Wireless World

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Weather Broadcasts

THE foreigner, especially if he lives in a country enjoying a relatively stable "continental" climate, is not entirely fair when he pokes gentle fun at British preoccupation with the vagaries of our fickle island weather. The weather is a matter of vital concern to large sections of the community and the most up-to-date information on it should be made available to all. There is no method of distributing information on this subject that can rival radio broadcasting. Up to a point, the B.B.C. forecasts meet the needs of the majority, but these bulletins are not sufficiently frequent, detailed and localized for the important minority which has more specialized requirements.

Farmers, fishermen, navigators of small craft and countless others who are more than usually dependent on sudden changes of weather have hitherto been catered for to some extent by the meteorological service broadcast until recently by "Airmet," and, before the war, by "Weather London." Now, the reallocation of frequencies under the Copenhagen Plan has taken away the 245-kc/s channel used by the station, and at the time of writing we are without any fully detailed radio-telephony service. Strong protests, with which *Wireless World* is entirely in sympathy, have been voiced, and the matter has been raised in Parliament. Though intended primarily for civil aviation, it would appear that Airmet is even more sorely missed by other interests: navigators of radio-equipped aircraft have other sources of information.

Provision of a comprehensive broadcast weather service seems to us to be something much more than a mere amenity, and we urge that the Airmet service should be restored without delay, possibly in an amended form of even wider usefulness, with perhaps less emphasis on the needs of aviation. We realize that the problem of finding a suitable vacant channel is a formidable one. The original long-wave allocation was almost ideal, and provided virtually nation-wide coverage from a single station at low cost. Short of annexing the B.B.C.'s low-frequency channel of 200 kc/s, there seems no chance of anything equally good being available.

Whatever frequency is chosen it seems highly desirable that it should ideally be within the coverage of the average inexpensive broadcast receiver. The only constructive suggestion so far put forward to meet this requirement was made in Parliament, where it was urged that the Third Programme channel (647 kc/s) should be used for the Airmet service during the time that it is idle during the daytime. The obvious objection here is that national coverage of this station, even when assisted by a number of low-power relay transmitters on 1546 kc/s, is admitted to be far from complete. Another objection is that an 18-hour service daily is inadequate, although it should be remembered that the Airmet transmission, rather surprisingly, did not operate through the night. However, the Postmaster General did not bring forward any reasons against using the Third Programme channel, and we think it might well serve at least as a temporary expedient, either by itself or in conjunction with one or more transmitters on other frequencies.

If a frequency covered by the ordinary broadcast receiver cannot be used, a bad second-best is the choice of one to which such receivers can easily and cheaply be adapted. The suggestion for using a frequency in the neighbourhood of 2 Mc/s answers this requirement fairly well but would demand a number of linked stations for adequate coverage. The costs of distribution in this manner would be high, but, as we have said, weather broadcasting is more than an amenity; it is sometimes a matter of life and death. Until a comprehensive broadcast meteorological service is available, it cannot be claimed that we are making proper use of all that radio has to offer us.

More About Positive Feedback

Applied Locally it Can Improve Negative-Feedback Amplifier Performance

By THOMAS RODDAM

THE use of positive feedback for controlling the output impedance of an amplifier was described in the February, 1950, issue of *Wireless World*. Since that article was written I have been using positive feedback to improve the performance of some audio-frequency amplifiers in respect of frequency response and distortion. This is just the reverse of what the reader has always been told: negative feedback improves the performance, while positive feedback makes it worse. The answer is, it all depends. This article is a description of how positive feedback can be used to make amplifiers better.

Suppose that we have a three-stage amplifier, and that most of the distortion is produced in the output stage. This is usually true, although if high-level Class "B" output stages are considered we may run into trouble at the driver stage. In domestic sound reproduction equipments up to the ordinary 10 watt level, it is the final stage which does most of the damage. A typical result, without feedback, will be for the output stage to give 10% distortion, while the two preceding stages are down below 1%. The total distortion is then between 10% and 11%: as the two distortion sources are in tandem I do not think it is justified to take the root mean of the sum of the squares.

