patent medicine advertisers don't usually go so far as to offer the same dose as a stimulant and also as a sedative.

Fig. 3, as we have seen, shows the correct compensated volume control characteristics, assuming:

(1) that the Fletcher-Munson curves hold good for mixtures of sound as well as for separate sounds.

(2) that the volume control setting giving the level characteristic makes all sounds in the programme 80 phons loud all the time.

(3) that 80 phons also happens to be "life size."

But if now the programme material changes so that "life size" is a level 60 phons, and we turn the volume control down by 20 db in the attempt to reproduce it so (which should require the values given on line *h* of the Table), it automatically introduces compensation to the extent shown on line *i* (difference between −20 and *e*), giving the loudness/frequency characteristic on line *j*, plotted as Fig. 4. Instead of being level, as it should be, it has a rise of over 30 phons at 50 c/s!

There are other things that affect the scale of reproduction at a given volume control setting. Such things as a small aerial, a distant station, an insensitive loudspeaker, and a large well-upholstered listening room tend to reduce the scale, quite independently of the bass compensation if it is linked to the volume control. Tying volume and tone control up together, therefore, is founded on a fallacy.

But, after all, is it often necessary to reduce or enlarge sound? Except in special circumstances, such as the need to avoid disturbing other people, surely it oughtn't to be? A debatable exception is when music is used as a background. One may retort that that isn't listening at all, so refinements of tonal balance need not be considered. But whether we approve of it or not, a lot of people do like musical backgrounds, and most of them prefer at least as large a proportion of bass as when the music is full-size. For one thing, low tones are less distracting than high.

Life-sized Intensity

But when programmes are listened to, and circumstances allow, surely the whole purpose of a volume control is to allow one to adjust the sound intensity always to optimum, which is presumably life-size as heard from the best seat in the hall. That is the moment at which some people say "How can you expect to be able to hear a full symphony orchestra at its loudest in an ordinary room at home?" I hope my remarks about intensity and loudness have disposed of the idea that there is necessarily any difficulty about that; but if not I would say that in 1938[3] I made tests with a sound level meter during a concert rehearsal in the old Queens Hall in the morning, comparing them with the same music as heard at home in the evening. The general conclusion can be summed up by saying that a receiver capable of giving only 1½ watts maximum output to a loudspeaker in a typical living room was fully capable of giving the same sound level as was experienced in a favourable seat in the concert hall, notwithstanding that some exceptionally heavy music was played.

So, it seems to me, the proper use of the volume control is to set the sound always to the level at which it is intended to be heard. When that is done, there is no scale distortion, so the

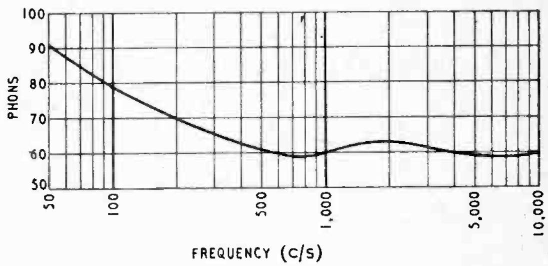


Fig. 4. If the compensated 60-phon characteristic of Fig. 3 were used, instead of a level one, to reproduce sound life-size at 60 phons, the result would be excessive bass as shown here.

[3] "Loud Speaker versus Orchestra," *Wireless World*, March 10th, 1938.

Scale Distortion—
volume control ought not to be tied up with any sort of tone compensation.

But what if there are special occasions when the level at which the programme is intended to be heard differs substantially from the level at which one wants to or is obliged to hear it? What is the correct policy when the scale is reduced? If the tone is left unaltered, then presumably the result will be the same as if the programme were heard at a distance; that is to say, it will be a natural result. (That is not necessarily quite so, because retreating to a distance usually introduces echo effects and unequal attenuation, which are not reproduced by turning down the volume control; but let us ignore them). Boosting the bass may restore the balance of tone, but it will be an unnatural result because it is in the nature of things for the bass to become less prominent when the sound is diminished. Here is the old controversy of Perfect v. Pleasing Sound Reproduction.

If when I go to a piano recital I am unlucky enough to get a seat bang up against the piano, the thought that the bass-heavy music I am hearing sounds exactly like natural piano music as heard bang up against the piano and is therefore a perfectly true and natural article is no consolation to me, and I would gratefully accept some device which would introduce a certain amount of bass cut. If, on the other hand, my ill luck takes me to the back of the hall under the gallery, and all I can hear is a distant tinkling, I would have no conscientious scruples against availing myself of a spot of bass boost.

As for using music as a background to work, persons who do this are so depraved that obviously the finer questions of audio ethics hardly enter into it. I myself favour some bass boost.

Photographic Analogy

One thing more I have been taken to task about[4] was using photographic enlargement and reduction as an analogy to explain scale distortion. I likened it to an imaginary and deplorable process of photographic reduction which resulted in a man's feet being reduced 100 times when his body was reduced 10 times. I did not intend this analogy to be scrutinized minutely—few analogies can stand up to that—but only as a rough illustration to introduce the subject. To have gone into the finer points in detail would have involved perspective, orthography, and such matters which would probably have required even more explanation than scale distortion itself. But since Mr. Patric Stevenson has raised some interesting points, and since I myself have recently gone fairly fully into the subject of perspective in another connection,[5] it may be worth discussing now as a sort of tailpiece.

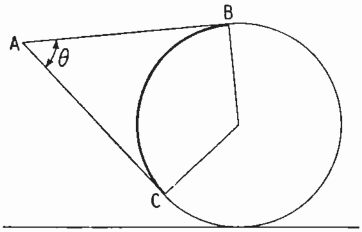


Fig. 5. A visual analogy of scale distortion.

Imagine a sphere about the same diameter as one's height. Viewing it from a distance, one can see practically half its surface—the whole of a hemisphere, in fact. But viewed close up, as at A in Fig. 5, the visible surface is reduced to what lies between B and C. Parts near C, which at a distance can be seen clearly spaced out, appear relatively small or even vanish. Except that it is when the view as a whole is made larger that the bottom part of the view suffers a proportionate loss, and it is a direct view and not a reproduction, this is quite a good analogy of scale distortion, though it is not the same as my earlier one or Mr. Stevenson's.

The visible proportions of the sphere, then, depend on the distance at which it is viewed. If it is photographed by a distortionless camera, the proportions disclosed by the photograph are, of course, the same as those seen from the point of taking. And if the photo is viewed at such a distance as to make the angle of view the same as the sphere itself makes at that point (e.g., θ in Fig. 5), the reproduction is perfectly natural, in that it appears the same size as a whole and in all its separate parts as does the original from the direct viewpoint. If the photographic reproduction of the "scene" is regarded as analogous to the loudspeaker reproduction of a programme, then this would correspond to hearing the programme at the correct intensity (angle of view) albeit using a smaller amount of sound power (picture smaller than the original). Ideally one should always look at a picture so as to make the angle subtended by it at the eye the same as the scene did at the camera; then and only then is it in correct perspective.

Out of Focus

But if the photo is taken close up and is printed small, it is generally impossible to view correctly, because it would be too close to the eye to be seen in focus. The ordinary contact print viewed at a comfortable distance therefore makes the size of the scene correspond to a more distant view than at the camera position, yet gives it the same proportions as if viewed close up, and is, therefore, unnatural—something that could not be seen at all without optical intervention. It corresponds to a sound programme that must perforce be heard at a reduced intensity, but has been compensated to give the same tone proportions as if heard close up. We are familiar with the type of snapshot in which the unnaturalness is only too obvious, especially when the nearest objects to the wide-angle camera were feet. That corresponds to a broadcast in which the microphone is too close to the source of sound, with the result that the sound picture is bass-heavy.

If sound were always reproduced at the original loudness and pictures were always viewed at the correct distance to subtend the same angle as the original, what a lot of argument it would save!

[4] Patric Stevenson. "Scale Distortion and Visual Analogies," *Electronic Engineering*, October, 1944.

[5] "Television Picture Size," *Wireless World*, January, 1948.

COPENHAGEN FREQUENCY ALLOCATIONS

New Wavelengths for Europe's Broadcasting Stations

ALTHOUGH the European Broadcasting Convention signed at Copenhagen last month is not yet generally available, we are able to give below, by courtesy of the Secretariat of the Conference, the frequency allocation plan agreed by the majority of delegates. The signatories were: Albania, Belgium, Byelorussia, Bulgaria, Czechoslovakia, Denmark, Finland, France, Great Britain, Greece, Hungary, Ireland, Italy, Monaco, Netherlands, Norway, Poland, Portugal, Morocco and Tunisia, Rumania, Switzerland, Ukraine, U.S.S.R., Vatican City, and Yugoslavia. Objections were raised by Austria, Egypt, Iceland, Luxembourg, Sweden, Syria, and Turkey, whose delegates did not therefore sign the Convention.

The Plan provides for the re-allocation of wavelengths in the long-wave and medium-wave bands to all broadcasting stations in the European Broadcasting Area—that is, to both the contracting countries and the non-signatories. This area is bounded on the South by parallel 30° N; on the West by a line extending from the North Pole along meridian 10° W to its intersection with parallel 72° N, thence by great circle arc to the point of intersection of meridian 50° W and parallel 40° N, and thence by a line leading to the point of intersection of meridian 40° W and parallel 30° N; on the East by meridian 40° E, so that it includes the western part of the U.S.S.R. and the territories bordering on the Mediterranean Sea.

It will be seen from the footnotes that provision has been made for the use of directional aerials by a number of stations. Except in cases where a definite power is specified directional aerials must give a reduction in the radiated power in the direction to be protected of approximately 10db relative to that of a non-directional aerial.

In the last column we have added the frequency at present used by the stations. Space does not permit the inclusion of the present power, but in general this is lower than the maximum prescribed in the Plan. The power of stations operating in the two international common frequencies is limited in some cases to 2 kW and in others to 0.25 kW. Whilst on the question of power, it is noteworthy that, whereas the Montreux Plan prescribed maximum day and night powers, the present Plan makes no such differentiation.

Provision is made for a number of stations not yet in operation, among them eight in this country. They are a third transmitter at each of the following stations: Burghead, Stagshaw and Westerglen; and new stations at Aberystwyth, Hartland Point (N. Devon), Carlisle, Ayr and Dundee.

So far as broadcasting in this country is concerned, the Plan provides for one long and thirteen medium wavelengths. This is three more than allocated in the Lucerne Plan, although at present the B.B.C. is making use of three "borrowed" wavelengths—one long and two medium.

Of the fourteen wavelengths allotted to the B.B.C. three of them (one long and two medium) are exclusive. It is learned from the B.B.C. that the frequencies will be utilized as follows:—The Light Programme will be radiated on 200 kc/s and 1,214 kc/s. Eight frequencies in the medium band, 692, 809, 881, 908, 1,088, 1,052, 1,151, 1,457 kc/s, will be used for the Home Service.

The Third Programme will be radiated on 647 kc/s, where provision is made for three new transmitters, and on 1,546 kc/s by the existing twenty-two low-powered synchronized stations. Incidentally, the power of Droitwich (647 kc/s) may be increased to 150 kW if the three new synchronized transmitters are not in use. The two remaining frequencies (1,295 and 1,340 kc/s) will be used for the European Service.

For ease of reference stations sharing the same frequency are given in the lists in alphabetical order of the countries.

LONG WAVES (150 to 285 kc/s)

Channel	Freq. (kc/s)	Power (kW)	Station	Pres. Freq. (kc/s)
1	155	10	Tromso (*Norway*)	291
		150	Brasov (*Rumania*)	160
2	164	450	Allouis (*France*)	—
3	173	500	Moscow I, Russia (*U.S.S.R.*)	174
4	182	100	Reykjavik (*Iceland*)	271
		10	Lulea (*Sweden*)	392
		120	Ankara (*Turkey*)	182
5	191	200	Motala (*Sweden*)	216
6	200	400	Droitwich (*Great Britain*) (or Ottringham)	200 (167)
7	209	150	Kiev I, Ukraine (*U.S.S.R.*)	248
8	218	200	Oslo (*Norway*)	260
9	227	200	Warsaw I (*Poland*)	224
10	236	100	Leningrad I, Russia (*U.S.S.R.*)	208
11	245	150	Kalundborg (*Denmark*)	240
12	254	200	Lahti (*Finland*)	160
13	263	150	Moscow II, Russia (*U.S.S.R.*)	232
14	272	200	Ceskoslovensko (*Czechoslovakia*)	155
15	281	100	Minsk, Byelorussia (*U.S.S.R.*)	269

INTERMEDIATE (415 TO 490 kc/s AND 510 TO 525 kc/s)

Channel	Freq. (kc/s)	Power (kW)	Station	Pres. Freq. (kc/s)
—	420	10	Ostersund (*Sweden*)[1]	415
—	433	10	Oulu (*Finland*)[2]	433
—	520	1	Hamar (*Norway*)[3]	519

[1] Directional aerial protecting S.W. [2] Directional aerial protecting S.W. [3] Directional aerial protecting S.

(For Medium Waves see next page.)

MEDIUM WAVES (525 to 1605 kc/s)

Chan-nel	Freq. (kc/s)	Power (kW)	Station	Pres. Freq. (kc/s)
1	529	150	Beromunster (*Switzerland*)	556
2	539	135	Budapest I (*Hungary*)	546
3	548	20	Oukhta, Finno-Karelia (*U.S.S.R.*)	1,195
		100	Simferopol, Russia (*U.S.S.R.*)	859
4	557	20	Cairo II (*Egypt*)	1,348
		100	Helsinki (*Finland*)[4]	1,420
		50	Monte Ceneri (*Switzerland*)	1,167
5	566	100	Athlone I (*Ireland*)	565
		5	Catania (*Italy*)	1,104
		10	Palermo (*Italy*)	565
6	575	100	Riga, Latvia (*U.S.S.R.*)	583
7	584	120	Vienna I (*Austria*)	592
8	593	60	Sofia II (*Bulgaria*)[5]	767
		150	Sundsvall (*Sweden*)[6]	601
9	602	150	Lyon (*France*)	895
10	611	5	Eidar (*Iceland*)	615
		120	Rabat I (*Morocco*)	601
		100	Petrozavodsk, Finno-Karelia (*U.S.S.R.*)	648
		60	Sarajevo (*Yugoslavia*)	603
11	620	150	Brussels I (*Belgium*)	620
		50	Moalatya (*Turkey*)	—
12	629	100	Vigra (*Norway*)	629
		120	Tunis II (*Tunisia*)[7]	823
13	638	150	Prague I (*Czechoslovakia*)	638
14	647	15	Burghead (*Great Britain*)	—
		120	Droitwich (*Great Britain*)	583
		15	Stagshaw (*Great Britain*)	—
		15	Westerglen (*Great Britain*)	—
		100	Kharkov, Ukraine (*U.S.S.R.*)	385
15	656	20	Bolzano (*Italy*)	536
		80	Florence I (*Italy*)	610
		80	Naples I (*Italy*)	1,312
		45	Turin I (*Italy*)	986
		150	Murmansk, Russia (*U.S.S.R.*)	648
16	665	100	Vilna, Lithuania (*U.S.S.R.*)	536
17	674	100	Marseilles (*France*)	749
		10	Bodo (*Norway*)	253
		100	Rostov-on-Don, Russia (*U.S.S.R.*)	556
18	683	150	Belgrade I (*Yugoslavia*)	686
19	692	10	Nicosia (*Cyprus*)	—
		150	Moorside Edge (*Great Britain*)	668
20	701	100	Banska-Bystrica (*Czechoslovakia*)	392
		5	Czechoslovakian sync. network	—
		120	Rabat II (*Morocco*)	868
		20	Finnmark (*Norway*)	347
21	710	150	Limoges (*France*)	648
		150	Stalino, Ukraine (*U.S.S.R.*)	776
22	719	120	Lisbon (*Portugal*)	629
		50	Damascus I (*Syria*)	592
23	728	100	Athens (*Greece*)	601
24	737	1	Akureyri (*Iceland*)	—
		20	Jerusalem I (*Palestine*)	677
		50	Gliwice (*Poland*)	1,231
		50	Seville (*Spain*)	731
25	746	120	Hilversum I (*Netherlands*)	995
26	755	20	Kuopio (*Finland*)	527
		50	Lisbon (*Portugal*)	722
		50	Timisoara (*Rumania*)[8]	968
27	764	150	Sottens (*Switzerland*)	677
28	773	50	Cairo I (*Egypt*)	620
		150	Stockholm (*Sweden*)[9]	704
29	782	100	Kiev II, Ukraine (*U.S.S.R.*)	200
		70	Soviet troops in Germany	722
30	791	150	Rennes (*France*)	1,040
		50	Salonika (*Greece*)	804
31	800	100	Leningrad II, Russia (*U.S.S.R.*)	1,010
32	809	100	Burghead (*Great Britain*)	767
		5	Dundee (*Great Britain*)	—
		20	Redmoss (*Great Britain*)	767
		100	Westerglen (*Great Britain*)	767
		135	Skopje (*Yugoslavia*)	1,240
33	818	100	Poznan (*Poland*)	868
34	827	100	Sofia I (*Bulgaria*)	850
35	836	150	Nancy (*France*)	959
		20	Beirut I (*Lebanon*)	730
36	845	150	Rome I (*Italy*)	713
37	854	150	Bucharest (*Rumania*)	823
38	863	150	Paris I (*France*)	695
39	872	150	Moscow III, Russia (*U.S.S.R.*)	832
40	881	5	Aberystwyth (*Great Britain*)	—
		20	Penmon (*Great Britain*)	804
(40)	(881)	150	Washford (*Great Britain*)[10]	804
		5	Wrexham (*Great Britain*)	804
		20	Cetinge (*Yugoslavia*)	1,377
41	890	100	Algiers I (*Algeria*)[11]	941
		20	Bergen (*Norway*)	260
		20	Kristiansand (*Norway*)	629
		20	Trondheim (*Norway*)	823
		20	Dniepropetrovsk, Ukraine (*U.S.S.R.*)	913
42	899	150	Milan I (*Italy*)	814
43	908	150	Brookmans Park (*Great Britain*)	877
44	917	135	Ljubljana (*Yugoslavia*)	527
45	926	150	Brussels II (*Belgium*)	932
46	935	100	Lwow, Ukraine (*U.S.S.R.*)	795
47	944	100	Toulouse (*France*)	913
		20	Voronezh, Russia (*U.S.S.R.*)	356
48	953	150	Morava (*Czechoslovakia*)	922
49	962	100	Turku (*Finland*)[12]	895
		120	Tunis I (*Tunisia*)[13]	—
50	971	70	British Zone (*Germany*)	904
		50	Izmir (*Turkey*)	704
		20	Kalinin, Russia (*U.S.S.R.*)	1,113
		20	Smolensk, Russia (*U.S.S.R.*)	658
51	980	100	Algiers II (*Algeria*)[14]	1,113
		150	Goteborg (*Sweden*)[15]	941
52	989	10	Rovaniemi (*Finland*)	—
		70	American Zone (*Germany*)	740
		20	Beirut II (*Lebanon*)	730
53	998	100	Kishinev, Moldavia (*U.S.S.R.*)	565
54	1,007	120	Hilversum II (*Netherlands*)	722
		20	Aleppo I (*Syria*)	704
55	1,016	150	Istanbul (*Turkey*)	758
56	1,025	100	Graz-Dobl (*Austria*)	886
		20	Jerusalem II (*Palestine*)	574
57	1,034	10	Turin II (*Italy*)	1,357
		40	Lisbon (*Portugal*)	1,068
		100	Tallinn, Estonia (*U.S.S.R.*)	731
58	1,043	70	U.S.S.R. Zone (*Germany*)	841
		5	Kalamata (*Greece*)	—
		20	Agadir I (*Morocco*)	—
		20	Marrakesh I (*Morocco*)	1,004
		20	Ujda I (*Morocco*)	—
59	1,052	10	Hartland Point (*Great Britain*)	—
		150	Start Point (*Great Britain*)[16]	977
		50	Tripoli (*Libya*)[17]	—
		10	Jassi (*Rumania*)	1,258
		5	Focsani (*Rumania*)	—
60	1,061	60	Eastern Denmark	541
		10	Cagliari (*Italy*)	536
		15	Lisbon (*Portugal*)	—
61	1,070	100	Paris II (*France*)	776
		20	Krasnodar, Russia (*U.S.S.R.*)	1,050
62	1,079	50	Breslau (*Poland*)	950
63	1,038	10	Korca (*Albania*)	1,250
		10	Shkodra (*Albania*)	—
		150	Droitwich (*Great Britain*)	1,013
		20	Norwich (*Great Britain*)	1,013
64	1,097	150	Bratislava (*Czechoslovakia*)	1,004
		5	Czechoslovakian sync. network	—
65	1,106	100	Moghilev, Byelorussia (*U.S.S.R.*)	870
66	1,115	50	Bari I (*Italy*)	1,059
		50	Bologna I (*Italy*)	1,303
		5	S. Remo (*Italy*)	1,348
		5	Norwegian sync. network	—
67	1,124	20	Brussels III (*Belgium*)	1,285
		5	Varna (*Bulgaria*)	1,276
		20	Viborg, Russia (*U.S.S.R.*)	749
68	1,133	135	Zagreb (*Yugoslavia*)	629
69	1,142	20	Constantine I (*Algeria*)	1,087
		40	Oran I (*Algeria*)	1,420
		20	Kaliningrad, Russia (*U.S.S.R.*)	904
70	1,151	5	Carlisle (*Great Britain*)	—
		100	Lisnagarvey (*Great Britain*)	1,050
		5	Londonderry (*Great Britain*)	1,050
		100	Stagshaw (*Great Britain*)	1,050
		5	Baia Mare (*Rumania*)	—
		20	Cluj (*Rumania*)	—
		5	Oradea (*Rumania*)	—
71	1,160	150	Strasbourg I (*France*)	859
72	1,169	150	Odessa, Ukraine (*U.S.S.R.*)	968
73	1,178	100	Horby (*Sweden*)	1,131

[4] Directional aerial protecting Switzerland.

[5] Directional aerial. Apparent power towards Sweden 10 kW.

[6] Directional aerial. Apparent power towards Bulgaria 20 kW.

[7] Directional aerial protecting Norway.

[8] Power to be reduced to 20 kW if directional aerial protecting Portugal is not used.

[9] Directional aerial. Apparent power towards Egypt 20 kW.

[10] Directional aerial. Apparent power towards Yugoslavia, 150 kW.

[11] Directional aerial protecting Norway.

[12] Directional aerial protecting Tunisia.

[13] Directional aerial protecting Finland.

[14] Directional aerial protecting Sweden.

[15] Directional aerial protecting Algeria.

[16] Directional aerial protecting Libya.

[17] Directional aerial protecting Great Britain.

Channel	Freq. (kc/s)	Power (kW)	Station	Pres. Freq. (kc/s)
74	1,187	135	Budapest II (*Hungary*)	1,040
75	1,196	70	French Zone (*Germany*)	1,031
		15	Kerkyra (*Greece*)	—
		20	Agadir II (*Morocco*)	—
		20	Marrakesh II (*Morocco*)	—
		20	Ujda II (*Morocco*)	—
76	1,205	100	Bordeaux (*France*)	1,077
		5	Haifa (*Palestine*)	—
		10	Lublin (*Poland*)	—
77	1,214	5	Ayr (*Great Britain*)	—
		60	Brookmans Park (*Great Britain*)	1,149
		20	Burghead (*Great Britain*)	1,149
		5	Dundee (*Great Britain*)	—
		10	Lisnagarvey (*Great Britain*)	1,149
		1	Londonderry (*Great Britain*)	1,149
		58	Moorside Edge (*Great Britain*)	1,149
		2	Plymouth (*Great Britain*)	1,149
		2	Redmoss (*Great Britain*)	1,149
		2	Redruth (*Great Britain*)	1,149
		10	Stagshaw (*Great Britain*)	1,149
		50	Westerglen (*Great Britain*)	1,149
		70	British troops in Germany	1,095
		2	Azores (*Portugal*)	—
		20	Kursk, Russia (*U.S.S.R.*)	—
78	1,223	20	Stara Zagora (*Bulgaria*)	1,402
		20	Barcelona (*Spain*)	795
		100	Falun (*Sweden*)	1,086
79	1,232	5	Budejovice (*Czechoslovakia*)	1,366
		25	Cechy-Zapad (*Czechoslovakia*)	—
		25	Morava-Vychod (*Czechoslovakia*)	—
		100	Prague II (*Czechoslovakia*)	1,113
80	1,241	50	Vaasa (*Finland*)	1,522
		20	Bayonne (*France*)	—
		20	Clermont-Ferrand (*France*)	1,321
		10	Corse (*France*)	—
		20	Grenoble (*France*)	1,339
		20	Le Havre (*France*)	1,456
		20	Montbeliard (*France*)	1,068
		20	Nice (*France*)	1,185
		20	Quimper (*France*)	832
		20	Tiraspol, Moldavia (*U.S.S.R.*)	1,068
81	1,250	5	Lower Egypt	—
		10	Nyiregyhaza (*Hungary*)	—
		20	Zalaegerszeg (*Hungary*)[18]	—
		50	Athlone II (*Ireland*)	—
82	1,259	100	Stettin (*Poland*)	1,384
83	1,268	135	Belgrade II (*Yugoslavia*)	1,086
84	1,277	150	Lille (*France*)	1,213
85	1,286	100	Kosice (*Czechoslovakia*)	1,456
		20	Radio Catolica (*Portugal*)	—
86	1,295	150	Ottringham (*Great Britain*)	1,122
87	1,304	20	Constantine II (*Algeria*)	1,443
		40	Oran II (*Algeria*)	1,276
		50	Danzig (*Poland*)	1,303
88	1,313	100	Stavanger (*Norway*)	850
89	1,322	100	Ouchgorod, Ukraine (*U.S.S.R.*)	1,185
90	1,331	50	Genoa I (*Italy*)	1,357
		25	Messina (*Italy*)	1,492
		25	Pescara (*Italy*)	—
		50	Rome II (*Italy*)	1,258
		25	Venice (*Italy*)	1,222
91	1,340	5	Alexandria (*Egypt*)	1,122
		150	Crowborough or Stagshaw (*Great Britain*)	1,122
		5	Budapest (*Hungary*)	—
		5	Magyarovar (*Hungary*)	1,321
		5	Miskolc (*Hungary*)	1,438
		5	Pecs (*Hungary*)	1,465
92	1,349	10	Corse (*France*)	—
		50	Marseilles (*France*)	1,339
		10	Nantes (*France*)	1,366
		50	Toulouse (*France*)	1,339
		20	Kuldiga, Latvia (*U.S.S.R.*)	1,104
		20	Modona, Latvia (*U.S.S.R.*)	1,258
93	1,358	100	Tirana I (*Albania*)	1,474
94	1,367	5	Thorshavn (*Faroe Islands*)	—
		25	Caltanissetta (*Italy*)	—
		24	Torun (*Poland*)	986
		5	Oporto (*Portugal*)	1,411
95	1,376	150	Strasbourg II (*France*)	1,393
96	1,385	100	Madrid I (*Spain*)	1,022
		150	Kaunas, Lithuania (*U.S.S.R.*)	153
97	1,394	5	Dornbirn (*Austria*)	519
		15	Graz (*Austria*)	1,285
		5	Innsbruck (*Austria*)	519
		5	Linz (*Austria*)	1,294
		5	Rhodes (*Greece*)	—
		20	Swedish sync. network	1,312
98	1,403	20	Bayonne (*France*)	—
		20	Lille (*France*)	1,456
(98)	(1,403)	10	Paris (*France*)	592
		20	Quimper (*France*)	—
		10	Montpellier (*France*)	1,393
		20	Nice (*France*)	1,393
		25	French troops in Germany	—
		5	Komotini (*Greece*)	—
		20	Baranovichi, Byelorussia (*U.S.S.R.*)	—
99	1,412	20	Banja Luka (*Yugoslavia*)	—
		20	Bitolja (*Yugoslavia*)	—
		20	Maribor (*Yugoslavia*)	668
		20	Pristina (*Yugoslavia*)	1,320
		20	Rijeka (*Yugoslavia*)	770
		60	Split (*Yugoslavia*)	—
100	1,421	20	Sarrebrucken (*Germany : French Zone*)	1,267
		5	Sfax I (*Tunisia*)	951
		5	Chernigov, Ukraine (*U.S.S.R.*)	1,013
101	1,430	5	Argyrokastro (*Albania*)	833
		70	Western Denmark	—
		10	Copenhagen (*Denmark*)	1,176
		50	Madrid II (*Spain*)	758
102	1,439	150	Luxembourg	232
103	1,448	25	Ancona (*Italy*)	1,429
		3	Florence II (*Italy*)	1,104
		5	Genoa II (*Italy*)	986
		50	Milan II (*Italy*)	1,357
		5	Naples II (*Italy*)	1,068
		5	Venice II (*Italy*)	769
		5	Portuguese sync. network	—
		20	Swedish sync. network	1,402
104	1,457	60	Bartley (*Great Britain*)	1,384
		60	Clevedon (*Great Britain*)	1,384
		20	Craiova (*Rumania*)	—
105	1,466	120	Monte-Carlo (*Monaco*)	731
		2	Norwegian sync. network	—
106	1,475	30	Vienna II (*Austria*)	1,312
		20	Salzburg (*Austria*)	1,267
		20	Klagenfurt (*Austria*)	1,285
107	1,484		International common frequency*	
108	1,493	60	French sync. network	—
		20	Gomel, Byelorussia (*U.S.S.R.*)	959
109	1,502	50	Cracow (*Poland*)	1,022
		10	Warsaw II (*Poland*)	1,339
		50	Zaragoza (*Spain*)	863
110	1,511	20	Brussels IV (*Belgium*)	868
		5	Chania (*Greece*)	—
111	1,520	5	Jihlava (*Czechoslovakia*)	1,348
		30	Ostrava (*Czechoslovakia*)	1,158
		30	Plzen (*Czechoslovakia*)	514
		20	Corunna (*Spain*)	968
112	1,529	1	Funchal (*Madeira Is.*)	—
		20	Swedish sync. network	—
		100	Vatican City	1,325
113	1,538	70	French Zone (*Germany*)	827
		5	Spanish sync. network	—
114	1,546		British sync. network†	1,474
		5	Vinnitza, Ukraine (*U.S.S.R.*)	—
115	1,554	70	Germany : U.S. Forces	1,249
		75	Nice (*France*)	—
		20	Turi, Estonia (*U.S.S.R.*)	—
116	1,562	5	Portuguese sync. network	1,547
		20	Swedish sync. network	1,402
		5	Swiss sync. network	1,375
117	1,570	70	U.S.S.R. Zone (*Germany*)	785
		5	Spanish sync. network	1,492
		5	Sfax II (*Tunisia*)	—
118	1,578	10	Italian sync. network	—
		10	Fredrikstad (*Norway*)	1,276
119	1,586	70	British Zone (*Germany*)	1,330
		5	Spanish sync. network	1,500
120	1,594		International common frequency‡	—
121	1,602	70	U.S. Zone (*Germany*)	1,195
		2	Norwegian sync. network	1,357
		5	Portuguese sync. network	—

[18] Directional aerial protecting Ireland.

* Shared by : Albania, Austria, Belgium, Cyprus, Czechoslovakia, Denmark, Finland, France, Germany : British Zone, Gibraltar, Great Britain, Greece, Hungary, Ireland, Italy, Lithuania, Malta, Morocco, Norway, Poland, Portugal, Rumania, Russia, San Marino, Spain, Syria, Trieste, Tripoli, Tunisia, Ukraine, and Yugoslavia. Vatican City is permitted to use this frequency with a power of 5 kW until receivers covering 1,529 kc/s are more generally in use.

† Belfast (5kW) ; Bournemouth (2) ; Brighton (5) ; Bristol (2) ; Cardiff (2) ; Dundee (2) ; Edinburgh (5) ; Exeter (5) ; Fareham (2) ; Glasgow (5) ; Hull (5) ; Leeds (5) ; Liverpool (5) ; London (20) ; Manchester (2) ; Middlesbrough (2) ; Newcastle-on-Tyne (5) ; Plymouth (5) ; Preston (2) ; Redmoss (2) ; Redruth (2) ; Sheffield (2).

‡ Shared by : Andorra ; Austria ; Belgium ; Bulgaria ; Cyrenaica ; Czechoslovakia ; Denmark ; Finland ; France ; Great Britain ; Greece ; Ireland ; Latvia ; Madeira Is. ; Morocco (Tangier) ; Norway ; Netherlands ; Poland ; Portugal ; Spain ; Switzerland ; Syria ; Trieste ; Yugoslavia.

FREQUENCY SHIFT KEYING

Comparison with On-off Keying Methods

By THOMAS RODDAM

IT is not very often that the problems of radio telegraphy are the subject of technical papers. Many readers, especially those with the pile of radar papers which make up the report of the I.E.E. Radiolocation Convention before them, may think that this is because there are no problems in transmitting what someone or other called "those damned dots." Others, more cynical, may suggest that the problems are there, but that no one tries to solve them. The real reason is probably that the main problems of radio telegraphy nowadays are those of high-speed long-distance transmission, which is very largely an affair for a limited number of large administrations whose work is co-ordinated by the International Telegraph Consultative Committee (C.C.I.T.). Improved systems are introduced only gradually, and after long periods of service tests. The most recent development has been a tendency to change over from on-off keying to frequency shift keying, which is really a change over from amplitude modulation to frequency modulation. An intermediate system, double-frequency keying, was tried at one stage, but this, for reasons which are fairly clear from our modern knowledge of F.M. theory, was not successful.

Telegraph transmission involves the sending of "mark" and "space" signals. The marks may be the dots and dashes of the morse code or the dots which are used in teleprinter working. A group of 5 dots can be used to indicate any one of 31 different characters. If 7 dots are used, or rather, if 3 dots which may appear in any combination of 7 positions are used the number of combinations is 35, although only 31 are used and the receiver can check that it has 3 and only 3 dots and thus can reject any false signals due to atmospherics or other disturbances. All these types of signal, however, have only two possible levels of modulation: zero and 100 per cent. For low telegraphic speeds the radio-frequency carrier may be modulated by a tone which is keyed on and off. This is called "modulated continuous wave" transmission, usually abbreviated to M.C.W. M.C.W. is wasteful in bandwidth and for high-speed commercial circuits C.W. is used. M.C.W. has certain advantages under multipath transmission conditions, as it provides a sort of frequency diversity. An "on-off" C.W. circuit operates simply by switching the carrier *off* whenever a mark is to be transmitted: in early systems the carrier was switched *on*, but fast-operating A.G.C. circuits are then left without any signal during pauses, and the gain rises to its full value, giving a large noise output.

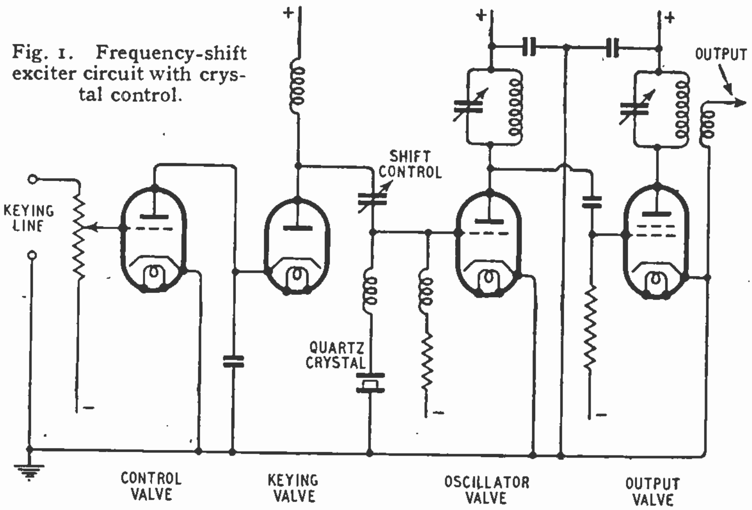


Fig. 1. Frequency-shift exciter circuit with crystal control.

The earliest circuits of all, with arc transmitters, were operated on a frequency shift basis. The carrier frequency was changed during a mark by short-circuiting part of the tuned circuit inductance. It was sometimes found convenient to listen to the space frequency rather than the mark frequency when jamming was bad, but there was no attempt to make a deliberate use of both frequencies in receiving the message. The only reason why this method of operation was adopted was that the arc could not be keyed on and off: as soon as valve circuits became available on-off keying, which corresponds to the keying of D.C. on a line, was adopted.

In 1928 Armstrong demonstrated a circuit in which the marks and spaces were transmitted on two frequencies separated by about 100 c/s. This system gave a considerable improvement over on-off keying, because it used *both* signals at the receiver. Unfortunately, Armstrong had done the right thing for the wrong reason, and the fact that the system gave an improved performance was overlooked in the triumphant demonstration that he had given the wrong explanation.

The next report of work in this field came in 1939, when K. L. Wood, of Cable and Wireless, described a system then under development. During the war considerable advances have been made, and the system has also been widely applied to multi-channel voice-frequency telegraphy systems on wires.

The important thing about F.S. keying is that it is a coherent carrier system, that is, there is no discontinuity in the carrier when the circuit is switched from mark to space. In double-frequency keying one oscillator is switched off and another switched on, so that there is no phase relationship during the transition period. This produces a strong disturbing signal and the system is inefficient. A frequency shift exciter is simply a frequency modulation exciter, driven from 0 to 100 per cent modulation, and there is a smooth transition from one to the other.

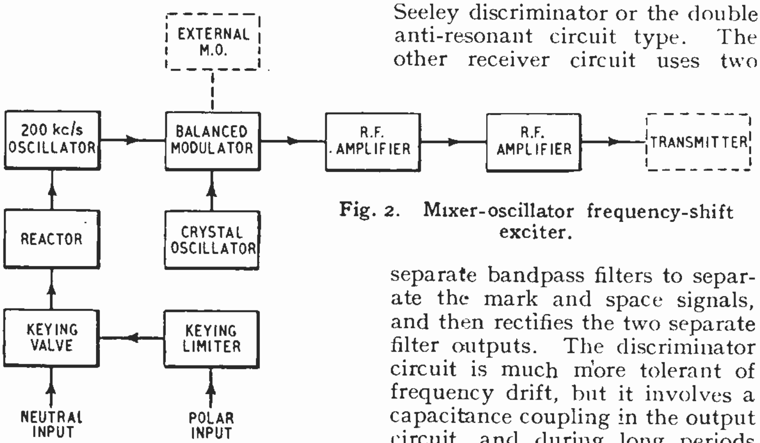


Fig. 2. Mixer-oscillator frequency-shift exciter.

Two circuits have been used. The simplest is arranged to connect a capacitance across the controlling crystal of the master oscillator. The circuit is shown in Fig. 1 (reproduced from the paper by Ruddlesden, Forster and Jelonek, *J.I.E.E.*, Vol. 94, Part IIIA, No. 12, p. 380). The control valve is normally held beyond cut-off by the negative bias, and as there is no current through the control triode the keying diode is an open circuit. The crystal oscillator operates at its normal frequency. When the triode grid is driven positive, the current through the keying diode makes it a low resistance, bringing into circuit the shift-control capacitor in series with the blocking capacitor from the diode cathode to earth. The frequency of the crystal oscillator is lowered by an amount which depends on the size of the shift control capacitor. The output valve acts as a limiter to prevent any amplitude modulation of the output.

The second circuit is shown in Fig. 2 (*loc. cit.*). This circuit is self-explanatory, the only difference between it and a frequency-modulated transmitter for telephony being that the full frequency shift is produced at 200 kc/s and a modulation operation is used to produce the final carrier frequency, instead of producing only a small frequency shift and then multiplying up. As the shift is only 850 c/s, instead of the ±75 kc/s of broadcast F.M., this difference is quite a logical one.

Two types of receiver circuits have been used. One is simply an ordinary discriminator type, using either the well-known Foster-Seeley discriminator or the double anti-resonant circuit type. The other receiver circuit uses two separate bandpass filters to separate the mark and space signals, and then rectifies the two separate filter outputs. The discriminator circuit is much more tolerant of frequency drift, but it involves a capacitance coupling in the output circuit, and during long periods without any traffic there is a D.C. drift which produces a "bias" in the receiver. Elaboration of the circuit is required to off-set this.

This illustrates an important difference between telephony and telegraphy: a telegraph signal is essentially unbalanced, consisting of applied voltages in one direction only. There is no mean level, any more than there is in a television signal, and D.C. restoration is essential to prevent the floating mean level produced by the A.C. couplings in the receiver, which results in a bias in the recording relays.

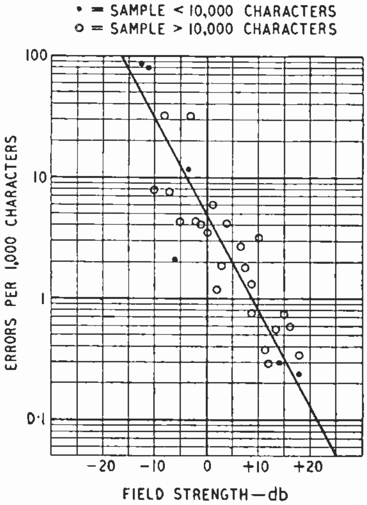


Fig. 3. Field strength/error curve for frequency-shift keying. Two-receiver diversity reception, I.F. bandwidth 1 kc/s. Frequency shift 850 c/s. 0 db = 1 μV/m.

Tests made by the Radio Corporation of America gave the results shown in Figs. 3 and 4 (reproduced from *R.C.A. Review*, Vol. 7, March, 1946, pp. 19, 20). These curves show the number of errors during tests involving the transmission of over a million characters from California to New York, using a frequency of about 10 Mc/s and powers of 200 and 800 watts. The improvement due to the use of F.S. keying is about 10 db. About the same improvement was obtained in British tests between Ascension Island and London. Later tests between Melbourne and London gave a better performance for an F.S. channel than for an on-off channel using 2.5 times the power. Here again the improvement must have been of the order of 10 db.

According to Smale, F.S. keying will not give its full advantage when multi-path transmission conditions are encountered. This may be off-set in practical operation by the use of space diversity reception, which is claimed by R.C.A. to give a considerable improvement for F.S. keying under multi-path conditions.

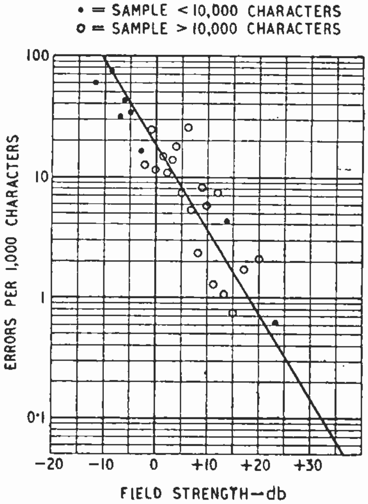


Fig. 4. Field strength/error curve for on-off keying. Three-receiver diversity reception, 1 kc/s I.F. bandwidth. 0 db = 1 μV/m.

Frequency Shift Keying—

All the discussion above relates to ordinary telegraphy. An intermediate field in which the frequency-shift technique may have considerable advantages is facsimile, both for the transmission of illustrations and for the sending of pages of typescript. For illustrations, especially, the method would appear to have all the advantages of frequency modulation in the transmission of speech. Multi-path distortion is always troublesome in F.M. problems, but it is also a serious problem in telegraphy and facsimile transmission: most readers will have seen examples of the displaced "ghosts" produced in television by indirect transmission paths.

Apart from the special modulating and demodulating arrangements for F.S. keying, there are some other points of interest in the design of the equipment. One point not immediately realized is that if a transmitter is converted from on-off to F.S. keying the power must be reduced. A transmitter sending "reversals," that is, a steady stream of dots with equal spaces, is actually operating for 50 per cent of the time. In radar language the duty factor is 0.5. When converted to F.S. keying, the carrier is kept on continuously, so that for the same heating in the circuit the power must be lowered from, say, 10 kW to 5 kW. This gives the F.S. system a 3 db handicap, which must not be forgotten in assessing the performance of the system. As far as bandwidth is concerned, there can be a small gain. It is usual to shape the signals in an on-off system so that only the fundamental and third harmonic are transmitted, instead of the infinite number of sidebands corresponding to a square dot. In line telegraphy the signals are rounded even more than this, and on long-distance circuits even squarer waveforms are preferred. Smale described a system using 500 c/s deviation, while the S.R.D.E. system described by Ruddlesden, Forster and Jelonek uses 850 c/s, which is the same as the R.C.A. value. In the S.R.D.E. system the bandwidth for an on-off channel is given as 1,200 c/s, and for the 850 c/s F.S. channel as 1,100 c/s, but it is pointed out that by operating with a 300 c/s shift the bandwidth can be reduced to 500 c/s. These figures correspond to rather high keying speeds and are therefore very sensitive to multi-path effects: by using slower speeds and multiplex working a more convenient arrangement is often obtained.

It may appear to the reader that this recent advance in telegraph technique is a rather obvious one, considering how much is now known about frequency modulation. It must never be overlooked, however, that telegraph circuits are highly efficient circuits from the point of view of the transmission of intelligence. They work at relatively low signal-to-noise ratios: if they don't, someone is wasting power, and the cost will be increased. On the other hand, if a false signal is recorded, code messages will be mutilated, and the message may be unintelligible. Each dot has a meaning in a telegraph message, while in telephony the circuit is quite workable even if only 80 per cent of the syllables are correctly heard. A telegraph engineer is really not satisfied about a new system until it has been tested over a whole sunspot cycle.

References

"Some Developments in Commercial Point-to-Point Radiotelegraphy," J. A. Smale, *J.I.E.E.*, Vol. 94, Part IIIA, No. 12, p. 345.

"Carrier-frequency-shift Telegraphy," Ruddlesden, Forster and Jelonek, *J.I.E.E.*, Vol. 94, Part IIIA, No. 12, p. 379.

"Observations and Comparisons on Radio Telegraph Signalling by Frequency Shift and On-off Keying," Peterson, Atwood, Goldstine, Hansell and Schock, *R.C.A. Review*, Vol. VII, March, 1946.

NEWS FROM THE CLUBS

Belfast.—The City of Belfast Y.M.C.A. Radio Club (GI6YM) celebrates its twenty-fifth anniversary this year. With the exception of the war years, the club transmitter has been on the air every week since 1926. Meetings continue to be held on Wednesdays at 8.0 at the Y.M.C.A., Wellington Place, Belfast. Sec.: F. A. Robb, GI6TK, 60, Victoria Avenue, Sydenham, Belfast, N. Ireland.

Bradford.—A demonstration lecture on disc recording will be given by A. R. Land, G2UY, to the members of the Bradford Amateur Radio Society on November 2nd. At the November 16th meeting E. M. Price, M.Sc., will talk on the transmission of signals through lines and filters. Meetings are held on alternate Tuesdays at 7.30 at Cambridge House, 66, Little Horton Lane, Bradford, Sec.: W. S. Sykes, G2DJS, 287, Poplar Grove, Great Horton, Yorks.

Cambridge.—The president of the Cambridge University Wireless Society (G6UW) for the 1948-49 academic year is J. A. Ratcliffe, O.B.E., M.A., of the Cavendish Laboratory. Sec.: F. S. Williamson, 42, South Road, Histon, Cambs.

Darlington.—Meetings of the Darlington and District Amateur Radio Society are held on alternate Thursdays at 7.30 in the Temperance Institute, Gladstone Street, Darlington. Next meeting, October 28th. Sec.: G. Walker, G2AWR, 7, Geneva Crescent, Darlington, Durham.

Holloway. — Lectures covering the syllabus for the City and Guilds amateurs' examination are included in the winter's programme of the Grafton Radio Society (G3AFT) which meets on Mondays, Wednesdays and Fridays at 7.30 at Grafton School, Eburne Road, London, N.7. Morse instruction is given at every meeting. Sec.: W. H. C. Jenings, G2AHB.

Liverpool.—J. H. Brierley will lecture on high-fidelity A.F. equipment and pickups before the Liverpool and District Short-wave Club at 7.30 on October 26th at St. Barnabas Hall, Penny Lane, Liverpool, 15. Sec.: W. G. Andrews, G3DVW, 17, Lingfield Road, Broadgreen, Liverpool, 14, Lancs.

Rochester.—A radio exhibition has been organized by the Medway Amateur Receiving and Transmitting Society to be held in the Corn Exchange, Rochester, Kent, from November 24th to 27th. In addition to exhibits of a number of manufacturers and traders, Admiralty electronic equipment will be shown. Sec.: S. A. Howell, 39, Broadway, Gillingham, Kent.

Southall.—The West Middlesex Amateur Radio Club has been granted a transmitting licence under the call G3EDH. Meetings of the club are held on the second and fourth Wednesdays of each month at 7.30 at the Labour Hall, Uxbridge Road, Southall, Middlesex. Sec.: C. Alabaster, 34, Lothian Avenue, Hayes, Middlesex.

Warrington and District Radio Society meets on alternate Mondays at 7.30 at the Sea Cadet Headquarters, Warrington. Next meeting, November 1st. Sec.: W. R. Murray, G3CUB, 56, Crow Wood Lane, Widnes, Lancs.

Worksop. — Although called the Swedish DX-fan Club the activities of this organization, which has its headquarters in Worksop, Notts, are not exclusively devoted to reports on Swedish stations. Particulars are obtainable from Eric Good, 5, Aldred Street, Worksop, Notts.

Worthing.—The Worthing Group of the R.S.G.B. has been re-formed into the Worthing and District Amateur Radio Club and thereby overcomes the limitation of its membership to R.S.G.B. members. Meetings are held on the first Thursday of each month at 7.30 at Oliver's Café, Southfarm Road, Worthing. Sec.: F. T. Tooley, 62, Becket Road, Worthing, Sussex.

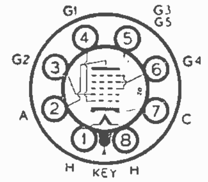
BETTER LISTENING
BETTER BRIMARIZE!

7A8
7B8

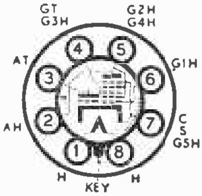
REMEMBER GENEROUSLY
SAT · NOV 6TH

TYPES 7A8 and 7B8 are frequency changers of similar classes, the former being an octode and the latter a heptode. The suppressor grid (G6) fitted to the 7A8 results in higher anode impedance and increased gain.

In A.C. and car radio receivers both valves may be replaced by the 7S7, whilst in AC/DC receivers the 7A8 must be replaced by the 14S7 owing to its low heater current of 0.15 amp. In 12 volt car radios using the 7A8, replacement by type 7S7 will necessitate the fitting of a balancing resistor in the heater circuit.



Types 7A8, 7B8 (7A8 has G6 connected to Cathode)



Type 7S7

CHARACTERISTICS

TYPE	7A8	7B8	7S7*	
Heater Voltage	6.3	6.3	6.3	volts
Heater Current	0.15	0.3	0.3	amp.
Anode Voltage	250	250	250	volts
Screen Voltage	100	100	100	volts
Osc. Anode Resistor	20,000	20,000	20,000	ohms
Bias Resistor	300	300	200	ohms
Impedance	0.7	0.36	1.25	Meg.
Conversion Cond.	0.6	0.55	0.53	mA/v

*Type 14S7 is identical to type 7S7 except for its heater ratings of 12.6 volts, 0.15 amp.

VALVE TYPE FROM	VALVE TYPE TO	CHANGE SOCKET	CHANGE CONNECTIONS	OTHER WORK NECESSARY	PERFORMANCE CHANGE
7A8	7S7 (14S7 in AC/DC sets)	Loctal (B8G) NO CHANGE	NO CHANGE	1. Re-align Receiver. 2. 12-Volt car radios—fit balancing resistor in heater circuit. See *note*.	NEGLIGIBLE
7B8	7S7	Loctal (B8G) NO CHANGE	NO CHANGE	Re-align Receiver.	NEGLIGIBLE

Note: (7A8 only). In 12-volt receivers where pairs of valves are connected across the 12-volt supply, the valve connected in series with the 7S7 must be fitted with a 40 ohm 2 watt resistor across its heater terminals.

BRIMAR says.. TYPE 7S7 CAN SUCCESSFULLY REPLACE TYPES X81M & X148

BRIMAR
RADIO VALVES

← PUNCH HOLES HERE →

INSTRUCTIONS: Punch holes where indicated and cut away this portion. Cut out and file them in the order in which they appear. This column will then give you a quick reference index.

STANDARD TELEPHONES AND CABLES LIMITED, FOOTSCRAY, SIDCUP, KENT.

20

MARCONIPHONE "*Companion*" RECEIVER

Five-valve, two waveband DC/AC "Companion" receiver T15DA. Weighing only 7½lb. and small enough to stand on the smallest "occasional" or bedside table, this transportable incorporates an inbuilt high "Q" frame aerial and needs only connection to the mains to be immediately ready for operation. Its excellent performance is enhanced by the use of all-glass valves throughout. The consumption figure is low, a mere 35 watts.

An internal dropping resistor besides eliminating the resistance type of mains lead has three voltage tappings which enable the optimum performance to be obtained on any voltage supply between 195-255 volts DC or AC (*25-100 cycles*).

Hear Model T15DA at your local Marconiphone Dealer.

SEE THE SIGNATURE *G Marconi* **ON EVERY SET**

M.68

The Marconiphone Company Limited, Hayes, Middlesex

ELECTRONIC CIRCUITRY

Selection from a Designer's Notebook

By J. McG. SOWERBY (Cinema Television, Ltd.)

Notes on Beam Switches

As most readers will be aware, a beam switch is a device for allowing two or more waveforms to be displayed simultaneously on a single cathode ray tube. In the simplest case of a two-beam switch the two signals are accepted by two amplifier channels, and these are connected alternately (switched) to the deflection plates of the C.R.T. This switching is commonly carried out by means of "gate" circuits under the control of a square wave generator of some sort, and the focal point of the device, on which its success depends, is the development of a satisfactory switching or gate circuit. As these gate circuits have other applications as well, it is proposed to devote a few paragraphs to descriptions of some of them.

Probably the simplest of the gate circuits is the pentode arrangement of Fig. 1. Here the signal is applied to the suppressor grid, and the switching waveform to the control grid. The switching waveform must be of sufficient amplitude to cut the valve off during the negative half-cycle, and must allow the valve to conduct—and hence amplify—during the positive half-cycle. Obviously, two such valves may be used, their anodes connected in parallel, and then, if the switching square wave is applied in anti-phase to the two control grids, only one valve will be conducting at any instant. If, in addition, the two valves have different anode currents, the two signals will appear alternately at different standing levels, so that the signals will appear displaced from one another (and not superimposed) on the C.R.T.

There are various "snags" about this circuit. The most obvious of these is that the top of the positive half-cycle of the switching waveform must be quite flat, because any irregularities are subject to the full gain of the valve, and will be seen superimposed on the signal. Also, when two valves are used in parallel, a square waveform will, in general, be obtained at the anode as well as the signals. This waveform feeds back through the suppressor-anode capacitance to the signal input. and this may often be undesirable.

If, in an attempt to overcome these difficulties, the roles of the two grids are interchanged, the output waveform across R_L can feed back into the square wave generator. Also, since both valves are always conducting to their screens, very thorough screen decoupling is needed, for otherwise the signal from one channel can feed across into the other. As before the positive "flat" of the switching waveform may have no irregularities, or these will be amplified and become superimposed on the signals. Generally speaking, this circuit, though often useful, is only suitable for relatively low switching rates.

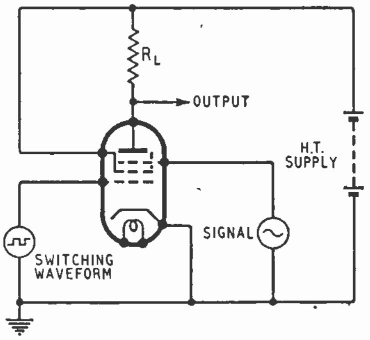


Fig. 1. A simple pentode "gate" circuit.

An alternative is the use of a hexode or other valve with two control grids, but here the designer is rather limited, as most available valves have an undesirable variable-mu characteristic on one of the grids.

An alternative and rather better arrangement—which uses two valves—is shown in Fig. 2. Here the signal is applied to the pentode and appears across R_L, provided the triode is cut off by the negative half-cycle of the switching waveform. On the positive half-cycle the pentode is cut off by the consequent positive excursion of the common cathode, and the signal disappears. The pentode is only necessary if it is desired to prevent feed back of the output across R_L back into the signal source via the grid-anode capacitance.

There are several disadvantages in this circuit; first, that as R_C has to be relatively large—comparable with R_L—considerable negative feedback is developed and the gain is severely limited. Secondly, every time the stage is switched, the pentode grid-cathode capacitance has to be charged or discharged through the signal source, so that for high switching rates a low-impedance driver (cathode follower) for the signal is essential. Nevertheless, the writer has succeeded in switching this circuit, using EF50 valves at 5-10 kc/s with a turnover time so short that the "haze" between two traces is practically invisible.

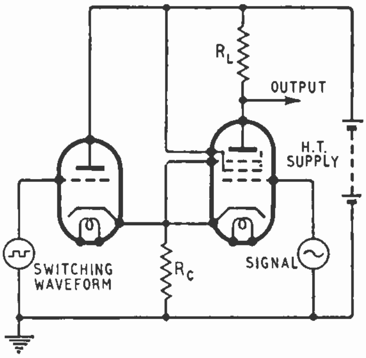


Fig. 2. Cathode-coupled two valve "gate."

A GREAT deal has been written from time to time on the construction of devices for obtaining

Electronic Circuitry—

a constant alternating voltage. A typical example is the so-called constant voltage transformer of which various types are currently available commercially. Less has been said, however, about constant current circuits which are occasionally valuable. A typical application is the supply of valve heaters at the end of a length of cable which may vary in length according to conditions of use, so that the total resistance of the circuit is subject to variation.

A "Constant Current" Circuit

Fig. 3 shows a rather neat type of constant current device in which Z_L is the load impedance subject to variation, and through which a constant current is required. If this circuit is analysed and resistive losses in the inductances L, and condensers C, are assumed zero, we find that the load current I_L is given by $I_L = \frac{E}{X}$, where $X = X_L = X_C =$ reactance of L or C at the frequency of the applied voltage (usually 50 c/s).

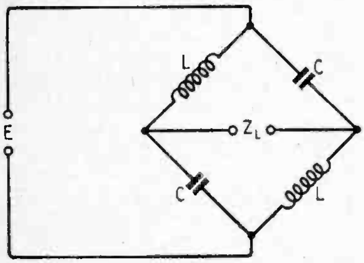


Fig. 3. "Constant-current" bridge circuit.

Thus we see that the current is independent of the load impedance. A similar circuit requiring a centre-tapped transformer is shown in Fig. 4. As before, $I_L = \frac{E}{X}$, where $X_L = X_C = X$.

Of course, losses in the inductances—which are often iron-cored—destroy the independence of

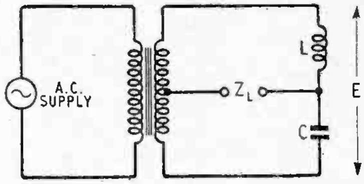


Fig. 4. Another "constant-current" circuit.

load current and load impedance. Nevertheless, a very considerable measure of current stabilization can be obtained in practice over a limited range of variation of load. In using this circuit, care must be exercised in the choice of components, because if Z_L is accidentally open-circuited, the voltages across L and C will rise enormously in an attempt to force the rated load current through the accidental infinite impedance.

MANUFACTURERS' PRODUCTS

E.H.F. Co-axial Connectors

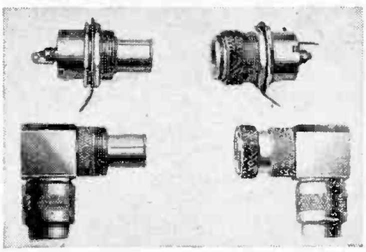
THE Plessey Company have introduced a range of concentric-type connectors which have been designed primarily for use at the extra high frequencies up to 15,000 Mc/s. These connectors, which are mainly for joining and terminating coaxial cables of between 70 and 80 ohms impedance, are available in two styles, major and minor.

Each series contains four types, described as free straight, free right-angle, bulkhead mounting and panel mounting. Male and female versions are available in each type, and to avoid confusion both inner and outer conductors of a particular connector assembly are either both male or both female and both patterns are interchangeable.

An adaptor is available to permit inter-coupling between the major and minor series and, like the actual connectors, this coupler is designed to maintain the correct impedance of 70 to 80 ohms at the junction.

The major series, which are suitable for use up to 5,000 Mc/s, take B.I.C.C. Types CWF81 and SAF78, also Uniradio 18 cables, while the minor range take the Type 1B1/75C/21-4M cable in the same make and are intended for use at frequencies up to 15,000 Mc/s.

Adaptors to junction cables to waveguides are included and all connectors and adaptors are precision machined from brass and given a burnished silver finish.



(Top) Plessey male and female panel-mounting E.H.F. connectors and (below) the free right-angled pattern.

The panel mounting types in the major series are suited for signal, video and intermediate frequency circuit connections in television sets.

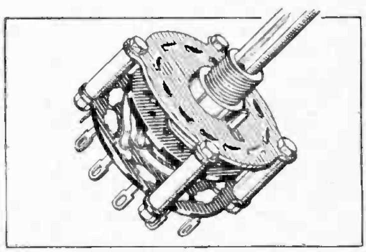
New Television Receivers

A PICTURE size of 8½in × 6¾in on a 10in diameter tube is a noteworthy feature of the Model 912 recently introduced by A.C. Cossor, Highbury Grove, London, N.5. The tube includes an ion trap to protect the screen from heavy ion bombardment. A cathode-follower video amplifier and automatic linearity control are features of the circuit. The set is housed in a console cabinet 33¾in × 18in × 23in and costs £78 15s including tax.

Two new television receivers have been introduced by Philips Electrical, Century House, Shaftesbury Avenue, London, W.C.2. The Model 383A is a table model for vision and sound with a 9-in tube, and the Model 663A with 12in tube is a console incorporating a 7-valve all-wave receiver for broadcasting. The price of the Model 383A is £61 14s 5d and of the Model 663A, £110 4s 4d, both prices include tax.

New Rotary Switches

A RANGE of 12- and 18-way plate-type switches, available as single units or as ganged assem-



Taylor single-pole nine-way rotary switch.

blies, has been introduced by Taylor Electrical Instruments, Ltd., 419-424, Montrose Avenue, Slough, Bucks.

The fixed plates measure about 1½in in diameter and have contacts arranged in two rings, the outer being the point contacts and the inner the selector pole, or poles. Contact is made by means of split wiper arms secured to a bakelite disc fixed to the spindle.

A 12-way plate can be assembled to give combinations of from 1-pole 12-way to 4-pole 3-way and any number up to four plates can be built up as a ganged assembly.

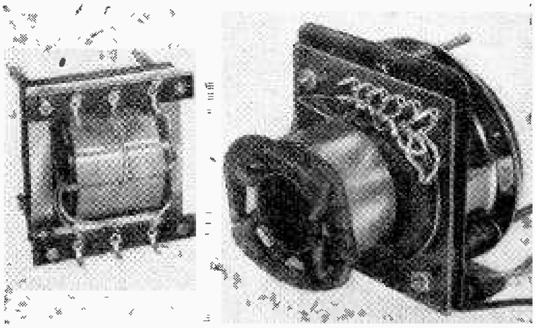
A range of combinations up to 3-pole 6-way or 4-pole 4-way is available with the 18-contact plates. All contacts are of generous size and silver plated to ensure a low contact resistance.

Television Scanning Equipment

COMPONENTS for the *Wireless World* Television Receiver have been submitted by Handy-Parts, of 226 - 228, Merton Road, South Wimbledon, London, S.W.19. They comprise a line-scan transformer and a deflector- and focus - coil assembly. The latter consists of the line- and frame-deflector coil yoke and the focus coil mounted on a bracket. The focus coil is spring-mounted for ready adjustment.

The parts are made to the published specification, with the exception of the focus coil which is of different construction. They have all been tried in the original model of the receiver, however, and were found to be entirely satisfactory.

The line-scan transformer is priced at £3 10s and the focus- and deflector-coil assembly at £6 6s. The focus coil is available separately at 37s 6d, the line coils at 25s and the frame coils at 30s.



Handy-Parts line-scan transformer and focus- and deflector-coil assembly.

New Plastic E.H.F. Insulator

POLYTETRAFLUOROETHYLENE, or P.T.F.E. as it will doubtlessly be known, is a new plastic material having exceptionally good R.F. properties, especially at the extremely high frequencies. It is virtually non-hygroscopic, unaffected by the common corrosive acids, alkalis and oils, and does not soften with application of heat. It has a low coefficient of expansion.

When moulded it has a whitish opaque appearance, feels slightly waxy and possesses considerable flexibility, especially in thin strips or film.

Radio components having P.T.F.E. as the insulation are being made by British Mechanical Productions, Ltd., 21, Bruton Street, London, W.1. They consist principally of miniature valve holders such as the B7G, C.R. tube holders, co-axial cable connectors and various types of insulating connectors for hermetically sealed components. In the last-mentioned category are included connectors for use in pressurized aircraft cabins.

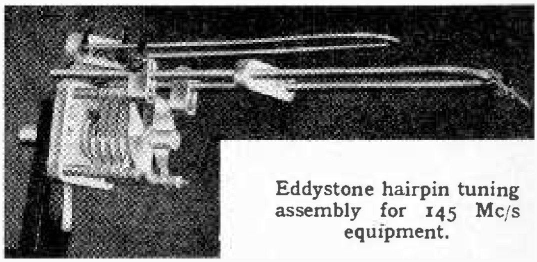
It is claimed for the new B7G valve holder that, as the mouldings can be produced to very close tolerances and the material has a certain amount of resilience, damage to valves from cracked bases is virtually unknown.

145-*Mc/s Tuning Unit*

THIS unit consists of a small butterfly-type variable capacitor, a hairpin-shaped single-turn coil and a coupling loop assembled on a single bracket. It is intended for the new amateur band of 145-146 Mc/s and can be used as a local oscillator circuit for a V.H.F. superhet or convertor, as an inter-stage R.F. coupling or as the tank circuit in a 145-Mc/s transmitter.

When used in an oscillator it would seem advisable to anchor the far end of the hairpin inductor to an insulator, as at these very high frequencies the slightest vibration can cause very bad frequency flutter.

The hairpin loop fitted is 6in long and spaced ⅞in. It is secured to the capacitor by small clamps which allow easy adjustment for length.



Eddystone hairpin tuning assembly for 145 Mc/s equipment.

The coupling loop is supported on a sub-bracket which can be removed from the main bracket and mounted separately if required. Adjustment of the coupling can be made by bending the loop towards or away from the tuned hairpin.

Wide spacing (0.052in) is used in the capacitor and as the flashover voltage exceeds 1,500 R.M.S. no special precautions are needed when the unit is used as the tank circuit in a 145-Mc/s transmitter with anode modulation. The maximum capacitance is about 4pF, but this is more than sufficient to cover the full 145-Mc/s band when it becomes available.

All the metal work, except the bracket, is heavily silver plated and ceramic insulation is used throughout.

The makers are Stratton and Co., Ltd., Eddystone Works, Alvechurch Road, West Heath, Birmingham, 31, and the price is 17s 6d.

"RADIO VALVE PRACTICE"

THIS booklet is intended to act as a link between the valve maker and the valve user: it is specially addressed to designers.

The contents comprises largely categorical information on subjects about which most of us are somewhat vague. For instance, what is the permissible variation in heater or filament voltage in relation to the rated voltage? Why is it considered undesirable to mount a valve upside down? What are the appropriate precautions against microphony?

The answers to these and many other questions are given in "Radio Valve Practice," copies of which are obtainable free by bona fide valve users from The British Radio Valve Manufacturers' Association, 16, Jermyn Street, London, S.W.1.

ELECTROMAGNETIC UNITS

Reasons Underlying Recent Changes in Accepted Standards

By **GEOFFREY STEDMAN,** B.Sc.

THE decision of the National Physical Laboratory to implement on January 1st, 1948, the recommendation of the International Committee of Weights and Measures of 1946, by reverting from the so-called "international" electrical units to units based on the absolute system, brings to the foreground the question of the units and definitions of the electrical quantities. But apart from this topical interest, a knowledge of the history of the electrical units is important in understanding electrical theory. The logical interdependence of the definitions forms a kind of skeleton work upon which electrical theory can be supposed to depend. More than one of the issues which provide perennial difficulty and discussion among students are settled unequivocally by referring to the definitions of electrical quantities. An example of this is given at the end of this article.

The relation between the electrical units is complex, partly because they were originally framed by physicists whose needs in this respect were different from the needs of engineers, and partly because the modifications imposed by engineers have not always been happy ones. In fact, it is difficult, even for those who have the will to do so, to absolve the engineers completely from the charge of short sight or of haziness about fundamental theory in the establishment and use of the practical units.

Unit of Current

The relations between the units are displayed in the diagram opposite. The starting point is the absolute electromagnetic unit of current, placed in a double border at the top left-hand corner of the diagram. This is defined as the current which, flowing in a circular coil of one turn and of one centimetre radius, exerts a force of 2π dynes on a unit magnetic pole placed at the centre, or as the current which, flowing in one centimetre of the arc of such a coil, exerts a force of one dyne on a unit pole placed at the centre. There — —ther ways of framing this definition to avoid the objection to the above forms that they rely upon unrealizable circuits. One such form is that unit current is the current which, flowing in *any* circuit, produces the same magnetic field as a magnetic shell of unit strength and whose contour is the circuit. All these forms, and others to be met with in the textbooks, can be shown to be mere mathematical variants of the same definition.

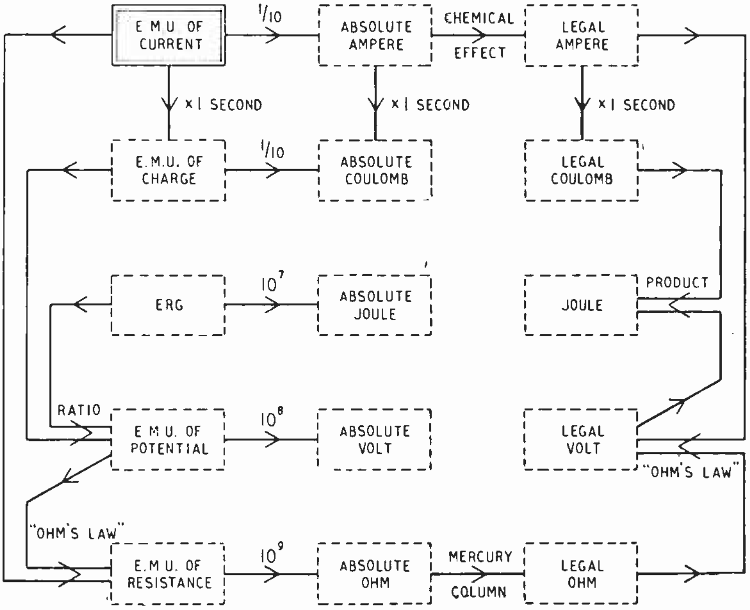
Having fixed in this way the size of the absolute unit of current, all the other absolute quantities are defined in terms of it and of familiar mechanical quantities. Thus there need be, and in fact is in the absolute system of units, only one primary electrical quantity. The way in which the other absolute quantities are derived from the unit of current is indicated in the diagram by the notes on the links connecting them to the unit of current. Thus an absolute unit of charge is conveyed by one absolute unit of current in one second, and one absolute unit of potential difference exists between two points if one erg of work is done by or against the electrical forces when one absolute unit of charge is conveyed from the one point to the other. The absolute unit of resistance is defined from the familiar relation "resistance is the ratio of potential difference to current" which is often referred to as Ohm's Law. The statement is not a law, but a definition of resistance, and one absolute unit of resistance requires one absolute unit of potential difference to pass one absolute unit of current through it. Ohm's Law specifies the conditions (nature of conductor, temperature, etc.) under which the resistance, defined in this manner, is independent of the current through it. All the other absolute units (of capacitance, inductance, etc.) are derived similarly from the absolute unit of current, but as the relations between the various systems of units can be displayed without considering these, the diagram has been extended no farther vertically.

It is important to notice that nearly all the precision measurements of electrical technology, with potentiometers and bridges, are methods of *comparing* currents or potential differences or resistance. To find the absolute value of any electrical quantity involves measuring it in terms of the absolute unit of current, or comparing its magnitude with a standard whose value has been so measured. It is by way of a reminder of the fundamental position of the absolute unit of current in this respect, that the tangent galvanometer and the Kelvin ampere balance figure so largely in a course of academic physics. In practice, the accurate measurement of a magnetic field presented formidable difficulties up to a few years ago. The British Association, therefore, sought to set up material standards of current and resistance which would be more convenient to realize, and also to measure these standards in terms of the absolute units. While they were doing so they decided to allocate special names, derived from the names of illustrious scientists, to multiples or submultiples by certain powers of ten, of the absolute units. The reason for the last decision was certainly inadequate, and one can only suppose that it was the prestige of the British Association that was responsible for an International Conference in 1881 in Paris adopting the B.A. nomenclature, and adding other names derived in the same way for the so-called practical units. The multiples of the absolute units are given in the second column of the

AND DEFINITIONS

diagram. It was further decided to construct and measure a column of mercury which, under specified conditions, should have a resistance of one ohm, and to determine what weight of silver one ampere would deposit on a cathode in one second from a solution of its nitrate in water, also under specified conditions.

These measurements were made, and in a series of Conferences, culminating in one at London in 1908, the "international" ampere and ohm were set up, defining the ampere as the current which deposits silver at the rate of 0.00111800 grams per second, and the ohm as the resistance of 14.452 grams of mercury of uniform cross section and of length 106.300 cm, at 0° C. These are known as the International or Legal units, having been made legal by enactments of the United Kingdom and of the other member nations of the Conferences. They are placed in the third column of the diagram, and the nature of the observations which link them to the corresponding absolute units are indicated on the connecting links. The "international" units were defined to be as near as possible identical in magnitude to the absolute ampere and the absolute ohm, and the name "practical units" dates from before any discrepancies had been observed between them. It is now therefore doubtful whether the adjective "practical" refers to the replacement of the absolute units by the multiples by powers of ten of those units, or whether to their replacement by the chemically defined ampere and ohm. Since by modern measurements these units are perceptibly different, it would seem best to abandon the use of the term "practical" and to use the adjective "absolute" for the one system, and the adjective "international" (or "legal") for the other, although in view of the almost certain loss of legality of the international units in the near future, the terms chemical ampere and mercury ohm may be appropriate.



Derivation and relationships of the principal electrical units.

The change from the absolute units to the international units has an almost exact parallel in the establishment of the metric standard of length. The French Government originally took the length of the quadrant of the earth as the standard of length, and defined a metre as a convenient submultiple (10^{-7}) of this length. A French Commission then prepared a bar of platinum-iridium to be as near as possible to one metre between the fiducial marks on it. Following the discovery of an error in the original measurement, the metre was re-defined as the distance between the fiducial marks on the bar. It is, of course, unlikely that the metric system will revert to the earth's quadrant as a basis, as the electrical system has reverted to its absolute basis.

There are two interesting consequences of the fact that only one electrical quantity is required to furnish a system of units, whereas the "international" system supplies two independent units. The first is that by the "Ohm's Law" relation a legal volt is obtained as the product of a legal ampere and a legal ohm. This legal volt is of very nearly the same magnitude as the absolute volt, but is quite distantly related to it, as is indicated by the diagram. On the other hand, the legal ampere and absolute ampere, like the legal ohm and the absolute ohm, are directly related, each by a single measurement. The second consequence is that from the legal ampere and volt, a new unit of energy is obtained, called the joule, but which is only approximately 10^7 ergs. To define a joule as 10^7 ergs, as some writers have done, is wrong, for the Paris Convention of 1881 initiated the term joule, and defined it as the international unit of electrical energy. By analogy with the absolute ohm and the absolute ampere, 10^7 ergs should be called one absolute joule.

Commissions and Conferences

We have stated that the reason for the introduction of the international units was to provide more easily realized standards of electrical quantities. At an International Conference of 1928 it was agreed that electrical quantities could now be measured in terms of the absolute units as accurately as in terms of the international units, so that the primary need for these latter units no longer

Electromagnetic Units and Definitions—

existed. It was therefore resolved that the numerical relations between these units should be measured with all attainable accuracy, and that a later Commission should effect a formal reversion to the absolute system for technical purposes. Accordingly, the American Bureau of Standards published these results of comparisons:—

1934.—One international ampere = 0.999928 ± 0.000020 absolute ampere.

1938.—One international ohm = 1.000468 ± 0.000020 absolute ohm.

A Commission in 1933 implemented the decision of the 1928 Conference by resolving that the change-over should take place on January 1st, 1940, and in the absence of the war, that would, presumably, have been decreed in this country. A Conference of 1946 resolved that the change-over should take place on January 1st, 1948, and in accordance with this, the National Physical Laboratory has announced that it will implement the decision in its measurements from that date. The most recent comparisons are:—

One international ampere = 0.99985 absolute ampere.
One international ohm = 1.00049 absolute ohm.

These figures are of interest to compare with the American estimates of a few years ago to observe the order of accuracy of recent determinations.

In setting up the international units, two changes were made: first, the difficult absolute measurements were replaced by the then simpler ones of the chemical ampere and the mercury ohm, and, second, more convenient multiples by ten of the fundamental units were adopted.

The M.K.S. system of units has been proposed to achieve identity of electromagnetic and practical systems. This system takes the metre, the kilogram and the second as the fundamental units of length, mass and time. If the system is adopted, it is to be hoped that a new name will be substituted for the "kilogram," and so the anomaly avoided of having a fundamental unit named in terms of another, a thousand times smaller. The new name should also, of course, be derived from the name of a scientist, following the avowed practice for the technical units.

"Practical" Units

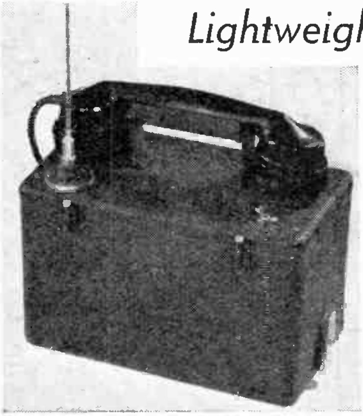
It may be worth while clarifying here a common misapprehension among engineers in connection with the practical units. If an engineer is asked why powers of ten appear in so many of his formulæ, e.g., the field of a solenoid is $4\pi ni/10l$, and the induced E.M.F. in a circuit is $10^{-8}d\Phi/dt$ volts, the writer's experience is that he will generally be told that this is due to the use of practical, instead of absolute, units. This, in fact, is not true. A consistent system of units must give the same formula as any other consistent system. These powers of ten arise in all engineers' formulæ which give the field of a current, and are due to the use of a mixed system of units, viz., practical units for the electrical quantities and absolute units for the magnetic quantities. There is no reason whatever why practical units of field and flux should not be used by engineers, and they would then have formulæ of the same form as those used by physicists, without the powers of ten. To call these formulæ "practical formulæ" is about as near the truth as to call the formula "circumference of a circle = 79.8 × diameter" a practical formula, for this is the mensuration formula which must be used by one who measures circumferences in millimetres and diameters in inches. The matter was made more difficult by the allocation of the name gauss to the absolute unit of magnetic field, thereby violating the explicit international resolution to use proper names for the "practical" units. But perhaps the limit of culpability in this matter was achieved when a later International Conference, having noted that the name gauss was being used in different senses by different writers, decided to abandon the term, and the new name oersted was allocated to the absolute unit of field, thereby repeating the same error after having been provided with a remarkably lucky opportunity to right it.

Another interesting light on electrical theory is given by a consideration of units. In the absolute system, the first quantity defined is current, and all the others are derived from it through mechanical relationships. Thus potential difference is the work done per unit charge, or the power per unit current, and resistance is the potential difference per unit current. We can, therefore, express resistance directly in terms of current and power, and the result is that resistance is the power per unit current squared. Thus the relation $R = W/I^2$ is the true definition of resistance. It is logically incorrect to regard this as a result which can be deduced from Ohm's Law, however convenient that viewpoint may be for the purposes of elementary teaching.

The definition of resistance in terms of power and current at once answers the question of the reality of the radiation resistance of an aerial, or of iron-loss resistance in iron-cored coils. These are often thought of as in some way unreal resistances; in fact, some text-books go so far as to distinguish between "ohmic resistance" and "fictitious resistance." The argument appears to run in some such way as this: In the case of an aerial, power is radiated when current flows in it; now, in a direct current circuit, power is developed when current flows, the amount being I^2R. Let us, therefore, pretend that the aerial has a resistance greater than its real resistance, just so great, in fact, as to make the relation $W = I^2R$ true. This value of R is called the radiation resistance of the aerial and is a fictitious resistance introduced to make our equations "come out right." It is, perhaps, unnecessary to say that an equation which needs such pretences to make it come out right is not worth having, and, in fact, the reality of radiation resistance is seen at once from the fact that whenever current supplies power, the circuit has a resistance of $R = W/I^2$ *by definition*. Any other meaning which the term resistance may acquire by habit is to be regarded with suspicion. It appears that engineers generally acquire another view of resistance which associates it with the frictional forces between molecules and electrons. This point of view was not inconvenient until technical apparatus appeared in which the chief forces on electrons in a wire were not the frictional molecular forces, but the fields in the wire. The work done against the molecular forces is turned into heat in the wire, while the work done against the field forces is radiated away in the case of the aerial, and transferred to the core in the case of the iron-cored coil. The distinction between ohmic and fictitious resistance would be justified if the definition of potential difference were the heat produced (instead of the work done) when unit charge passes from the one place to the other.

"PERSONAL" RADIO TELEPHONES

Lightweight Economical "Walkie-Talkies"



British Communications Model L59 "walkie-talkie."

WE had an opportunity recently to test and examine two very interesting portable radio telephones of the type often referred to as "walkie-talkies." These are sets of practical utility, not merely experimental models and, moreover, they are actually being produced on a moderate scale by British Communication Corporation, Gordon Avenue, Stanmore, Middlesex.

Such sets have numerous possibilities and those we saw were of a kind that would serve for the police and fire services, for newspaper reporting, for dispatching trains and, among other applications, for forestry patrol and even for ship to shore communications where a fixed installation is not convenient.

The range of the sets will be more than adequate for these and similar purposes as although up to 10 miles, according to prevailing conditions, is claimed, from the results obtained during our tests we think this figure is a little conservative.

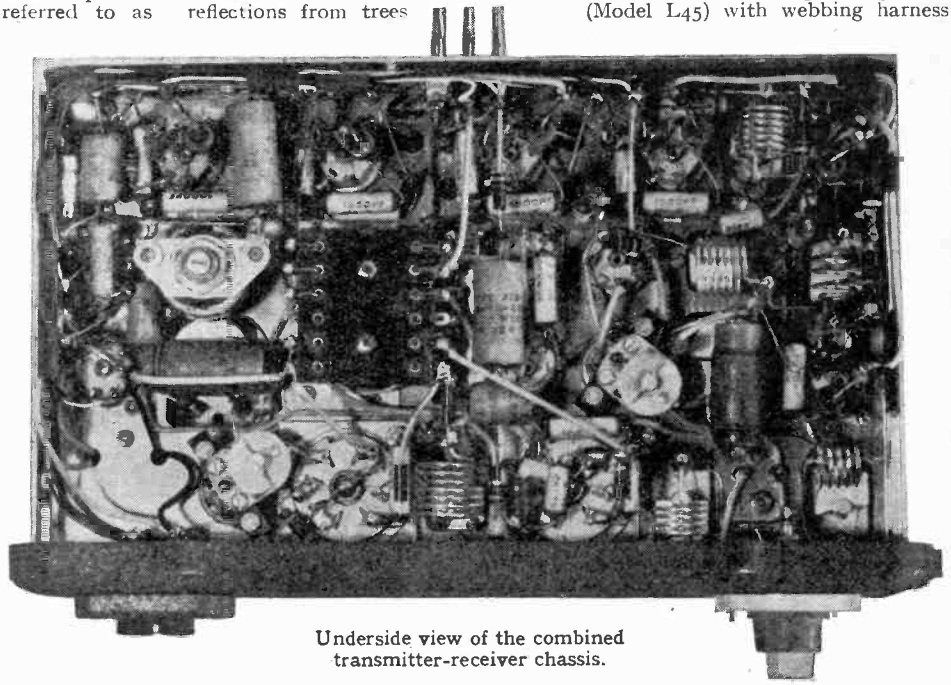
Tests were made from a mobile installation in a car and although no great range was attempted communication was maintained under widely different conditions: for example, on one occasion from a road passing through dense woodland, then in the midst of houses, and finally in the open country.

Under all conditions the reception in the car was perfect. Some flutter due to reflections from trees and buildings when on the move was noticeable, but this is quite common with most single-channel transmission systems using V.H.F. Substituting for the normal "whip" aerial a one-inch length of wire enabled communication to be maintained over about half a mile.

During transmission the set takes about 30 mA from a 135-volt battery, but when receiving the consumption is reduced to about 20 mA at 90 volts.

Two models of this radio telephone are available but both contain the same chassis. The only differences are that one is designed for carrying by hand and is about the size of a G.P.O. desk telephone with the hand set resting in a cradle on the top. It weighs about 10 lb and is described as the model L59.

The other is a pack-type set (Model L45) with webbing harness for carrying on the back, or slung over the shoulder. It has larger capacity batteries than the hand-



Underside view of the combined transmitter-receiver chassis.

Personal Radio Telephones—
portable and uses a separate microphone and head telephones. The all-up weight of this model is just under 16 lb and the overall size is $11 \times 9\frac{1}{2} \times 4$in.

Despite the fact that space is at a premium in sets of this kind the transmitter and receiver are entirely separate, so far as the circuits are concerned, but a common chassis is employed. Needless to say, really miniature parts are used throughout, for example, the send-receive relay which changes over the aerial, switches L.T. from transmitter to receiver and switches the H.T. batteries is not much larger than a thumb nail. Furthermore the sets are fully tropicalized.

The receiver is a double superhet with a single crystal-controlled oscillator serving for both mixers. It has one R.F. amplifier and three I.F. stages at 1.6 Mc/s. The first I.F. has no separate amplification. Detector, A.G.C. and noise limiter are all germanium crystals. There is one A.F. amplifier.

Four valves are used in the transmitter, which is also crystal controlled. Of these two are R.F. stages and two modulators, the amplitude system being employed. This set gives an R.F. output of not less than 250 milliwatts over the working range of frequencies (75 to 100 Mc/s).

The fine performance of these sets can be attributed to a combination of good design, workmanship and careful attention to small detail.

Model L45 is a pack-set version.

Silver plating is used wherever it has been found to confer any advantage. Incidentally, the vertical aerial is of special design having great flexibility yet always returning to the original position no matter how far it is bent. It can even be coiled up and when released springs out to a straight rod. It also is silver plated.

BOOK REVIEWS

The Symbolic Method of Vector Analysis. Pp. 28, with 15 diagrams. Price 3s.

A.C. Network Analysis by Symbolic Algebra. Pp. 41, with 37 diagrams. Price 4s.

Both by W. H. Miller, A.M.I.E.E. Classifax Publications, 9, White Moss Avenue, Manchester, 21.

THESE two booklets are the first in a new series intended to provide students with the essential information on specific subjects without their having to buy large and expensive works containing much that may be unnecessary to them. The titles are perhaps rather alarming to the student who is not strong in mathematics, and a glance at the interiors might confirm the fear that they are too advanced. Actually, however, only very elementary algebra and a mere smattering of trigonometry are required, and the abundance of equations is at least partly a result of the author's care to place his stepping stones so close together that his weakest followers are not likely to fall down between them.

The first booklet is, as the subtitle says, a simple explanation of the "j" operator. The author dismisses the terms "imaginary" and "complex," which suggest something difficult, and starts from the idea that it is just as easy and logical to use the symbol $\sqrt{-1}$ to mean a 90-degree change in direction as it is to use -1 to mean a change in direction of 180°. From this he goes on to explain the "general number," a+jb, and how it is subject to ordinary simple algebra. Each stage is illustrated by diagrams and numerical examples. The "scalar product," which experience shows is a difficulty to some students, is not introduced.

In the second booklet he shows how to apply the "j" technique to the calculation of A.C. circuits. The principles are general to all branches of electrical engineering. Thus, although one-third of the book is devoted to star-delta conversion and the detailed working out of an example of electrical power distribution network, this example can be regarded equally as a solution of the unbalanced bridge. And although resonance is not specifically mentioned, the principles are all there. It is notable that admittance is given equal status with impedance. The distinction between a rotating vector and the vector operator is clearly pointed out.

There are a few misprints, especially in the first booklet. The nomenclature and symbols are on the whole well chosen; an exception is that instead of the standard alternative to heavy type for indicating vector quantities—a bar overhead—a dot is used, which more usually signifies $\frac{d}{dt}$. And a very strange and unexplained symbol appears on pages 10 and 11. Readers may be confused by the misuse of the symbol $\pm$ in connection with expressions for admittance (but not in the corresponding expressions for impedance). In general, however, the teaching is clear, simple, and painstaking. It is recommended to everyone who has need to make A.C. calculations and is not entirely happy about using "j" for the purpose.

Two commendable features are the Dewey classification numbers on the front covers, and the repeating of diagrams where necessary to ensure that they are always to be seen at the same opening as the related text. M. G. S.

BOOKS RECEIVED

Wörterbuch der Electrotechnik. By G. Swoboda and R. Filipowsky. An English-German glossary of electrical technical terms, including radio and television. Pp. 312. Manzoche Verlagsbuckhandlung, Kohlmarkt 16, Vienna. Price $4.30.

The Amplification and Distribution of Sound. By A. E. Greenlees, A.M.I.E.E. A second edition of this standard text-book on sound reinforcement and public address work first published in 1938. The matter has been rearranged and revised and numerous additions have been made in the light of recent developments. Pp. 302, with 108 diagrams. Chapman and Hall, 37, Essex Street, London, W.C.2. Price 16s.

Radio's Conquest of Space. By D. McNicol. A historical account of the development of radio from the earliest days up to the evolution of radar. Pp. 374; 53 figures and many illustrations. Published in Gt. Britain by Chapman and Hall (address above). Price 18s.

WORLD OF WIRELESS

Birmingham Television Frequencies ✦ French 819-Line System ✦ "Old Soldiers . . . ." ✦ E.H.F. Broadcasting

B.B.C. Television

THE frequencies to be employed by the Sutton Coldfield television station have at last been announced by the B.B.C. They are: vision 61.75 Mc/s and sound 58.25 Mc/s. Asymmetric sideband transmission, in which the upper sideband of the vision transmitter will be partially suppressed, is to be used to reduce the bandwidth required. The sound channel will be A.M.

The output of both the 35-kW vision transmitter and the 12-kW sound transmitter will be radiated from a single aerial supported by a steel lattice mast, 750 feet high. This mast, which is being erected by B.I. Callender's Cables, is of novel design. The main triangular support mast will be 600 feet high, at this level the cross section changes to circular, and for the next 110 feet the mast resembles a steel chimney. Above this will stand a short, square tower carrying eight dipoles.

When reviewing the progress of the B.B.C. television service recently the Director-General remarked: "Exactly what is the right order of priority for television in our British economy at present no one can say dogmatically. There is no simple or easy answer . . . All I would dare to say is this. Television is a permanent addition to the twentieth-century way of life. Its extension to cover the whole country and its eventual marriage with sound broadcasting, once the two coverages are approximately similar, will overshadow all other broadcasting problems in importance during the next few years."

French High-Definition Television

WE learn from a correspondent that if present plans materialize, Parisians will have a public television service of 819 lines by the end of the year. This will operate simultaneously with the existing 455-line system. The picture signal (interlaced) will have a waveform which does not differ greatly in shape from the existing systems in Paris and London. A three-van mobile unit which will be used for O.B.s will operate on either standard by a simple switching arrangement. For O.B.s at too great a distance to use existing cables an aerial suspended from a balloon and using decimetric waves will be used. The actual transmitter for the 819-line system is in the Eiffel Tower and will operate on about 200 Mc/s.

A particularly interesting point is that the new system is stereoscopic. The projected images appear on the screen, one above the other and are separated by a horizontal line. The aspect ratio per picture being 8:3. By viewing the screen with a piece of equipment resembling a pair of opera glasses, the normal aspect ratio of 4:3 is restored and the two images combined stereoscopically.

Better Listening

SOME interesting facts were revealed during the recent "Better Listening" campaign organized jointly by the R.I.C. and the B.B.C.

From a review of sales figures during the past few years it is apparent that 5.5 million householders—43.5 per cent of the country's licence holders—are using sets which are more than ten years old.

An investigation by leading dealers in various parts of the country reveals that the average annual cost of repairs to these old sets is between £2 and £3 10s.

Sir Noel Ashbridge, B.B.C. Director of Technical Services, has expressed the view that listeners become "drugged with bad quality" to such an extent that the high-fidelity reproduction of a modern set is disliked. A pamphlet giving hints on better reception has been issued by the B.B.C.

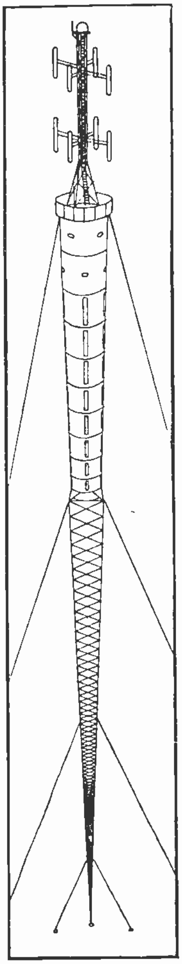
Radio Recruiting

RADAR operators, supervisors and mechanics, R/T operators and wireless mechanics are urgently needed by the Air Defence Units of the Royal Auxiliary Air Force. These units, manned by 20,000 men and women volunteers, will form part of the Fighter Command raid reporting and control system covering the whole country.

Among the ground trades in the R.A.F. Volunteer Reserve for which recruiting has re-opened is that of radio servicing. At present only men who have served in the R.A.F. will be accepted.

Details regarding both of these Services are obtainable from R.A.F. Recruiting Centres or from the Inspector of Recruiting, Victory House, Kingsway, London, W.C.2.

Special units of the Territorial Army are said to be very short of radio technicians, especially those who served as officers and N.C.O.s during the war. They are required as instructors. Particulars regarding recruitment are obtainable from Territorial Centres.



TELEVISION.—This sketch gives some idea of the construction of the Birmingham mast. The slots in the upper section are for a "slot" aerial for sound broadcasting, probably F.M. A similar mast will be used at Wrotham, Kent.

F.M. or —— ?

WE recently put forward the plea that before embarking on a nation-wide F.M. service the B.B.C. should try another parallel experiment — amplitude modulated E.H.F. It was, therefore, gratifying to learn from a recent B.B.C. statement that a second transmitter, "which can work on A.M. or some other method of modulation" is being installed at the Wrotham (Kent) station where work on the erection of Europe's first high-power F.M. transmitter has begun. By installing the second transmitter the engineers will be able to compare results side by side.

Army Signals

THE Signals Research and Development Establishment of the Ministry of Supply at Christchurch was open for inspection by representatives of industry, the Services and the Press during September. Visitors were shown the various

World of Wireless—
activities of the Establishment ranging from pure scientific research through design and development of communication apparatus to final extensive testing under the equivalent climatic and rough handling conditions likely to be encountered in the field.

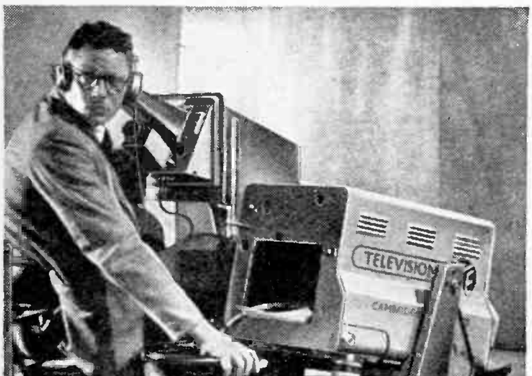
The principal Army wireless sets were displayed and a mock battle involving infantry, tanks and aircraft was staged to demonstrate the scope of radio communication in the modern army. The No. 10 set for multichannel pulse communication and the lightweight No. 88 set, which, together with its batteries, stows easily in an infantryman's ammunition pouch, were highlights of the demonstration.

25 *Years of Metal Rectifiers*

THE Westinghouse Brake and Signal Company recently celebrated a quarter of a century of manufacture of metal rectifiers. It was in 1923 that the first copper-oxide rectifier was evolved and two years later applied to railway signalling. It was not until 1927 that it made its first appearance in a trickle charger and H.T. battery eliminator for radio sets. Subsequent developments produced the bridge-type instrument rectifier and Westector for use at radio frequencies.

Whilst the copper-oxide type still finds many applications as low-power rectifiers the introduction of the selenium rectifier a few years ago largely displaced the earlier pattern in the field of power rectification.

Improvements still continue to be made, the most recent being the double-voltage rectifier which has enabled the size and weight to be considerably reduced. This is manifest in the extremely small size of some of the Westinghouse E.H.T. rectifiers now being produced for use in television sets. For example, a rectifier 8in long and 7/16in diameter gives an output of 10kV.



PYE television camera with demountable electronic view finder in use in the temporary studio at the Copenhagen exhibition.

OBITUARY

It is with regret we record the death of **K. B. Warner,** W1EH, the managing secretary of the American Amateur Radio Relay League and secretary of the International Amateur Radio Relay League.

PERSONALITIES

Sir Noel Ashbridge, B.B.C. Director of Technical Services, has accepted the invitation to become president of the Junior Institution of Engineers for the 1948-49 session.

Dr. R. L. Smith Rose, D.S.I.R. director of radio research, gave two lectures under the auspices of the British Council on radar and navigational aids during the period of the British radio components exhibition organized by the R.C.M.F. in Stockholm.

Prof. Balth. van der Pol, D.Phys., the new director of the C.C.I.R., was inadvertently referred to as "of Germany" in our last issue. He is, of course, the well-known and highly esteemed member of the board of management of the Physics Laboratory of the Philips organization in Eindhoven, Holland.

Leslie McMichael, director of McMichael Radio, has been made a Fellow of the Institute of Radio Engineers of Australia. He has recently been on a visit to Australasia.

Sydney C. Shaw, who from 1936-1944 was in the Engineering Division of the B.B.C. and from 1944-47 in Royal Signals, has joined R.C.A. Communications, Inc., and is at Tangier, Morocco.

H. A. Lewis, M.B.E., T.D., B.Sc.(Eng.), who served in R.E.M.E. during the war with the rank of lieutenant colonel, has relinquished his appointment with the B.B.C. Engineering Division to join Marconi's W.T. Co., where he is taking charge of the Broadcasting Division, which includes television.

W. J. Lloyd, B.Sc., who resigned his position as chief engineer of Guy R. Fountain, Ltd., in March, has joined Philips Electrical as chief engineer of the company's Amplifier and Public Address Department. During the war he was in the B.B.C. Recording Department, where he worked on the development of the War Correspondents' miniature recorder.

W. J. Lloyd, B.Sc.

IN BRIEF

Licences.—Over eleven per cent of the month's increase of 31,250 in the number of receiving licences in Gt. Britain and Northern Ireland were for television receivers. The total number of licences at the end of August was 11,324,000, of which 61,700 were for television.

Licence Fees.—In response to a question in the House, the P.M.G. stated that during the 1947-48 financial year the Exchequer received £1,575,417 and the Post Office £670,390 from broadcast receiving licences. As stated in the last issue, the B.B.C. received £8,927,363 from the same source during the same period.

Amateur Exhibition.—Twenty-seven exhibitors have taken space at the R.S.G.B.'s annual amateur radio exhibition which is to be opened at the Royal Hotel, Woburn Place, London, W.C.1, on November 17th at 2.30 by Dr. Smith Rose. Admission to the exhibition, which will continue until the 20th (hours 11.0 a.m. to 9.0 p.m.), is by catalogue, price 1s.

E.H.F. Record?—What is claimed to be an amateur record for E.H.F. two-way communication was set up when a frequency of 2,350 Mc/s was successfully used over a distance of 13 miles. The stations were situated at Brighton Racehill and Salvington Hill, Worthing.

Air-Ground communication channels for civilian aircraft are being moved progressively from the M.F. band to the E.H.F. band. The freed medium frequencies will then be used for essential radio-navigational services. The change-over has been necessary because of the reduced number of medium frequencies available to aeronautical telecommunications at last year's Atlantic City Conference.

Radar Course.—Among the full-time courses in electronics, telecommunications and radio engineering offered by University College, Southampton, during the coming months is one on radar. This eight-week course, which costs

£5, plus one guinea enrolment fee, embraces the full requirements for the Ministry of Transport examination for the certificate in radar maintenance. The college is equipped with two radar sets, the Admiralty Type 268 3-cm, and the 10-cm marine set Type 271. Details are obtainable from A. Orba, B.Sc., University College, Southampton. Information on the M.o.T. certificate is obtainable from the Secretary, M.o.T., Berkeley Square House, London, W.1.

City and Guilds.—Regulations and syllabuses for examinations in telecommunications and electrical engineering, radio servicing and for the radio amateurs' licence are given in a booklet issued by the City and Guilds of London Institute. Obtainable from the Department of Technology, 31, Brechin Place, London, S.W.7, priced 1s 3d by post, it sets forth in considerable detail the courses available.

Radio and Television Courses, including circuit theory and workshop practice, have been arranged by the Sydenham General Evening Institute. Particulars are available from the principal of the Institute at Sydenham Secondary (Central) School, Kirkdale, London, S.E.26.

I.E.E. Publications.—From January 1st changes are being made by the I.E.E. in the publication of its *Journal*, which has for some time been issued in three parts. In future the *Journal* will contain information intended for members only and will continue to be issued monthly. In addition, the institution will issue in three parts the *Proceedings of the I.E.E.;* Part I (General) will be devoted to papers and proceedings of Ordinary Meetings; Part II (Power Engineering) to the activities of the Utilization, Measurements and Supply Sections; and Part III (Radio and Communication Engineering) to the activities of the Radio Section. Each part will be issued in alternate months. Subscription rates will be £1 1s, £1 11s 6d and £1 11s 6d, respectively.

School Broadcasting.—In reply to a question in the House the Minister of Education stated that, according to an estimate made by the School Broadcasting Council, reception in 30 per cent of the 15,000 schools equipped with radio was unsatisfactory.

I.P.R.E.—The South-West Section of the Institute of Practical Radio Engineers was formed at an inaugural meeting in Newton Abbot, Devon. The secretary is F. C. Roberts, "Inglenook," South Brent, Devon.

FROM ABROAD

Citizens' Radio.—New rules have been proposed by the U.S. Federal Communications Commission for the operation of transmitter-receivers for private communication purposes. The recommendation proposes two types of station, one operating within the band 460-470 Mc/s with a power of 50 watts and another limited to 10 watts on 465 Mc/s. Until the proposals are adopted only experimental licences are being issued.

South Africa is to have sponsored broadcasting. The South African Broadcasting Corporation, which is modelled on the lines of the B.B.C., has been requested by the Government to provide for commercial programmes as soon as possible. The service will be in addition to the bilingual service in English and Afrikaans operated by the Corporation.

Radio New Zealand, the short-wave station of the New Zealand Broadcasting Service, started overseas transmissions on Dominion Day, September 27th. The 7.5-kW transmitter, which at present radiates from 0700 to 0900 G.M.T. on 9.54 Mc/s (ZL2), and 11.78 (ZL3) and 15.28 (ZL4), is situated at Titahi Bay, some 17 miles from Wellington. Reports on the transmissions, which are at present primarily for the New Zealand Dependencies in the Pacific, will be welcomed by the Director, Radio New Zealand, P.O. Box 3045, Wellington, N.Z.

"Radio Craft," our twenty-year-old American contemporary, has changed its name to *Radio Electronics*, as the old title "no longer reflects the editorial content of the magazine."

Swiss Broadcasting.—A copy of the annual report of the Swiss broadcasting authority, Société Suisse de Radiodiffusion, has been received. It deals with the activities of the country's three main broadcasting stations which provide a trilingual service. The report on each station is printed in the language used by the station—Sottens (French), Monte Ceneri (Italian), Beromunster (German).

Walkie-Talkie sets are being supplied to the Cable and Wireless staff on the Cocos Islands to provide communication between Home and Direction Islands, which has hitherto been maintained by irregular sailings by the islanders.

I.R.E. (India).—At a recent meeting of the Institute of Engineers (India) in Bombay it was decided to form an independent Institute of Radio Engineers (India).

Brazil's first television station, which is to be erected in Rio de Janeiro, is being equipped with American gear.

Hungary.—A three-year production plan for the Hungarian telecommunications industry aims at increasing production to 120 per cent of the pre-war total. The target for broadcast receivers is 155,000.

EXPORT

Scandinavian Television.—A total of 117,000 people attended the television demonstrations given by British radio manufacturers during the British Exhibition which was held in Copenhagen from September 18th to October 3rd. Since leaving Copenhagen the cameras and mobile transmitting equipment have been used for a week in Stockholm, Sweden, where a demonstration of receivers has been arranged by Pye, Ltd., the manufacturers of the transmitter. For the demonstrations in Copenhagen over twenty receivers, provided by twelve British manufacturers, were used.

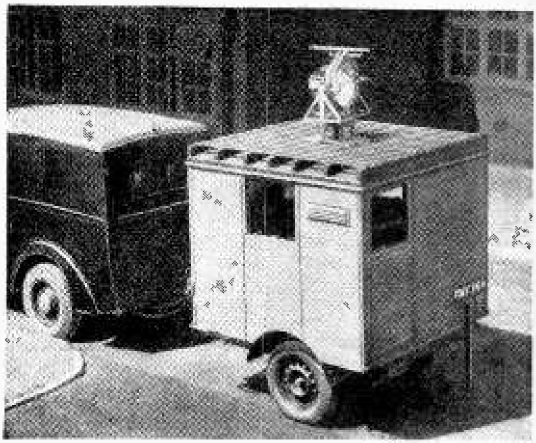
Competition between American and British manufacturers in the television export market was discussed at the autumn meeting of the American Radio Manufacturers' Association. It is understood that American producers are planning a campaign to persuade other countries to adopt their higher definition system (525 lines) and are endeavouring to keep export markets open until they have met the present demand in the States.

Components in Stockholm.—Thirty-six member firms of the Radio Component Manufacturers' Federation had stands at the exhibition of components, accessories and materials organized by the Federation in Stockholm from October 18th-22nd. Although Sweden is now making nearly all her own receivers, she has imported over a million pounds' worth of British radio gear so far this year.

Whiteley Electrical Radio Co. reports that their exports of Stentorian loudspeakers have shown a marked increase during the past year. Recent shipments were consigned to Argentina, Malta, India and Trinidad.

INDUSTRIAL NEWS

Marconi communication and D.F. equipment is to be installed in Britain's latest airliner—the Handley Page Hermes IV. The transmitter, which operates on both 'phone and C.W., covers the frequency range 2-18.5 Mc/s and 320-520 kc/s. Twenty pre-selected crystal-controlled frequencies are pro-



MOBILE RECEIVER used by G.E.C. research engineers for measuring the atmospheric absorption of millimetre waves over paths of up to 1·5 miles. Above the aluminium paraboloidal aerial is the telescope used for aligning the aerials. The region investigated was between 4.5 and 6.5 mm.

World of Wireless—
vided in the H.F. band and ten in the M.F. band. On H.F. the maximum power is 150 watts and on M.F. 120 watts.

G.E.C.'s recently conducted tests with F.M. equipment on the Thames showed that one low-power transmitter, strategically placed, gave ample signal strength for radio-telephone communication with ships along the entire length of the river which comes within the jurisdiction of the Port of London Authority—some sixty miles.

"Production Engineering," a new 226-page book produced by our associated journal *Machine Shop Magazine*, gives an insight into the various systems of production planning and control. The author, J. S. Murphy, deals with the basic principles and the treatment of the subject is general rather than particular. The book is published by The Louis Cassier Co. and costs 12s 6d.

F. C. Robinson, who some time ago resigned from the managing directorship of Cossor Radar, Ltd., has set up an organization, to be known as F. C. Robinson and Partners, to act as consultants on industrial electronic applications and for the supply and maintenance of electronic equipment. The head office is at Dalton House, Hargate Drive, Hale, Cheshire, and the showroom and service depot at 308, Deansgate, Manchester, 3.

B.E.A.M.A. Catalogue.—The Directory Publications Department of our Publishers has undertaken the production of the 1949-50 catalogue and directory of the products of the members of the British Electrical and Allied Manufacturers' Association. This 700-page reference book, which will be published early next year, will include a classified buyers' guide and a trade directory.

Blind Operatives.—One of the best sources of employment for blind persons is the radio industry, according to a brochure, "Skilled Hands," issued by the National Institute for the Blind.

S. Spencer-West, of Quay Works, North Quay, Gt. Yarmouth, has started a research and manufacturing concern and is developing industrial electronic equipment.

Charles Britain (Radio), Ltd., has moved from Wilson Street, London, E.C.2, to 11, Upper St. Martins Lane, London, W.C.2 (Tel.: Temple Bar 0545).

MANUFACTURERS' LITERATURE

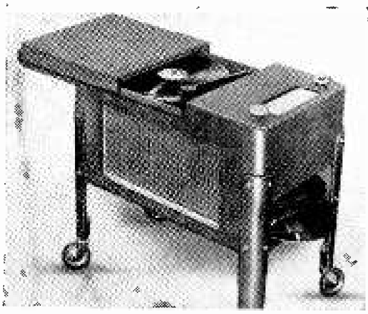
Descriptive leaflet dealing with the Type 1200 "Stroboflash" and accessories from Dawe Instruments, Harlequin Avenue, Great West Road, Brentford, Middlesex.

Technical Bulletin D.T.B. dealing with coil turrets CT6 and CT7 and giving complete data and recommended circuits from Denco (Clacton), 355-9, Old Road, Clacton-on-Sea. Price 3s.

Illustrated folder giving complete range of domestic receivers (Autumn, 1948) from the General Electric Co., Magnet House, Kingsway, London, W.C.2.

Literature describing Lustraphone microphone, miniature moving-coil loudspeaker and Model 483 mixer unit, from Lustraphone, Ltd., 84, Belsize Lane, London, N.W.3.

Illustrated leaflet describing the "Motavia" car radio - transportable, from The Motavia Co., Timperley, Cheshire.



CHAIRSIDE RADIOGRAM made by Telefunken which is an example of the few "special" receivers seen at the Leipzig and Hanover Fairs. A four-valve "Standard Super" costs RM475 —three months' wages of the average worker in the British Zone.

MEETINGS

Institution of Electrical Engineers
Radio Section.—"A Storage System for Use with Binary Digital Computing Machines," by Professor F. C. Williams, O.B.E., D.Sc., D.Phil., and T. Kilburn, M.A., on November 2nd.

"Aids to Training—The Design of Radar Synthetic Training Devices for the R.A.F.," by G. W. A. Dummer, M.B.E., on November 3rd.

Continuation of the Discussion on "To what Extent does Distortion really matter in the Transmission of Speech and Music?" re-opened by P. P. Eckersley, on November 9th.

"Printed Circuits, including Miniature Components and Sub-Miniature Valves," by J. E. Rhys-Jones, M.B.E., on November 23rd.

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

Cambridge Radio Group.—Discussion on "To what Extent does Distortion really matter in the Transmission of Speech and Music?" opened by P. P. Eckersley, at 8.15, on November 2nd, at the Cavendish Laboratory, Cambridge.

Address of the chairman of the Radio Section, F. Smith, O.B.E., at 6.0, on November 16th, at the Cambridgeshire Technical College, Cambridge.

Mersey and North Wales Centre.—"Analysis-Synthesis Telephony, with special reference to the Vocoder," by R. J. Halsey, B.Sc. (Eng.), and H. Swaffield, Ph.D., at 6.30, on November 15th, at the Liverpool Royal Institution, Colquitt Street, Liverpool.

North-Eastern Radio and Measurements Group.—Discussion on "To what Extent does Distortion really matter in the Transmission of Speech and Music?" opened by P. P. Eckersley, at 6.15, on November 15th, at King's College, Newcastle-on-Tyne.

Sheffield Sub-Centre.—"The Design and Construction of a New Electron Microscope," by M. E. Haine, B.Sc., at 6.15, on October 27th, at the Scunthorpe Technical School.

North - Western Radio Group.—"Practical Aspects of Marine Navigational Radar," by A. K. Nuttall, M.A., at 6.30, on November 17th, at the Engineer's Club, Albert Square, Manchester.

Scottish Centre. — "The Wartime Activities of the Engineering Division of the B.B.C.," by H. Bishop, C.B.E., B.Sc. (Eng.), at 7, on November 10th, at the Heriot-Watt College, Edinburgh.

Rugby Sub-Centre.—"Three Dimensional Cathode-Ray Tube Displays," by E. Parker, M.A., and P. R. Wallis, B.Sc. (Eng.), at 6.30, on November 2nd, at the Electricity Showrooms, Rugby.

Southern Centre. — "Analysis-Synthesis Telephony with special reference to the Vocoder," by R. J. Halsey, B.Sc. (Eng.), and J. Swaffield, Ph.D., at 6.30, on November 10th, at the A.S.R.E., Haslemere.

British Institution of Radio Engineers
London Section.—"U.H.F. Radio Equipment for Mobile Services," by D. H. Hughes, at 6.0 on November 18th at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

South Midlands Section.—"Measurement and Suppression of Radio Interference," by J. H. Evans, at 7.0 on November 25th at the Technical College (Room A.5), The Butts, Coventry.

Merseyside Section.—"Television Receiver Design Technique," by P. Jones, at 6.45 on November 17th at the Incorporated Accountants' Hall, Derby Square, Liverpool, 2.

Television Society
London. — "Studio and Outside Broadcasting Television Practice," by T. H. Bridgewater, at 7.15, on October 27th, at the G.B. Theatre, Film House, Wardour Street, London, W.1.

Midlands Centre. — "Luminescent Materials for Cathode-Ray Tubes," by Dr. G. F. J. Garlick, at 7.0, on November 2nd, in Room 6, Chamber of Commerce, New Street, Birmingham. Sec.: R. R. T. Baxendale, 50, Alcester Road, Moseley, Birmingham.

British Sound Recording Association
"Some Fundamentals of Magnetic Recording," by E. W. Berth-Jones, B.Sc., at 7.15 on November 19th, at the E.M.I. Studios, 3, Abbey Road, St. John's Wood, London, N.W.8.

Radio Society of Great Britain
"Speech Clipping," by P. F. Cundy, at 6.30, on October 29th, at the I.E.E., Savoy Place, London, W.C.2.

Institute of Physics
Electronics Group. — Discussion on "Valves for Low-Noise Wide-Bandwidth Amplifiers," opened by R. J. Ballantine, M.Sc., and A. E. Widdowson, Ph.D., at 5.30, on October 5th, at the Institute's House, 47, Belgrave Square, London, S.W.1.

Junior Institution of Engineers
North-Western Section.—"The Electron Microscope," by M. Venner, B.Sc. (Eng.), at 2.30 on November 20th at the Manchester Geographical Society, 16, St. Mary's Parsonage, Manchester.

THE "BELLING-LEE" PAGE

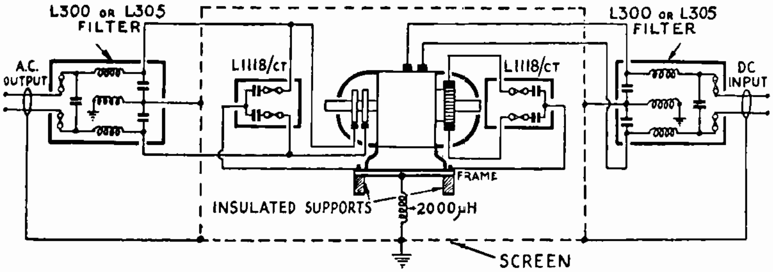
Providing technical information, service and advice in relation to our products and the suppression of electrical interference

Suppression of Small Rotary Convertors.

We receive, by almost every post, requests for advice on the suppression of electrical interference caused by small rotary convertors, and we can therefore appreciate the motives behind "DIALLIST'S" remarks on the subject, in the "Wireless World," July issue.

Filtering of all leads will probably be necessary, and this is preferably carried out at the point of entry into the screening box (L.300/3, L.305*[2], according to rating).

Although the filters do not cover frequencies above 30 Mc/s, this treatment will normally be effective against interference at T.V. frequencies, provided that the screening is adequate, since T.V. interference is almost entirely radiated.



The above diagram shows the recommended suppression methods for small rotary convertors. Standard "Belling-Lee" filters are employed, the L300 (1 amp.) or L305 (2 amp.) being used according to rating.

For those whose electricity supply is D.C., a rotary convertor is, in many cases, a necessary evil, and it may interest them to know how to set about suppressing its principal defects.

Double capacitor suppressors (L.1118/CT)*[1] should be connected between the brushes and frame of the machine. Two will be required, one for each set of brushgear. The connecting leads used must be as short as it is possible to make them, never exceeding three inches in length.

The convertor and its capacitor suppressors should be enclosed in a screening box. Expanded or perforated metal is recommended, but wire netting or mesh must be avoided. All joints in its construction should be continuously soldered, and the cover so arranged that multi-point contact with the rest of the screen is assured.

The carcass of the convertor should be insulated from the screen, being earthed, if necessary, through an R.F. choke.

The screen must be solidly bonded to earth, and the convertor so sited that the earth lead is kept short, and independent of the earthing system of the receiver.

The input and output leads may be shielded, with the shield bonded only to the screen enclosing the convertor.

In the many thousands of cases of T.V. interference which have passed through our hands, only twice have we encountered instances of such interference being mains borne. If any reader has such a case, we should be glad to hear about it, but we do ask that the nature of the interference shall be confirmed beforehand.

"Flutter" in a Television picture.

It is very gratifying to have received a batch of letters from retailers telling us that our *[3] aerials stand up well to severe weather conditions. They are designed with a generous margin of safety which, although contributing somewhat to the overall weight, has from our long experience justified our policy. Of the willow it has been said "it will bend but it will not break." Of the oak, "it will break but will not bend." A good television aerial must do neither.

A television aerial that flaps about in wind, one that "flutters" will give a picture that flutters and may give a great deal of annoyance. This effect may only manifest itself on a windy day or night. If the elements are whippy the effect is more pronounced when eighth wave spacing is employed than with quarter wave spacing.

At the present stage of the television studio art, lighting variations at that end may tend to mask the effect of flutter due to lack of rigidity in an aerial, but as the studio technique is continually improving it is better to be on the safe side and be sure to insist on a rigid, robust aerial, one preferably with quarter wave spacing.

In Praise of Paint.

The great trouble with a steel aerial is the protective finish. Plating is unsuitable. Continuous exposure to sulphurous fumes in chimney locations, sometimes salt spray as well, all call for paint. Our standard finish is aluminium paint, but we recommend an additional coat at the time of erection. And we have to remind customers and readers that even bridges, iron lamp-posts, park railings, etc., are painted again and again. Yet many people are surprised that a slender "Skyrod"*[4] or television aerial will not stand year after year submitted to far worse conditions, and without any attention, just because it is difficult to get at it.

> Will those in coastal towns, fishing ports, yachting centres etc., bear in mind that "Belling-Lee" are specialising in suppression on board ship.
> We have done such work on ships of all sizes from the "Queen" class to trawlers, drifters and yachts.

1.* Condenser suppressor for fitting at the source. **L.1118/CT. 27/6.**

2.* Set lead suppressors **L.300/3** (1 amp.) all-wave **59/6. L.305** (2 amp.). Short and medium wave **63/-.**

3.* "Viewrod" television aerial for London frequencies **L.502/L,** for Birmingham frequencies **L.634,** each **£6/6/-.** Both types include dipole reflector and chimney lashings (less mast). Required length of feeder extra.

4.* "Skyrod" 18ft. vertical aerial with "Eliminoise" transformers, screened feeder and earth wire, etc., **L.638/K** for chimney mounting **£10/-/-. L.638/CK** for mast mounting **£8/15/-.** The words "Viewrod," "Skyrod" and "Eliminoise" are regd. trade marks.

BELLING & LEE LTD
CAMBRIDGE ARTERIAL ROAD, ENFIELD, MIDDX

PHILIPS

SOUND AMPLIFYING EQUIPMENT

THE "VOXMOBILE" AMPLIFIER

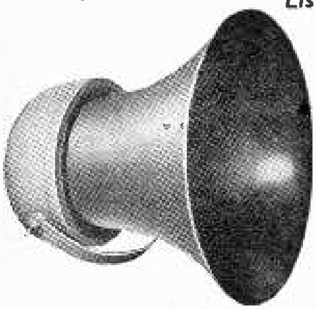
Type 2856R

Mobile — Indoor — Outdoor
Operates from A.C. Mains or 12-volt battery
Output:—12-watts. Self-contained

The Voxmobile is a really versatile amplifier. While it produces excellent quality, it is light, quickly connected, and operated equally as well either from A.C. mains 250 volts or a 12-volt car battery.

One of the outstanding features of this amplifier is the high sensitivity; only 3·5 mV being required into 1 megohm to produce the full output, thus allowing wide pick-up and the use of high quality microphones.

List Price: £38 . 0 . 0



Loudspeaker Type 9816T

Excellent reproduction and wide angle distribution.
Weatherproof — light — robust.
For use Outdoors, Indoors, or on a Vehicle.
No back radiation and therefore minimum feed-back.
The ideal "general-purpose" quality P.A. Speaker.
Complete with line transformer tapped at either 1, 3 or 6 watts.

List Price: £8 . 0 . 0

Complete Voxmobile "All-Purpose" Equipment

The ideal general-purpose equipment for Dealers and for Religious, Political, Social and Sporting Organisations. Comprises:—Amplifier, high fidelity moving-coil microphone, substantial stage-type microphone stand and two type 9816T speakers.

List Price: £70 . 0 . 0. Available to all bona fide Traders

PHILIPS ELECTRICAL LIMITED, AMPLIFIER DEPARTMENT, CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2

TELCON'S LATEST MAGNETIC DEVELOPMENT

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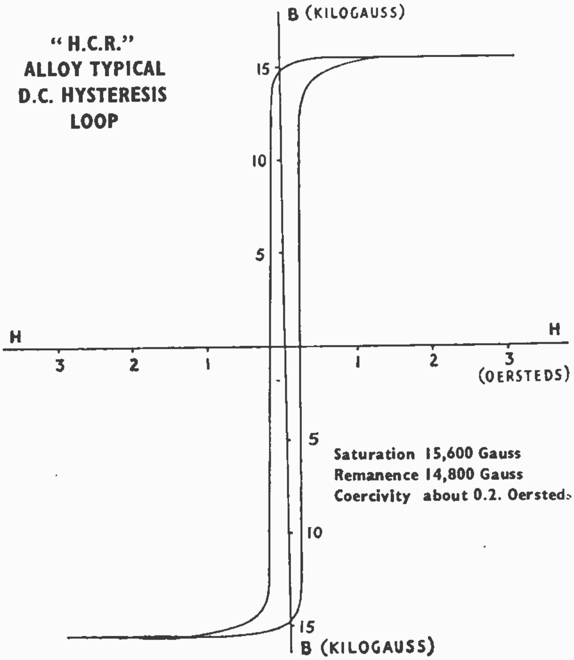

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STABILIZED POWER SUPPLIES

2. Some Refinements and Modifications

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

IN Part I we discussed the design of series-valve units, illustrating it with an example for providing an output voltage adjustable from 200 to 400 V. stabilized against mains fluctuations of + 4% to − 8% and load fluctuations between zero and maximum, 100 mA. Using a high-gain pentode for output feedback, we found such a unit to be capable of a basic mains-voltage stabilization, even with a source resistance as high as 1000 Ω, of around 280 : 1, and an internal resistance of a few ohms. By the use of properly adjusted input feedback via the screen-grid, we found it possible not only to neutralize the bad effects of the stabilizing tube resistance, but also to neutralize the source resistance (giving theoretically infinite mains voltage stabilization), or both source resistance and series-valve resistance (giving zero internal resistance), or a compromise between the two.

In relation to its performance, which is amply good for most purposes, the arrangement arrived at so far is quite a simple one. Most of the component values have already been calculated, but there are a few practical details still to be noted.

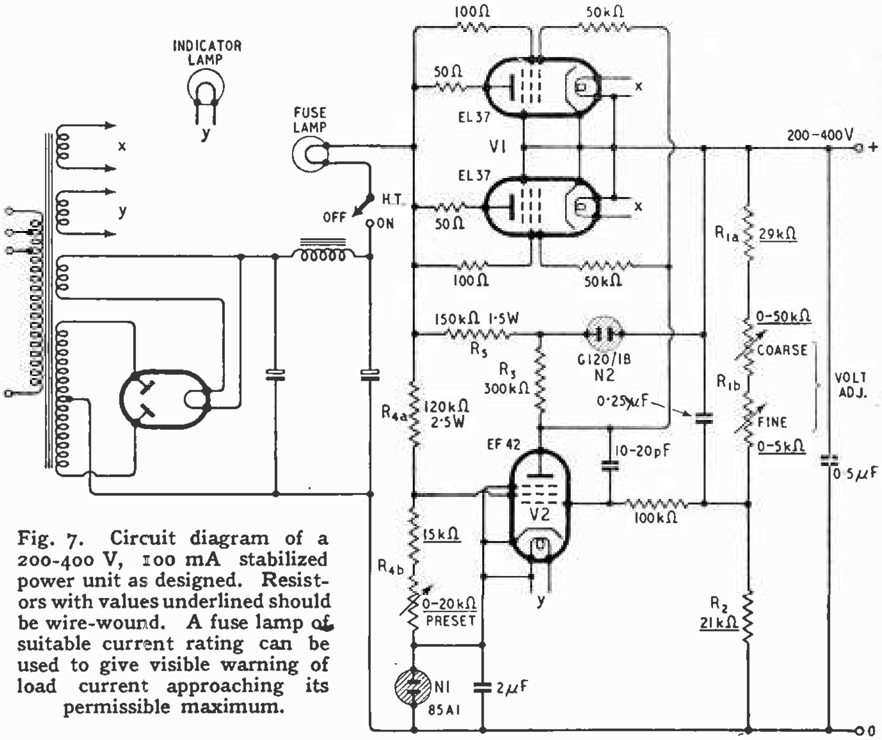


Fig. 7. Circuit diagram of a 200-400 V, 100 mA stabilized power unit as designed. Resistors with values underlined should be wire-wound. A fuse lamp of suitable current rating can be used to give visible warning of load current approaching its permissible maximum.

Applying output feedback by a simple potential divider, ripple in the unstabilized source is reduced in the same ratio as slow mains fluctuations. It can, as already mentioned, be reduced still more by means of a capacitor across R_1. The value is not critical; 0.25 or 0.5 μF is generally satisfactory.

We have a considerable gain in the output feedback loop, and as usual must look out for spurious oscillation. A check on this, and on residual hum, can be made with an oscilloscope connected (with a good blocking capacitor) across the output terminals, using sufficient wide-band amplification to show 1 mV. Stray capacitances that would tend to cause phase shift or positive feedback should be avoided; and it is wise to screen everything connected to the control grid of V2, especially if the A.C. power section is on the same chassis. If, in spite of precautions, high-frequency oscillation starts up, add enough capacitance from grid to anode of V2 to stop it; 20 pF should be ample, assuming a grid stopper of about 100 kΩ. The gain is thereby considerably reduced at high frequencies, and the internal impedance of the unit correspondingly increased; so it is advisable to provide a H.F. bypass capacitor across the output terminals, say 0.5 μF.

The heaters of V1 and V2 should be connected to their cathodes and fed from separate well-insulated transformer windings.

It will be noted that in the example the maximum V_a rating for V2 is liable to be considerably exceeded. In a stabilizer with a high voltage output this is almost inevitable, and does not seem to be a cause of trouble[4].

For close adjustment of V_0 it is a good idea to divide R_{1b} into coarse and fine controls, say 50kΩ and 5kΩ respectively.

Gathering all our results together we arrive at the complete circuit diagram, Fig. 7. The rectifier and smoother may be on conventional lines. In this design, little margin has been allowed for

[4] For example see "Voltage-Regulated Power Supplies," A. B. Bereskin, *Proc. I.R.E.*, Feb., 1943.

Stabilized Power Supplies—

tolerances in valves and other components. If it were necessary to ensure effective control over the full working ranges without laboratory checks after renewing valve and neon tubes, and to meet "commercial" conditions generally, it would be desirable to design rather more conservatively. The rather abnormally high source resistance assumed — 1000 Ω — leaves considerable scope for this, by reducing it.

The observed performance of a unit similar to this one agreed well with expectations. In fact, as regards absence of transients in V_0 on suddenly switching the load on and off it exceeded the highest hopes. With R_{4b} critically adjusted, switching 70 mA or so on and off caused only a flicker of the order of 10 mV, or say 1 in 30,000, corresponding to a mean resistance of $\frac{1}{7}$ Ω. Larger or smaller load changes, or the same change at a different V_0, without readjustment of R_{4b}, naturally gave less remarkable results, owing to inconstancy of r_{1a} and m, and the reduction of mains fluctuations was only slightly better than "basic"—but that itself was very good. With R_{4b} critically adjusted for mains stabilization, a sudden mains change of 10% caused only a momentary flicker of about 15 mV; but that was followed by a slower drift of as much as 0.8 V due to valve heaters. Where large fluctuations in mains voltage are liable to occur, a high degree of stabilization can be obtained only by stabilizing the heater supplies too, as described for example in reference [1] (in Part I).

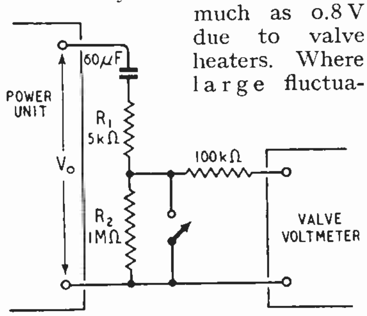


Fig. 8. Method of observing small changes in output voltage V_0.

Without any exceptional smoothing in the filter, hum was about 1mV in amplitude; mainly 100 c/s. It depended largely on the layout of the grid circuit of V2. Random noise of relatively high frequency and about 2 mV peak was reduced to a negligible level by 2 µF across N1. The performance of the unit depends largely on this, the voltage standard. Some tubes are liable to "flicker" every few seconds, as can be seen on the oscilloscope; or they have discontinuities in the characteristics, and may even set up oscillation. The 85A1 has been designed to avoid these defects, and certainly seems very satisfactory.

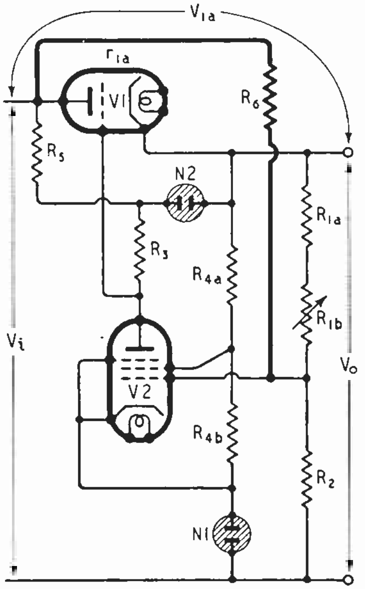


Fig. 9. Input feedback to the control grid of V2 via the high resistance R_6, as an alternative to feedback to the screen grid.

Incidentally, the method of observing such small V_0 fluctuations as 1 in 30,000 may be of interest. A bank of paper capacitors totalling 60 µF, selected for low leakage, was connected across the output as in Fig. 8, in series with a current-limiting resistance R_1 and a high resistance R_2. The voltage across R_2, being the difference between V_0 and the practically steady capacitor charge, was observed by a twin-triode Z.F. voltmeter. Except when actually noting the effects of mains and load changes, R_2 was kept shorted by a switch to set the capacitor charge quickly to equality with V_0 and to protect the valve voltmeter.

With a fixed compromise setting of R_{4b}, the type of circuit described gives a performance which preserves and to a varying extent improves on the basic stabilization conferred by a large amount of output feedback. It is particularly suitable for variable-output units, because the input feedback is independent of the setting of the output voltage control. But some alternatives and refinements may fit certain circumstances better.

If N1 can be fed from the stabilized output, there are no appreciable voltage changes across its resistance to be neutralized, assuming the variations in I_{2k} are very small. To retain the use of g_2 for neutralizing source resistance, it can still be fed from V_i, but the required value of resistance may be too small by itself to drop the required V_{2g2} without drawing excessive bleeder current. In such a case it may be supplemented by a neon tube.

Alternatively, g_2 can be fed at constant voltage from V_0 and input voltage feedback applied to g_1, in a method already well known[5], by means of a high resistance R_6, as in Fig. 9. If V_0 is to be kept constant when V_i varies, the whole of the variation must occur in V_{1a}. Assuming constant current, this can be brought about by a voltage change μ_1 times smaller at the grid of V1, and $\mu_1 m$ times smaller at the grid of V2. So the required condition is that $1/\mu_1 m = p_i$, where p_i is the fraction of the V_i change applied to the grid of V2. Since V_0 is constant, R_1 and R_2 are in parallel as regards current via R_6, so—

$$p_i = \frac{R_1R_2}{R_1 + R_2} \Big/ \left(\frac{R_1R_2}{R_1 + R_2} + R_6\right).$$

From this, neglecting 1 in comparison with $\mu_1 m$, we get

$$R_6 = \mu_1 m \frac{R_1R_2}{R_1 + R_2} = \mu_1 m p_0 R_1,$$

p_0 being the fraction of V_0 applied to the grid of V2.

In the example we have been considering, $\mu_1 m p_0$ has been of the order of 500, so if R_1 were, say, 60 kΩ, the value of R_6 required to

[5] "A D.C. Supply Apparatus with Stabilized Voltage," Lindenhovius and Rinia, *Philips Technical Review*, Feb., 1941; described also by Hogg (ref. 3, Part I).

balance out input fluctuations completely would be of the order of 30 MΩ.

Just as with the feedback via g_2, the optimum adjustment of R_6 for mains variations is not the same as that for load variations. For when I_0 changes there is not only a change in V_i due to source resistance R_i, which is neutralized, but in addition a component of change in V_{1a} due to valve resistance r_{1a}, which is not neutralized, but can be by reducing R_6. The system is then somewhat over-stabilized for mains variations (see Appendix, Eqn. 14c in final instalment), so that changes in V_i cause small changes in V_0 of opposite sign.

Unlike feedback to g_2, feedback via R_6 varies when V_0 is adjusted, because p_i is a function of R_1. Optimum R_6, as we have seen, is proportional to p_0R_1, which is R_1 and R_2 in parallel. In our example, provision for varying V_0 from 200 to 400 V necessitates varying p_0R_1 in the ratio 1 : 1.4. The effect of this can be completely avoided by splitting R_6 into two, R_{6a} and R_{6b}, as in Fig. 10. Suppose V_0 is at its minimum, with R_{1b} at zero. Then R_{6a} and R_{6b} are directly in parallel, and if their combined value is the same as optimum R_6 in Fig. 9, their effect is obviously the same. Also if R_{6a} and R_{6b} are respectively

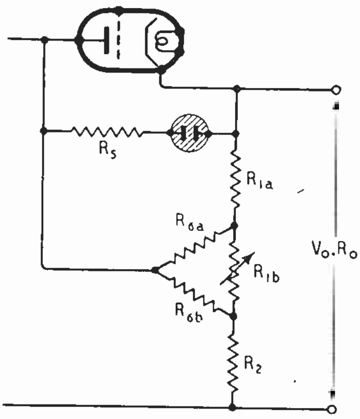


Fig. 10. If R_6 in Fig. 9 is divided as shown here, the input feedback is rendered independent of R_{1b}, the output voltage control.

proportional to R_{1a} and R_2, these four form a balanced Wheatstone bridge, completed via the negligibly low R_0. So both ends of R_{1b} are at the same potential as regard input feedback current, and its resistance can theretore be raised to any extent without upsetting

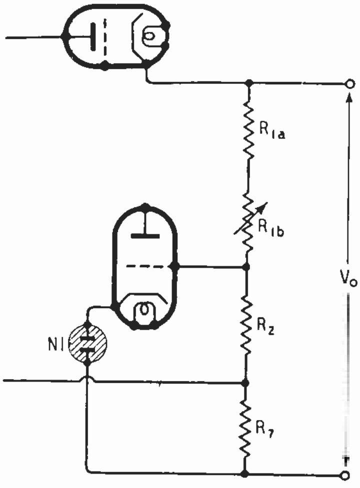


Fig. 11. Output current feedback, normally used together with input voltage feedback, to neutralize the resistance of V1.

the optimum feedback adjustment.

Fulfilling the conditions just stated gives the following values of R_{6a} and R_{6b} for perfect input voltage stabilization:

$$R_{6a} = \mu_1 m R_{1a}$$
$$R_{6b} = \mu_1 m R_2$$

If it is inconvenient to provide such large values of adjustable resistance (of the order of 60 MΩ in our example), they can be stepped down by taking the feedback voltages from an adjustable tapping on R_5. Such a tapping also avoids the difficulty of having to vary R_{6a} and R_{6b} simultaneously. But if the latter are below, say, 5 MΩ, it may be necessary to modify the values of R_1 and R_2 to allow for the current coming from R_5.

All the methods of input feedback described so far have the disadvantage that although they can be adjusted to cancel the residual effects of input voltage changes, or output current changes, they cannot do both completely at the same setting. The former necessitates cancelling the source resistance, R_i, whereas the latter necessitates cancelling the valve resistance, r_{1a}, also. The two settings, therefore, are in the ratio $R_i : (R_i + r_{1a})$. If input feedback is set to cancel R_i, then it is completely effective against mains fluctuations, and also against that part of the effect of load current fluctuations due to R_i. The effect of r_{1a} can be cancelled by feedback from a low resistance, R_7, carrying the load current. This device, also described by Lindenhovius and Rinia, is shown in Fig. 11. The voltage change across it, due to changes in load current, when multiplied by $R_1/(R_1+R_2)$, m, and μ_1, must be equal and opposite to the voltage change across r_{1a} due to approximately the same current. So

$$R_7 = \frac{r_{1a}(R_1 + R_2)}{\mu_1 m R_1} = \frac{R_1 + R_2}{g_{1m} m R_1}$$

If in our example $R_1 = 60\ k\Omega$, $R_2 = 21\ k\Omega$, $g_{1m} = 0.012$ A/V and $m = 275$, the optimum R_7 is 0.41 Ω. If input feedback is not used it should be greater, in the ratio $(R_i + r_{1a}) : r_{1a}$.

To render such feedback independent of R_{1b} adjustments, the analogous arrangement to Fig. 10 is shown in Fig. 12. It will be shown (Appendix, Eqn. 18) that the appropriate values for R_{8a} and R_{8b} are

$$R_{8a} = g_{1m} m R_7 R_{1a}$$
$$R_{8b} = g_{1m} m R_7 R_2.$$

To avoid upsetting the R_1R_2

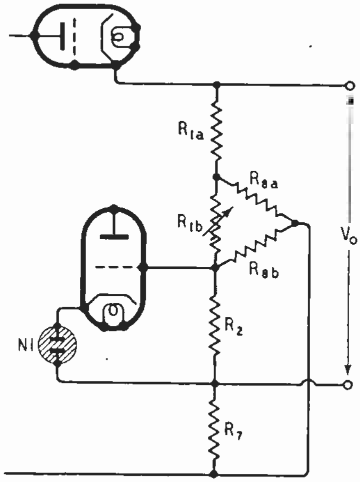


Fig. 12. Modification of Fig. 11 to make it independent of R_{1b}.

potential divider unduly, R_7 should be as large as can be tolerated, say 100 Ω.

Stabilized Power Supplies—

Fig. 10 and Fig. 12 can be combined. In seeking thus for more and more perfect stabilization, the fact that these critical balances depend on other variable factors must not be forgotten. We saw from Fig. 5 how the gain, *m*, can not only be much increased (giving greater basic stabilization) but also made far more constant (which we now see enables "perfecting" feedback to be applied more effectively over a wide range of output voltage) by the use of N2. Most of the optimum values for supplementary feedbacks depend on $g_{1m}m$ or r_{1a}/m. This is fortunate, because the remaining inequality in *m* tends to be offset by simultaneous changes in g_{1m} or r_{1a}. So although it is possible to render *m* practically constant over a wide range of I_{2a} by using a suitable non-linear resistor for R_3, the overall result is likely to be worse, especially as *m* is inevitably less with such a resistor owing to its A.C. resistance being lower than the D.C.

For a flexible-output unit such as Fig. 7, input feedback would conveniently be via g_2, rather than R_6; but if it were important to stabilize very thoroughly against both mains and load fluctuations it might be well worth while to add Fig. 12, and, if mains fluctuations were large and more than momentary, to stabilize the heater voltages.

(*To be concluded.*)

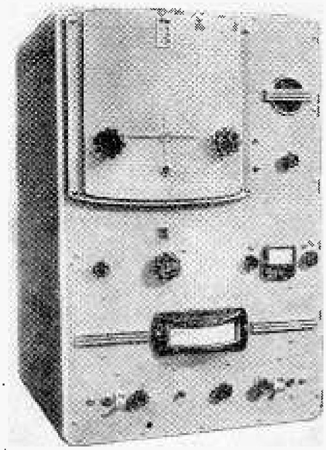
RADIO DEVELOPMENTS IN FRANCE

Precision Frequency Meter and Aircraft Sets

EQUIPMENT exemplifying the latest radio technique in France was shown at a recent display arranged by Cossor Radar of the products of the Laboratories Radio-electrique of Paris.

A superhet frequency meter (type 924A) covering 550 to 5 Mc/s attracted considerable interest. The instrument contains two distinct R.F. channels, one is a sensitive superhet which receives the unknown frequency and the other accepts the harmonic output from a crystal-controlled multi-vibrator.

The superhet local oscillator is common to both channels and the circuit arrangement is such that its own variations cancel out in the final determination of the frequency. The accuracy of the meter is the sum of two independent errors, one being the accuracy of the crystal oscillator, in this case one part in a million, and the other the error due to the direct-reading frequency meter which measures the beat with the selected standard harmonic. It is claimed that with the aid of a special adaptor this error can be reduced to a few cycles.



Frequency meter type 924A.

Included in the display was a V.H.F. transmitter-receiver measuring 17.9 x 13.6 x 7.5ins and weighing about 44lb for use in aircraft. It covers 116 to 126 Mc/s and provides 20 crystal-controlled channels, 10 each for send and receive. Amplitude modulated telephony or M.C.W. telegraphy can be employed with a carrier output of 3 watts and giving an operational range of about 100 miles at 6,000ft.

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There was also an H.F. transmitter-receiver covering 5 to 10 Mc/s for light aircraft and giving a radio telephone range of about 30 miles. Incorporated in the set is a broadcast receiver with a wave range of 205 to 1,850 metres and having a self-contained loop aerial and a "left-right" pointer-type indicator which gives the approximate bearing of a ground station. It can also be used for "homing" and is a simple form of radio compass for private aircraft.

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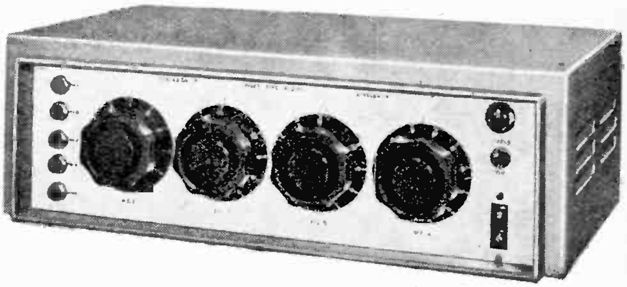

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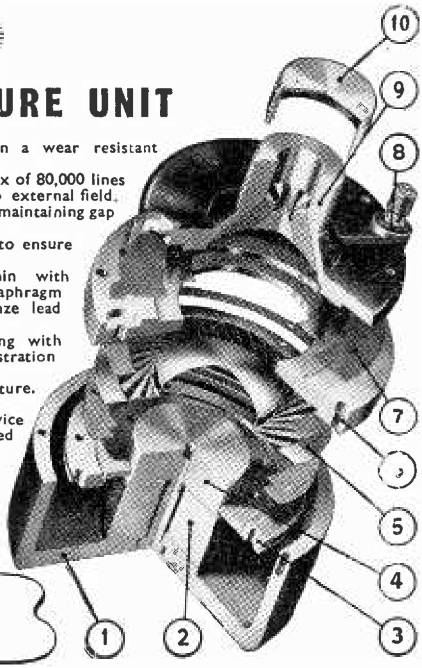

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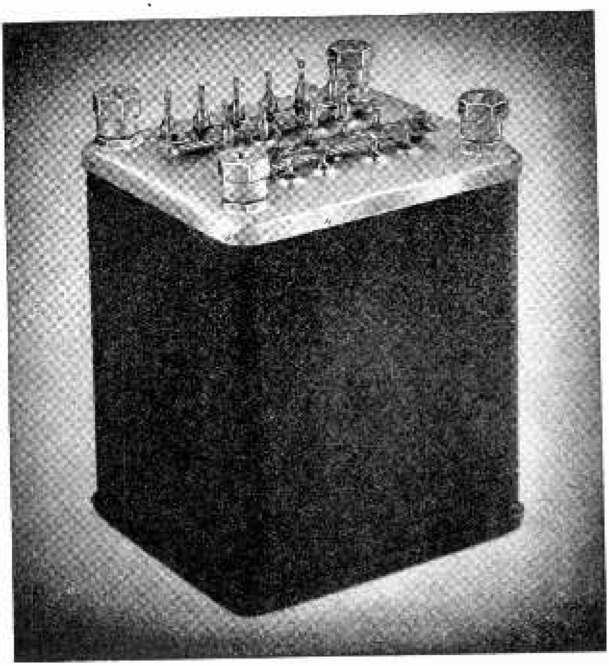

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RESISTOR RATINGS

Characteristics and Operating Conditions

H. G. M. SPRATT,
B.Sc., M.I.E.E.

PRIOR to the invention of the triode and the start of the radio industry the electrical engineer was seldom concerned with the use of non-metallic resistors. He rarely wanted values so high that they could not be obtained from resistance wire; nor did he need really low time constants, except in the instrument field, where wire had to be used anyway. He already had the carbon brush, the carbon pile and the carbon microphone. He was well content to leave it at that.

It was in the early 'Twenties that a widespread demand for a non-wire-wound resistor arose. It was wanted for use as a grid leak; consequently no exacting specification was implied. If it had been written down, it would probably have read as follows: Resistance—to be within the limits 1 to 5 MΩ; maximum applied voltage—5V; maximum frequency, 2 Mc/s. Carbon was the obvious material to use for this purpose, and it is hardly surprising that manufacturers met this specification requirement without any great difficulty. 1-MΩ carbon resistors led to 0.1-MΩ and then to 10,000-Ω carbon resistors, and these, too, were generally quite satisfactory provided they were not called upon to carry more than a fraction of a milliampere. If they were, they usually sank to zero or rose to infinite resistance immediately.

As a result, a considerable amount of research took place and in the late 'Twenties carbon resistors of all values, with ratings of ½ and 1 watt, appeared on the market. Considering the short development time they were remarkably good, standing up to their full loads, and sometimes appreciably more, with a good heart. The next few years saw a steady improvement and no particular setbacks.

During the early days of television development, however, a new application of these resistors was attempted, namely, in the H.T. circuits feeding the C.R. tube. Under any circumstances some permanent leak of the order of 10 MΩ was needed to prevent the smoothing capacitor from retaining its charge unduly long after switching off. Apart from this, though, the early C.R. tubes generally had up to three auxiliary electrodes requiring intermediate voltages which could not economically be provided except by dropping down from the full H.T. potential. Such values as 1 MΩ, 1 watt, carrying a current of about 0.8 mA (0.64 W) were chosen, but after a short time the intermediate voltages were found to be quite incorrect. Examination invariably showed that the 1-MΩ resistors had dropped in value some 30-50 per cent, and since this was constantly occurring and the resistors were obviously not being overloaded as regards current, it was finally concluded that the high voltage was responsible. On the manufacturers' advice 700 volts was accepted as the maximum permissible voltage, regardless of loading, for a 1-W resistor and from then on no further trouble of this kind was experienced.

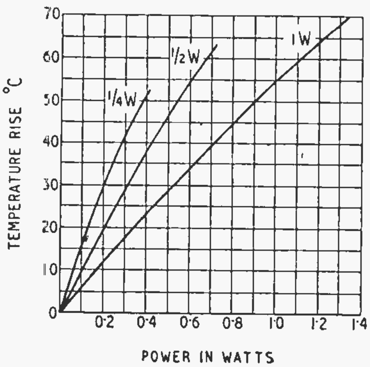


Fig. 1. Temperature rise v. load for insulated resistors.

The next event was the drafting, during the war, of the stringent Service requirements as regards ambient temperatures. This brought home forcibly the realization that final temperature, and not temperature rise, was the essential factor determining the satisfactory operation of resistors as of many other components.

To-day a much healthier state of affairs exist, with the appreciation that these two parameters must be taken into account. Their consideration may be an annoyance, but it is the safer course.

Resistors now commonly used fall into two main categories: general purpose and high stability types. Their characteristics and the significance of their ratings are not as widely understood as they should be. In particular, it is not always realized that the "wattage rating" is a purely nominal one and most certainly does not mean that a resistor will dissipate a power equal to its rating under all conditions of use. The actual power at which it can safely be used is severely limited by high voltage or by a high ambient temperature. The products of different manufacturers may vary somewhat in detail, and the figures quoted below apply strictly to Dubilier resistors, to the makers of which the author is indebted for much of the data used in this article.

In the case of the general-purpose resistor the question of maximum permissible voltage has been handled in the way previously found satisfactory, namely, by imposing limits irrespective of resistance value. These limits are 250, 350 and 500 volts for the ¼-, ½- and 1-watt sizes respectively, and they show up somewhat forcibly at the higher resistance values. For example, a nominal ¼-watt resistor of 1 MΩ cannot be loaded to more than $250^2/10^6 =$ 1/16 watt, while its 1-watt counterpart is restricted to $500^2/10^6 =$ ¼ watt.

Safeguards against overheating are effected by the provision of two sets of curves. The first, Fig. 1, shows temperature rise against loading, and it will be observed that full load corresponds to 35°,

Resistor Ratings—

45° and 55° C approximately for the three sizes in order. The second curve, Fig. 2, is a plot of

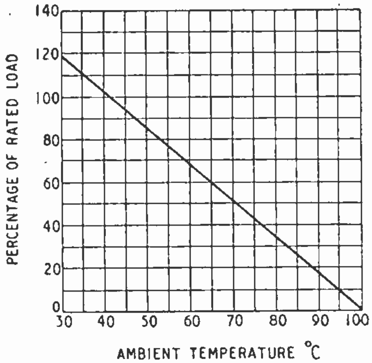


Fig. 2. Variation of maximum load with ambient temperature for insulated resistors.

the maximum permissible percentage of rated load against ambient temperature. The interesting features of this curve are: (1) it is common to all three sizes; (2) it is a straight line; (3) as the ambient temperature falls below 40° C a slight increase over full rated load becomes permissible; and (4) at 100° C and above these resistors cannot be used at all.

These clear-cut restrictions provide salutary safeguards on the life and stability of the resistor, which is quite likely to be surrounded by other heat-dissipating components and may possibly be introduced into equipment intended for the tropics. Thus a $\frac{1}{4}$-watt resistor will be rated down to 68 per cent of its nominal full load for an ambient temperature of 60° C. Under these conditions the resistor temperature, from Figs. 1 and 2, will be 27° + 68° = 95° C. If the resistor were subjected to its full $\frac{1}{4}$-watt load, its temperature would rise to 103°C, which is above the permissible maximum given by Fig. 2. If a $\frac{1}{4}$-watt load is essential, a nominal $\frac{1}{2}$-watt resistor must be employed and its temperature will be 91° C. Should an ambient temperature of 60° C appear excessive, outside the tropics, it would be worth while to attempt to envisage conditions in the space between the mains transformer and the rectifiers in a television receiver on a hot day!

Fig. 3 shows the resistance-temperature coefficients for this type. These figures are given on a statistical basis for 99 per cent of a batch. Little comment is necessary except to state that the coefficient is always negative and reasonably small. As an example, consider a 0.1-MΩ 1-watt resistor. Its temperature coefficient will lie between −0.025 and −0.075 per cent/degree Centigrade. Hence from no load to full load, a temperature rise of 55° C, the resistance change will be from −1.38 to −4.1 per cent.

The high stability and Service type is made up of five different-sized units, which are deliberately designated by symbol and not by rating. Two distinct conditions of operation are recognized: (1) general industrial and radio uses wherein the maximum stability is desired over long periods of continuous use, with operating temperatures normally below 40° C; and (2) use in Service equipment where ambient conditions up to 71° C must be covered.

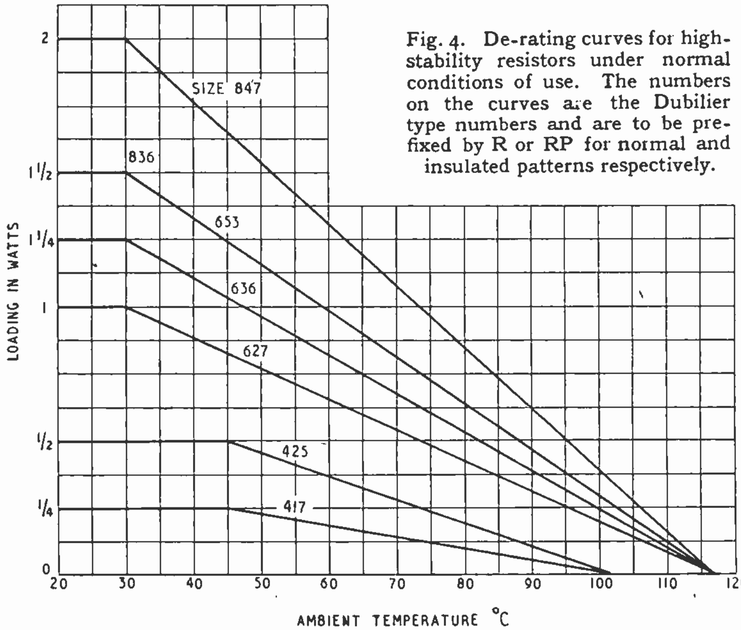


Fig. 4. De-rating curves for high-stability resistors under normal conditions of use. The numbers on the curves are the Dubilier type numbers and are to be prefixed by R or RP for normal and insulated patterns respectively.

Once again maximum voltage limits are given for each size, ranging from 150 volts for a resistor of length about 0.5in to 750 volts for one of about 2in long, and here it is clearly stated that over-voltages are liable to lead to burning or sparking or both.

Consistent with the principle of omitting precise ratings for the various sizes, no curves are provided to show temperature rise against load. On the other hand, two sets of ambient-temperature permissible-loading curves, Figs.

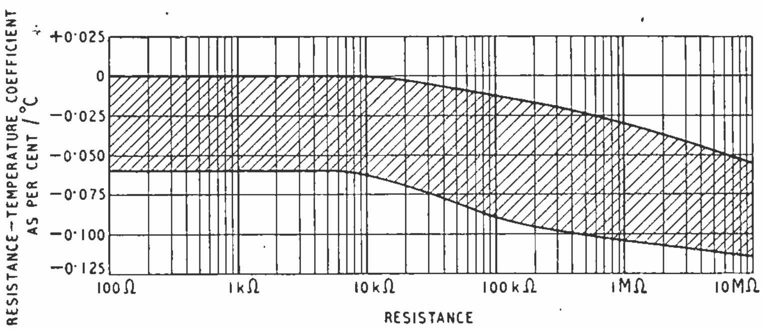


Fig. 3. Temperature coefficient of resistance; 99% of a batch lie within the shaded area.

4 and 5 are given, these relating to the different conditions of use. Under conditions (1), Fig. 4 shows that up to 30° - 45° C, depending upon size, these resistors are capable of carrying constant specific loads from ¼ to 2 watt. Above, the permissible load falls linearly with temperature to zero at approximately 100°-115°C. Thus to ensure high stability and long life the size for a ¾-watt load will have to be increased three times if the ambient temperature is raised from 50° C to 75° C. Fig. 5, which relates to Service use, is similar but shows a common maximum limiting ambient temperature of 71° C for constant maximum loading, above which all sizes are derated linearly to zero loading at 100°-115° C. Not unnaturally the constant loads are not in all cases the same for conditions (1) and (2) while a penalty has to be paid for the severer demands of the latter, this penalty taking the form of a shorter expectation of life for the resistor. Again, at the higher ambient temperatures a slight increase in temperature calls for an increase in size.

As might be expected, the temperature coefficient of this class of resistor is somewhat lower than that of the general-purpose type. It lies approximately between −0.02 and −0.06 per cent/degree Centigrade. Thus the resistance value of any resistor of this type would be expected to drop 1.1-3.3 per cent for a temperature rise of 55° C or 1.42-4.25 per cent for a temperature rise of 71° C.

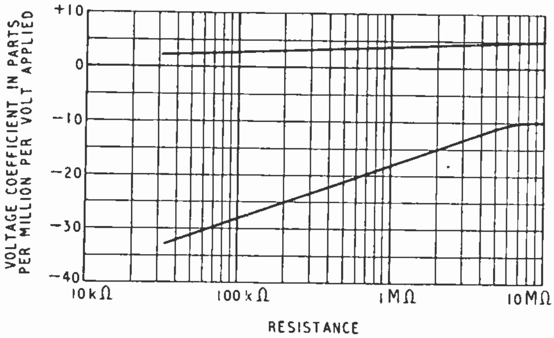


Fig. 6. Voltage coefficient of high-stability resistors; the curves show the limits within which 99% of resistors fall.

One added advantage arising from the form of construction and the conservative ratings is the fact that short-period overloads of 50 per cent or even 100 per cent will not damage the resistor, though it may cause a permanent change in value of 1-2 per cent. This is a marked improvement over resistor performance in the past.

The same two factors contribute to a low voltage coefficient and a low noise level. The former is defined as the instantaneous change in resistance value which takes place with a change in the applied voltage and which is quite independent of the change brought about by temperature

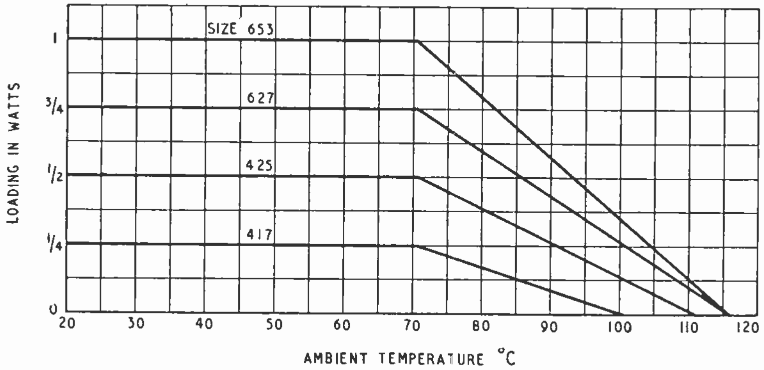


Fig. 5. De-rating curves for high-stability resistors used in Service equipment.

Resistor Ratings—

rise. It is customary to measure it in parts per million per volt applied and the curves in Fig. 6 show the limits, again on a statistical basis, within which the coefficient will lie for this type of resistor. Consider a 500,000-Ω 1-watt resistor. Its full-load voltage is 224 volts and its voltage coefficient, according to the curves, lies between -2×10^{-6} and -31×10^{-6} parts per volt.

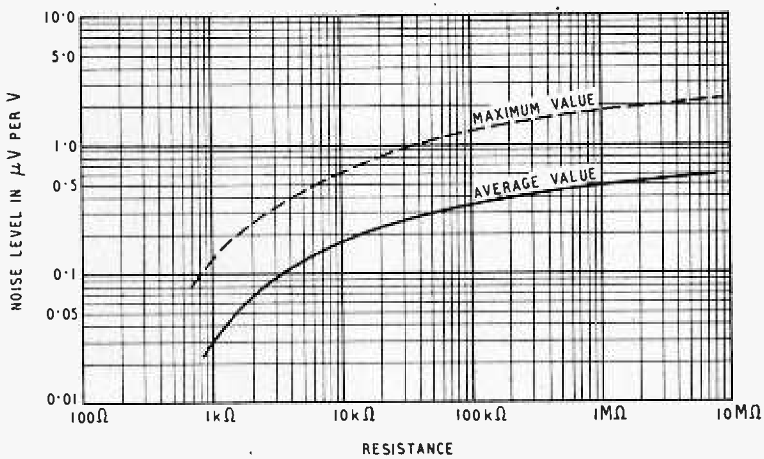


Fig. 7. The curves show the maximum and minimum noise levels for 99% of resistors.

So, with a sudden change for half to full voltage, there will be an immediate resistance change ranging from −0.02 to −0.35 per cent. For a 200,000-Ω 1-watt resistor the corresponding figures are −0.07 to −0.56 per cent. One might be tempted to dismiss these changes as of no consequence, except in measuring circuits, but they are not strictly proportional to the voltage applied and there is some reason to believe that they give rise to cross modulation.

The noise level referred to above is a characteristic of carbon resistors and depends upon the materials used and the type of construction. It is not to be confused with the inherent thermal-noise voltage of a resistance which is proportional to the square root of the resistance and dependent on frequency, bandwidth and absolute temperature. The noise levels characteristic of this type of resistor are given in Fig. 7. where the values in μV/V are shown against resistance value. According to the curves, a 50,000-Ω 1-watt resistor would be expected to have a noise level of 0.3 μV/V or 67 μV at full load. Let us consider a case where noise is likely to be of greater interest, say a 1,000-Ω resistor with 20 volts across it. The noise level here will not exceed $0.15 \times 20\mu V = 3.0\ \mu V$, an amount which could in most cases be ignored.

In this type of resistor, the resistance path through the element is of a spiral form. As a result, all resistors have a small but definite inductive component, this component being greater, for any particular resistance value, in the larger sizes. Values range, according to the size, from 0.0007 to 0.017 μH at 100 Ω to 0.06 to 2.0 μH at 1 MΩ corresponding to phase angle ranges of 0.16′-3.7′ and 0.1″-2.5″ respectively.

General-purpose and high-stability types of resistors are rarely made in value above 25 MΩ. Cases, however, arise, in industrial rather than radio connections, where higher values than this are required. An ultra-high resistance range meets this requirement partly by virtue of a different form of construction and partly by increased length. For example, a unit 2-in long will provide a resistance value of 5,000 MΩ, but a 12-in length is needed for 50,000 MΩ. It is hardly necessary to state that the maximum permissible voltages are higher than the previously quoted figures and in fact extend from 500 volts up to 4,000 volts for the lengths mentioned.

Another class of resistor, the high-voltage type, is made in two sub-types, one with a spiral resistance path to give high resistance values and capable of standing high voltages, while the other has a straight resistance path so providing lower resistance values but at the same time reduced inductive components. The temperature coefficient of this type is of the order of 0.2 to 0.05 per cent per degree Centigrade.

This mass of data is a measure of the lessons learnt from the failures and revelations of the past. The designer, while restricted in the use to which he can put any particular type of resistor, has more types to choose from and should justifiably feel more confidence in the reliability of his final choice. With the increased interest in tropical operation and the gradual entry of electronics into industry this is a matter of some importance. Industry will not be satisfied with equipment whose standard of reliability falls short of that acceptable in the mechanical world and this standard will be reached only if the components used are properly chosen for the job they have to do and to suit the conditions under which they must operate.

OUR COVER

The trend towards more compact radar equipments for merchant ships is illustrated by this picture of a Kelvin-Hughes installation fitted on a bracket from the mast. The rotating scanner, which has a span of 5ft., is mounted directly on top of the transmitter-receiver unit, which is housed in a weatherproof steel case. This method of construction reduces the length of the vulnerable waveguide to a minimum and eases the problem of excluding moisture.

SHORT-WAVE CONDITIONS

September in Retrospect : Forecast for November

By T. W. BENNINGTON and L. J. PRECHNER (Engineering Division, B.B.C.)

DURING September, in accordance with the seasonal trend for these latitudes, the average daytime maximum usable frequencies were much higher than in August, and the average night-time M.U.F.s were considerably lower. It may be expected that the M.U.F.s will continue to vary in that manner for the next two months or so.

Owing to the increase in the average maximum usable frequencies the communication on the 28-Mc/s amateur band was much more extensive than in August, contacts having been made as far as New Zealand. Frequencies below 11 Mc/s for distances exceeding 3,000 miles were not often usable at night.

The rate of incidence of Sporadic E was less than in August, and decreased sharply towards the end of the month. This was in accordance with the seasonal trend, and thus rather few contacts were made *via* this medium on the higher frequencies. Long-range tropospheric propagation was observed, sometimes over almost record distances, on many occasions towards the end of the month. This may have been perhaps due to favourable weather conditions.

Sunspot activity in September was somewhat less than in August. Two fairly large groups were observed which crossed the central meridian of the sun on the 3rd and 17th. Ionospheric storms were observed on 1st-7th, 13th, 25th-27th and 30th, those occurring on the 1st, 2nd, 4th, 5th and 25th being particularly violent.

Relatively few "Dellinger" fadeouts have been recorded in September, none of which were really severe.

Forecast. — Daytime M.U.F.s during November should reach very high values which, although exceeding those for October, will be probably below the sunspot maximum values obtained in November, 1947. Long-distance communication on very high frequencies should be therefore possible in all directions from this country. The 28-Mc/s amateur band should be regularly usable at suitable times of day, and considerably higher frequencies than in October may be workable over certain circuits. It is even possible that a long-distance contact or two may take place on 50 Mc/s, though this is not very likely. Night-time M.U.F.s will, on the other hand, be considerably lower than in October, frequencies as low as 9 and even 7 Mc/s probably being necessary for many night-time circuits.

Below are given, in terms of the broadcast bands, the working frequencies which should be regularly usable during November for four long-distance circuits running in different directions from this country. (All times G.M.T.) In addition, a figure in brackets is given for the use of those whose primary interest is the exploitation of certain frequency bands, and this indicates the highest frequency likely to be usable for about 25 per cent of the time during the month for communication by way of the regular layers:—

Montreal :	0000	7 Mc/s	(10 Mc/s)
	1000	9 ,,	(12 ,,)
	1100	15 ,,	(19 ,,)
	1200	21 ,,	(26 ,,)
	1300	26 ,,	(32 ,,)
	1800	21 ,,	(30 ,,)
	1900	17 ,,	(25 ,,)
	2000	15 ,,	(21 ,,)
	2100	11 ,,	(17 ,,)
	2200	9 ,,	(13 ,,)
Buenos Aires :	0000	11 Mc/s	(17 Mc/s)
	0300	9 ,,	(13 ,,)
	0700	11 ,,	(16 ,,)
	0800	17 ,,	(24 ,,)
	0900	21 ,,	(27 ,,)
	1000	26 ,,	(32 ,,)
	1900	21 ,,	(31 ,,)
	2000	17 ,,	(25 ,,)
	2200	15 ,,	(22 ,,)
	2300	11 ,,	(17 ,,)
Cape Town :	0000	11 Mc/s	(17 Mc/s)
	0100	9 ,,	(13 ,,)
	0600	15 ,,	(19 ,,)
	0700	21 ,,	(33 ,,)
	0800	26 ,,	(36 ,,)
	1700	21 ,,	(31 ,,)
	1900	17 ,,	(25 ,,)
	2100	15 ,,	(22 ,,)
	2200	11 ,,	(17 ,,)
Chungking :	0000	7 Mc/s	(10 Mc/s)
	0500	9 ,,	(14 ,,)
	0600	17 ,,	(22 ,,)
	0700	21 ,,	(26 ,,)
	0800	26 ,,	(36 ,,)
	1200	21 ,,	(26 ,,)
	1300	17 ,,	(22 ,,)
	1400	15 ,,	(19 ,,)
	1500	11 ,,	(16 ,,)
	1800	9 ,,	(14 ,,)
	2000	7 ,,	(11 ,,)

Though ionosphere storms are not particularly prevalent during November, those which do occur are likely to be troublesome over the night paths. At the time of writing it would appear that such disturbances are more likely to occur within the periods 10th-11th, 19th-20th, 22nd-25th than on the other days of the month.

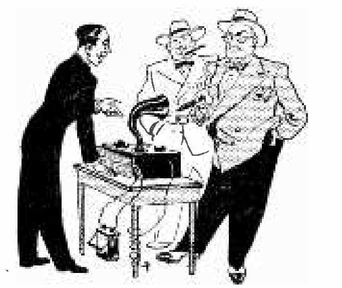
Unbiased

By FREE GRID

Rationed Radio

IT is astonishing what a lack of elementary psychology is shown by government officials when they express surprise that their repeated exhortations to smoke fewer cigarettes or drink less beer leads forthwith to a still greater consumption. They don't seem to grasp the fact that the way to make people want a thing, and to want it badly, is to tell them they can't have it. If, for instance, they told the world in general that British goods would not be exported as they were for home consumption only they would be staggered at the demand created in foreign countries. Even Wigan could command an unheard-of influx of foreign tourists by merely taking a leaf out of the book of the Lhasa borough council and calling itself "the forbidden city." I suppose everybody knows that prohibition was introduced into the U.S.A. in the early twenties by the brewing and distilling interests as a sales boosting stunt.

I should, however, have expected a little more common sense from members of the radio industry. Some of them are still naively complaining that in spite of reduced purchase tax and the recent "better listening" campaign, many listeners still seem reluctant to invest in a new set. Surely the reason is obvious and the remedy also. They should get Sir Stafford Cripps to



Gullible American tourists.

make a speech telling people that they must on no account buy new wireless sets or, better still, get Mr. Wilson to ration them and make it as difficult as possible to get a permit to buy an extra one.

I know of at least one dealer who has followed the broad outlines of this scheme by putting his sets under the counter and letting it be known that they are only available to those who come clandestinely to the door after dark. The result is that he has made enough to set up his own factory and be independent of manufacturers. Success breeds success, as it always does. He has been able to get rid of several hopelessly out-of-date sets to credulous American tourists by representing them to have been used by Queen Elizabeth when listening in one of the innumerable beds up and down the country which were put at the disposal of that formidable female.

I don't want to seem harsh in my judgment of the radio industry, but it is absolutely no use trying to sell sets on their results after the public has been educated for nearly a decade to assess the value or desirability of goods solely by their scarcity. If cars became plentiful tomorrow fully fifty per cent of the people on the dealers' waiting lists would cancel their orders straight away and look about for something else with a healthy waiting list.

What About It, Mr. Bevan?

THERE is a striking similarity between a hospital and a prison; the latter being primarily intended to bring that balm and healing to our erring souls which the former brings to our broken bodies. Moreover, men often find themselves on the wrong side of the entrance gates of both places through their own indiscretions and not infrequently their maladies of body or of morals become chronic, with the result that their first visit is not the last.

But here the comparison ends. Prisons set out to effect their moral cures by stern disciplinary measures in which bodily comfort is at a discount. Hospitals, however, endeavour to offset the unpleasant effects of their noxious healing draughts by providing lily-handed houris to soothe our fevered brows and apply the balm of Gilead to our troubled spirits as they adjust our headphones so that we can listen to the psychotherapeutic symphonies of the Third Programme. Unfortunately, things are not in this ideal state, as not only are hospital houris in short supply—as our non-English-speaking Whitehall bureaucrats call it—but headphones are in a similar plight, though I can see no reason for the latter shortage.

Maybe I am wrong to generalize from a particular case, but recently having occasion to visit a casualty in one of the largest hospitals in the country I was astonished to find that many patients were unable to listen, solely because it appeared to be nobody's business to see to the replacement or repair of damaged

The balm of Gilead.

headphones. It could scarcely have been a question of financial stringency, as the hospital I visited was never dependent on voluntary contributions but was run by the county council before Mr. Bevan took the burden of it on to his broad Christopher-like shoulders. As it was, when I had supplied headphones to my friend I was met with eager requests from other patients to be told where their relatives could obtain suitable phones, for which they were more than willing to pay. Fortunately, phones are available in plenty for a few shillings a pair, at any rate in the London area.

I cannot help thinking that the matter is one which might well be ventilated by means of a question in the House addressed to Mr. Bevan.

There is also another matter which concerns the radio industry and that is the designing of special headphones and earpieces giving the minimum of discomfort to sick persons and also a special type of flat reproducer for slipping under the pillow of those whose particular malady renders the ordinary headphones difficult to use. I believe one of these has recently been produced. It seems high time, too, that hospital beds were wired so that alternative programmes are on tap to each patient. After all, the musical tastes of gentlemen of the road may be expected to differ from that of Vermin in Ermine from the Upper Chamber who are henceforth to be bedfellows.

LETTERS TO THE EDITOR

Stabilized V.H.F. Broadcasting ✦ Aligning F.M. Receivers ✦ Television Topics

A.M.—V.H.F.

IN recent editorials you have urged that before the B.B.C. committed itself finally to an F.M. broadcasting service it should set up an experimental A.M. station. With both systems there is the problem of maintaining local oscillator frequency stability. In the case of A.M. this difficulty could be overcome quite simply by having the transmitting station send out not only the normal carrier wave but also a frequency conversion wave. This would, of course, be an unmodulated signal at a suitable difference frequency, such that, when mixed with the modulated signal a suitable I.F. would result. At the frequencies now being considered the band width required cannot be considered great, and the two signals could be easily received, amplified and converted in the usual way. The cost of a receiving set would be low, and it would be free from complications.

E. C. NEATE.

Winchester.

Direct-coupled Amplifiers

THE letter from E. Jeffery (your Sept. issue) seems to provoke a reply. In estimating the relative merits and demerits of rival A.F. amplifying systems one should bear in mind how far the aural results are tolerable after listening to the reproduced sounds for more than ten minutes. The problem of problems is to obtain a really faithful and acceptable reproduction of the sound-patterns consisting of massed frequencies simultaneously and concurrently generated in the studio. The chief difficulty is to secure a satisfactory reproduction of the 1,000- to 4,300-cycle band in such circumstances. Experiments conducted for a period of twenty years have convinced me that the introduction of the blocking condenser in the inter-stage couplings of an A.F. amplifier constitutes an insuperable obstacle to the achievement of the highest standard of upper audio-frequency reproduction. Whatever the snags associated with direct coupling they are quite insignificant compared with this major problem which resistance-capacity coupling is unable to solve. Those who have achieved success by means of a recently developed method of direct coupling will not lightly abandon it for any other method till a better has been found. The introduction of tone correction has no bearing on the question, since the filters are not an integral factor in the essential coupling circuit and are usually regarded as optional adjuncts.

NOEL BONAVIA HUNT.

Stagsden, Bedford.

F. M. Alignment

A. G. CROCKER and I have gone on record (*Wireless World*, July and September, 1948) with rather different views about the alignment of F.M. receivers. I agree that with the facilities available to Mr. Crocker satisfactory performance can be obtained, and indeed I have no reason to doubt that the −60 db distortion figure needed for multi-channel telephony can be maintained. I agree also that Sturley's alignment procedure is impracticable.

A feature not discussed, however, is the protection afforded against impulsive noise. A single noise peak will set the I.F. circuit ringing, and unless the response is symmetrical and the discriminator is accurately centred on the I.F. mid-band frequency, the noise-reducing properties of F.M. are not realized. This is discussed by Landon (*Electronics*, February, 1941, and "Frequency Modulation," Vol. I, R.C.A.). The oscillograms (Fig. 1 of this paper) show, at I, the effect of a 10-pF unbalance across the 100-kΩ diode loads.

Failure to take account of the special problems of impulsive noise reduction may lead to dissatisfaction with F.M., in view of the general belief that F.M. solves all noise problems.

THOMAS RODDAM.

Aircraft and Television

DURING the war an attempt to "blind with science" on the subject of radar was not unusual, but it is with some surprise that I read "Diallist" in your September number.

Probably the most common form of interference with television from an aircraft is a rhythmic quick fade of the signal, which is surely due to the relative phase of the direct and reflected rays which is changing at a frequency dependent on the speed at which the aircraft is approaching or going away from the receiving station. This is very noticeable with aircraft nearby when the fre-

Letters to the Editor—

quency of fluctuation slows down as the aircraft is heard to pass (i.e., when it is neither coming towards nor going away from the receiving station at any great speed).

The explanation of a flutter on radar when an aircraft is turning is presumably similar in that separate signals are being received from two or more parts of the aircraft and the relative distance these signals have to cover is varying as the aircraft turns, thus causing large fluctuations of the resultant signal as its two or more components come in and out of phase.

I feel that "Free Grid's" excellent column could well have dealt with the explanation which "Diallist" credits to the pundits (we did not call them that in the Navy!), and it could be elaborated to allow for a four-bladed propeller with each blade $\lambda/2$ in length!

From experience I can assure "Diallist" that no matter whether the aerial switch was working or not, the effect of a turning aircraft was always the same.

G. C. TURNER.
H.M.S. Duke of York.

I FOUND R. M. Staunton-Lambert's letter in the August issue, regarding aircraft interference with television very interesting as I live in the same locality and have experienced similar trouble.

There does not seem to be much purpose in using the usual directional arrays as the aircraft's course is in line between the transmitter and receiver and it is on this line that the bent or refracted signal needs to be eliminated.

Experiments to minimize the trouble seem to prove that providing the receiver is close enough to A.P. an "H" installation with the reflector facing the station (i.e., 180 degrees out of phase) is a great improvement.

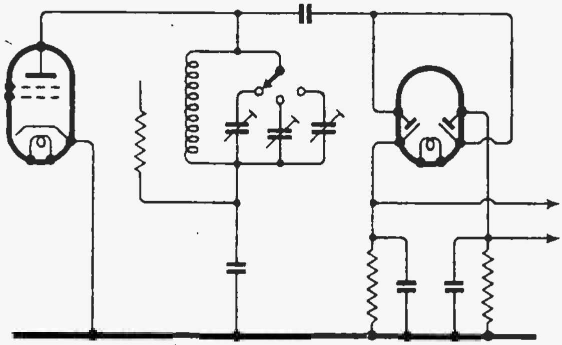
For distances greater than this I think the cure will prove to be the use of diversity reception.

Two dipoles mounted at opposite extremes of the house feeding a T joint and thence to the set should prove to be a definite advance, as, at the frequency used, an anti-phase on one aerial would be counter-balanced by a correct signal on the other.

Electronic switching between the two aerials would be the best solution but is likely to be an expensive refinement. M. A. SALTER.
London, N.W.10.

"High-level Detection"

W. MacLANACHAN evidently believes (your September issue) that his third R.F. stage, consisting of a KT61 and untuned RF transformer, can deliver to the diode detector signals up to 120 V R.F. without distorting the modulation. But has he proof of this? The net load of the diode circuit on the secondary of the R.F. transformer will be a resistance of value little greater than 10 kΩ, and therefore the power consumed at 120 volts will be nearly 1.5 watts. Also the KT61 will probably have to supply quite a lot of wattless current into the shunt reactances present, whilst it is not very likely that a L.W. R.F. transformer will give an optimum impedance match. It seems to me, therefore, that quite careful design is needed if the third R.F. stage is not to overload on modulation peaks, and I should like to suggest that better coupling could be obtained between the third R.F. amplifier and the detector with the accompanying circuit.



I think better screening and stability would be obtained if an EF55 (CV173) were used in place of the KT61.

Mr. MacLanachan does not give the ratio of primary turns to feedback turns for the output transformer used in his set, but I guess it is not less than five or ten. The feedback volts are then again reduced in the ratio $R_{19}/R_{19}+R_{20}$ (approx.). It seems unlikely, therefore, that any useful amount of negative feedback is obtained. On the other hand, the effect of such feedback as there is will be to reduce the apparent values of R_{20} and R_{23}, so that the A.C. loading of the diodes will be increased. It seems quite possible, therefore, that the feedback will increase distortion rather than reduce it. E. F. GOOD.
Malvern, Worcs.

"Series-capacitor Heater Circuits"

I HAVE a receiver which I built over three years ago incorporating a capacitor in the heater circuit in the way described in your September issue. The two original dial lamps are still in use and I have not had one breakdown, although the set is in daily use.

The 6-volt 0.06-amp. dial lamps are shunted across two of the 6-volt 0.3-amp. heaters. I know this is not very good practice since the lamps shunt part of the heater current, but it certainly is trouble-free.

As regards the breakdown voltage of the capacitors: I tested mine first by wiring them in series with a choke and connecting directly across the mains. The voltage across the capacitors was about 600 V R.M.S. during the test. The choke got rather hot after a time, but the capacitors stood up to the test. S. V. STEPHENS.
London, S.E.24.

"Television Standards"

I WOULD like to draw your attention to an inaccuracy in the above article (October *Wireless World*). The writer states that it has been found practicable to equalize ordinary telephone lines up to some 1.5-2 Mc/s provided only a very few miles is involved.

In actual fact, the average circuit supplied to the B.B.C. over "ordinary telephone lines" has a response of ±1 db from 50 c/s-2.5 Mc/s, falling to some −6 db at 3 Mc/s, the reference level being 10 kc/s. GEOFFREY LEES.
London, N.W.1.

Better Listening

THE radio industry, in conducting its recent "Better Listening" campaign, might have combined it with a war against man-made interference. Unfortunately, high-fidelity listening is not just a function of the receiving equipment. Listening can be intolerable with a high-quality R.F. unit in a district where interference is prevalent.

It is my lot to live in such a district and no amount of aerial gear, mains suppressors and help from the Post Office engineers has so far been able to make fidelity listening a practical proposition for me. RAYMOND E. COOKE.
Doncaster.

Long-range Television

IN your June issue a correspondent gave a detailed report of reception of Alexandra Palace television in Bristol.

My own experiences at a considerably greater distance, in Liverpool city boundaries, may be of interest.

Since last November I have been receiving the sound and vision from A.P., at first very rarely, but, after various aerial experiments, quite often, occasionally exceptionally well.

At the present the vision side is quite fair "amusement value" (note I don't say "entertainment value") on three or four days a week.

To obtain high gain I am using single sideband with 500-kc/s band; this gives quite tolerable definition for most pictorial scenes, but not for written subjects. A signal of 10 μV/metre gives me a poor quality picture with indifferent synchronism; this seems to be the average condition here, the better days being about 6-10 db better than this. The receiver (video side) uses 2 R.F.—mixer—6 I.F.—video det.—2 video-sync. sep.—D.C. restorer.

The antenna now in use is a combination (with phase compensation) of 3-element beam and Beveridge long-wire directional for A.P. (*and* incidentally Birmingham, which *should* "roll in"!) The Beveridge aerial really is useful since the wave front at long distance is decidedly "tilted," also the bandwidth characteristics are admirable for this particular purpose.

Best conditions for this distance and location seem to be cool, still evenings after sunny, clear days. Unstable air-streams from any quarter seem to reduce the field as much as 20 db. R. A. S.

Liverpool.

MARCONI ON RADAR

A Forecast of 1922

PLAUSIBLE early forecasts of radar are rare, and so particular interest attaches to the following passage in an address delivered by Marconi before the American Institution of Radio Engineers on June 20th, 1922, well over a decade before even the preliminary work on the subject was initiated:—

"Some years ago, during the war, I could not help feeling that we had perhaps got rather into a rut by confining practically all our researches and tests to what I may term long waves, or waves of some thousands of feet in length, especially as I remembered that during my early experiments as far back as 1895 and 1896 I had obtained some promising results with waves not more than a few inches long. The progress made with the long-wave antenna system was so rapid, so comparatively easy, and so spectacular that it distracted practically all attention and research from the short waves, and this I think was regrettable, for there are very many problems that can be solved, and numerous most useful results to be obtained by, and only by, the use of the short-wave system.

"Since these early tests of over twenty years practically no research work was carried out or published in regard to short waves, so far as I can ascertain, for a very long period of years."

Marconi went on to say:—

"In some of my tests I have noticed the effects of reflection and deflection of these waves by metallic objects miles away.

"It seems to me that it should be possible to design apparatus by means of which a ship could radiate or project a divergent beam of these rays in any desired direction, which rays, if coming across a metallic object, such as another steamer or ship, would be reflected back to a receiver screened from the local transmitter on the sending ship, and thereby immediately reveal the presence and bearing of the other ship in fog or thick weather.

"One further great advantage of such an arrangement would be that it would be able to give warning of the presence and bearing of ships, even should these ships be unprovided with any kind of radio."

Proc. I.R.E., Vol. 10, No. 4.

ABATEMENT OF INTERFERENCE

TWO "Codes of Practice" on reduction of interference to radio reception are not quite so well known as their importance would justify.

The first (No. CP1001; 1947) deals with interference arising from motor vehicle I.C. engines, explaining its nature and describing how it can be suppressed, or at least minimized by suitable design and also by the user.

The other code (No. CP1002; 1947) is concerned with interference generated by electro-medical and industrial R.F. equipment. Guidance is given as to means of suppression in design and manufacture as well as by the user.

The codes, which were prepared jointly by the Institution of Electrical Engineers and the British Standards Institution, cost 2s each by post from B.S.I., 28, Victoria Street, London, S.W.1.

RANDOM RADIATIONS

By "DIALLIST"

Television Interference

You may recall that not long ago I made a suggestion in these notes about a possible cause of the unpleasant flopping from good to bad and bad to good which occurs in the television image when an aircraft flies more or less on an imaginary straight line joining transmitter and receiver, or its prolongation. "Beating," a similar flopping in the break on the C.R.T. trace, was a fairly common phenomenon in wartime radar sets. We were told by the pundits who conducted the strenuous radar courses during the war that this was due to the fact that the number of r.p.m. of the rotary aerial switch of GL2 was just about that of an aircraft's propeller. At certain angles this produced a beating effect. Ours not to reason why—and, even if we'd wanted to, the speed of those courses was so breathtaking that there wasn't much time for thinking things out. It was reckoned that the wartime "long" radar course got through in five crowded months what should normally have taken at least two years! Anyhow, the suggestion that in television receivers some form of beating might take place in certain circumstances because the frame sync time base has a frequency of $50 \times 60 = 3{,}000$ per minute and a common speed for aircraft propellers is 1,500 r.p.m. just won't wash. Reason? Well, several readers have written to say that the same flopping occurs when the aircraft overhead is a jet. And that rules out completely all the propeller r.p.m. business for the very good reason that there's no propeller and no revolutions.

Doppler Effect

This type of interference is undoubtedly due to the arrival of the signal by direct and reflected paths at the receiving aerial. The flopping is caused by the constantly changing phase relationship of the two signals. There would be no variation in this relationship, were the aircraft stationary. But, of course, it isn't. If it's more or less on a straight line between your aerial and that of the transmitter, it must be either approaching or receding. Hence the reflected signals are as effectively "dopplered" as the sound waves from the whistle of an express locomotive approaching, passing and receding from the station platform on which you may be standing. What all this comes to is that if you're receiving a television signal by the direct path and by reflection from a moving object, the image will flop in queer ways. All of which, though interesting to the physicist, doesn't vastly help the fellow who lives somewhere near an aerodrome and has installed a televisor in his home. Perhaps the back-room boys of Belling and Lee or Antiference will be able to evolve some solution. What seems to be needed is an aerial so screened that it cannot receive signals arriving at vertical angles greater than that of the direct wave.

"Wireless" or "Radio"?

In the last few days I've been severely taken to task by a friend for talking about "wireless." That, he contends, is an obsolete term. In his view "radio" is the word that is used by all up-to-date people when they are referring to communications of any kind made by means of electro-magnetic waves. "Could there be anything more ridiculous than to describe as a wireless receiving set a piece of apparatus which may contain hundreds of yards of wire?" He contends further that it was just as antiquated and absurd to call the equipment which disseminates broadcast a wireless transmitter as to dub the normal conveyance of to-day a horseless carriage. "Wireless," he maintained, was a term crystallizing the amazement of the 1900s that a communication could be sent from here to there without intervening wires, just as "horseless carriage" summed up the amazement of the 1890s that a vehicle could move without the aid of a horse. We'd long ago got over any feeling of surprise about either; this age of progress demanded matter-of-fact terms like motor car, motoring and radio. I was so flabbergasted by this sudden fierce onslaught that I couldn't think of half the crushing retorts that have since come to mind. I did, however, mention that a certain periodical of world-wide standing was content to retain "wireless" as a part of its title and that the word had, anyhow, the advantage of being exclusively English. Interestingly enough, both the French *sans fil* and the German *drahtlose* are literal translations of wire-less.

Unit of Sales Resistance

In view of the Better Listening campaign I made a kind of minor Gallup Poll amongst friends who live near by, asking in rather more tactful form the question: Why on earth do you go on enduring the unspeakable reproduction of that awful old set of yours? A few (whose loudspeakers I hear blaring at no matter what time I pass their homes) replied that as there was never anything worth listening to on the wireless nowadays, they made hardly any use of their sets, so that the odd chunk of distortion was neither here nor there. The rest were singularly unanimous in the reason they gave. Almost without exception, they said that they'd go in for new sets at once, if only it wasn't for that etc., etc., etc., purchase tax. From which I gather that sales resistance to-day is to be measured in O.H.M.S. I understand their feelings perfectly.

New Works

Lately I've given quite a bit of thought to the question of worn-out broadcast receivers and their periodic replacement. Apart from the purchase tax snag of to-day, what sticks in the gizzards of many people is that they will have to dispose for a song not only of the innards of the old set but also of its cabinet. The cabinet, particularly if it is that of a console or a radiogram, may represent no small part of the price of the set. And if, as is likely, it has received the same good treatment as the rest of your furniture, it may well be almost as new when its contents have seen their best days. The lady of the house chose that cabinet to fit in with the other bits and pieces; you both like it; you haven't seen a set in the shops with a cabinet you like so much. So perhaps you go on putting up with poor performances on the part of the set because you can't bring yourselves to "trade in" cabinet and contents for what seems an absurdly small sum. I wonder if those set makers who go in for really good cabinet work wouldn't be well advised to offer complete chassis replacements after, say, two years, to those who have purchased their wares.

Wider Coverage Needed

We'll have, I feel, to revise a bit our present ideas about the frequency range covered by the preset signal-frequency tuning stages of television receivers. It seems all wrong from both the manufacturers' and the users' point of view that it shouldn't be possible to adjust *any* given receiver to any frequency required within the twenty-odd megacycle limits of the metre-frequency television band. From the manufacturers' angle it would surely be sound policy to design and market models which can be adjusted to any vision and speech range between 40 and 65 Mc/s; it seems absurd that different components will have to be used in the S.F. stages of London and Birmingham sets. Good profits and low prices are best assured by the biggest possible runs in the factory of identical apparatus. Further, if televisors have to be specially made to suit particular areas, it's inevitable that mistakes exasperating to the purchaser will be made. He'll wait, maybe, for weeks for a receiver of the type to which he has pinned his faith, only to find when its delivered that it won't tune to the frequency of his station. Surely, too, the man who invests quite a bit in a television set should have some guarantee that it will tune to the frequency of another transmitting centre, in case he has to move.

Ultrasonics

My note last month, must, I fear, have given a totally misleading impression of J. M. M. Pinkerton's work on ultrasonics at the Cavendish Laboratory, Cambridge. Pinkerton did not, as I stated, discover the existence of cavitation: that was known to be one of the snags by ASDIC workers in World War I. His work is concerned with the absorption of ultrasonic waves in certain liquids; here it is most important to avoid cavitation at all costs.

RECENT INVENTIONS

A Selection of the More Interesting Radio Developments

Short-wave Aerials

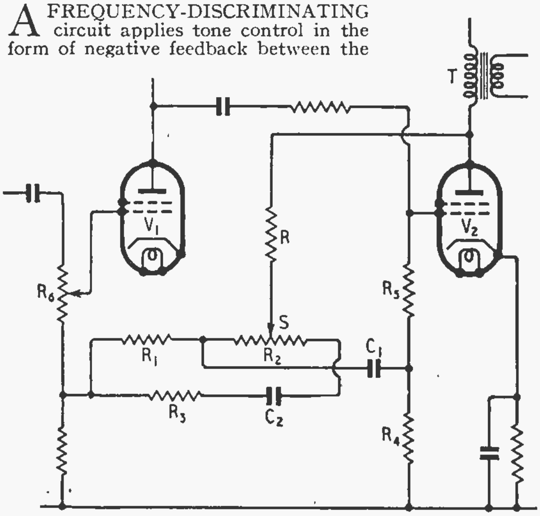
AN elongated slot, in the shape of a flattened Z, is cut in the side of a closed metal tube, each of the upper and lower limbs of the opening being substantially a quarter wave-length. The inner and outer conductors of a coaxial feeder are connected to the opposite sides of the comparatively short transverse slot connecting the two horizontal limbs.

In effect, the feeder is thus coupled across the two metal parts of the tube defined by the upper and lower edges respectively, of the elongated opening, and since the two parts in question have, at any given moment, different capacities to earth, they can oscillate as dipoles. At the same time, the system is electrically balanced about the transverse slot containing the feed point. The construction provides a robust form of aerial, which is particularly suitable for use on aircraft, or where high mechanical strength is required.

Standard Telephones & Cables, Ltd., and E. O. Willoughby. Application date, Feb. 6th, 1945. No. 592760.

Tone Control

A FREQUENCY-DISCRIMINATING circuit applies tone control in the form of negative feedback between the anode and grid of the last A.F. stage, and positive feedback between that valve and the previous amplifier.



Tone control feedback circuit.

As shown, a resistance R, in shunt with the output transformer T of the power amplifier V2, is tapped back at S to a looped circuit R1, R2, C2, R3, of which R2 is much the largest resistance. The other components are so chosen that when the tapping S is at its left-hand limit, frequencies above 150 c/s are fed from the anode to the grid of the valve V2 through resistance R, capacitance C1, and resistances R4, R5, in phase-opposition, so that their amplitude is reduced. On the other hand, frequencies below 150 cycles pass through resistances R1 and R6 to the grid of V1 in phase to apply positive reaction, the nett result being maximum base response. The right-hand setting of the control S produces no appreciable reaction through either of the above-mentioned paths, though frequencies above 1,000 c/s are boosted by being fed back through C2 and R3 to the grid of the amplifier V1.

E. K. Cole, Ltd., and E. L. Hutchings. Application date, April 25th, 1939. No. 598287.

Receiving F.M. Signals

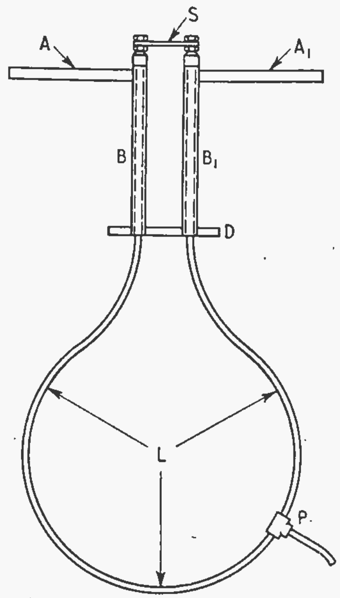
A FREQUENCY - MODULATED carrier is liable for various reasons to develop disturbing fluctuations in amplitude. A limiter valve can be used to smooth these out, prior to detection, provided a high level of signal input is available, since to be effective the limiter must be operated at saturation point.

As an alternative, according to the present invention, the I.F. pentode amplifier immediately preceding the discriminator stage is arranged to operate also as a grid-leak detector. The rectified voltage built up across the leak resistance, as a result of any amplitude variations that may be present, is tapped off to an auxiliary amplifier, located outside the normal signal channel and from there is fed back to an earlier I.F. amplifier, in the phase required to eliminate or offset the original irregularity. The required correction is thus applied automatically, and without affecting the normal amplification of the F.M. signal.

Marconi's Wireless Telegraph Co., Ltd. (assignees of N. I. Korman). Convention date (U.S.A.), July 29th, 1944. No. 596531.

Dipole Aerials

THE dipoles A, A1 are welded to the upper ends of a pair of tubular quarter-wave supports B, B1, which are mounted firmly on a baseplate D. The dipoles are fed through a looped coaxial line L from a tapping-point P, which is chosen so that one branch of the loop is 180 deg longer than the other branch, as measured from the plate D. The outer conductor of the coaxial line is connected to the inner end of each of the dipoles, whilst the



Dipole coupling system.

inner conductor passes up through an insulating cap at the top of the supports to a conducting strap S.

Since the currents in the inner conductor must be 180 deg out of phase at the lower end of the supports B, B1, the latter will present an infinite quarter-wave impedance to the inner ends of the dipoles, thus allowing these to be directly connected to the outer conductor of the looped line, without the use of a transformer or other coupling-network. Moreover, the combination of the parallel-resonant circuit formed by the supports, with the series-resonant load of the two dipoles, serves to broaden the frequency characteristic of the aerial as a whole.

Marconi's Wireless Telegraph Co., Ltd. (assignees of G. H. Brown). Convention date (U.S.A.), February 23rd, 1942. No. 591987.

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