This performance, of course, is no good at all, and we add a negative feedback circuit, reducing the overall gain by 20 db and bringing the distortion down to about 1%. Throughout this article I shall assume that the gain without feedback, A, is large and that the feedback B is such that we can write $1 + AB = AB$ It is nonsense to fuss about whether the distortion is 1% or 1.1%.

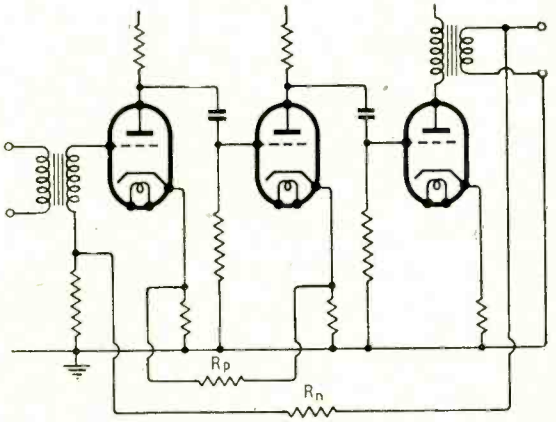


Fig. 1. Basic circuit for using positive feedback through R_p and negative feedback through R_n.

That is the conventional solution, and very nice it is, too. But we can do better than that. Suppose that we provide positive feedback from the second stage to the first, and that we choose this feedback to give us an increase of gain of 6db. The distortion in these two stages will be increased from 1% to 2%. Assuming the worst possible way in which the distortion from the output stage can add to this distortion, the overall distortion will now be 12%, without negative feedback. When we put on the negative feedback, however, we make an interesting discovery. The overall gain, A, has been doubled, and if we keep the value of B constant, so that the gain with negative feedback is the same as before, the value of AB is also doubled. We therefore have 26db of negative feedback, and the distortion is reduced to 0.6%. We can go still further, adding positive feedback to give 10% distortion in the input stages, making 20% in all (or 14% if we can use the r.m.s. sum), and then restoring the original gain with negative feedback by using 40db of negative feedback. The distortion will then be 0.2%.

It is not difficult to see that the same improvement in frequency response can be obtained, provided that the output transformer is the only limiting factor. Another improvement which is of special importance in measuring instruments is in gain stability. The combination of positive and negative feedback gives a circuit which is extraordinarily independent of heater and anode voltages.

Pentodes v. Double Triodes

The use of positive feedback also makes a considerable difference when the problem of using triodes or pentodes is under investigation. If we restrict ourselves to using a particular number of "bottles," we have the choice of replacing a pentode by a double triode. A resistance-coupled pentode will give a stage gain of about 150 times, but a twin-triode will give a stage gain of at least 900 times without positive feedback, and this can safely be increased to 2,000 times with positive feedback. A "two-bottle" amplifier using a double triode can, therefore, have more than 20db extra negative feedback compared with an amplifier using a pentode in the input stage.

With all these advantages the reader may well feel that he is being sold a share in the New Jerusalem. There are some quite serious difficulties in the way of using positive feedback, but they are straight-

forward design difficulties. I do not want to go too deeply into the mathematics of the design problems, because if I do the Editor will not like it. But there is one short piece of maths which I do not think we have had before in *Wireless World* and which is rather useful.

Suppose that we have an amplifier with gain A and feedback B, the signs being left to common sense. The gain with feedback G, is given by

$$G = \frac{A}{1 + AB}$$

Let A be complex; that is, let us take account of the phase shift in the amplifier. We can write

$A = |A| \angle \theta = \alpha + j\beta$

where $|A| = \sqrt{\alpha^2 + \beta^2}$

and $\tan \theta = \beta/\alpha$

The effect is, of course, to make G complex, and we have

$$G = |G| \angle \phi$$

After a little manipulation we can obtain the equation

$\cot \phi = \cot \theta + |A|\, B \operatorname{cosec} \theta$

When we use negative feedback $|A|\, B$ is positive, because $G < A$: this is what I mean by common-sense use of signs. This means that $\cot \phi > \cot \theta$ if $\operatorname{cosec} \theta$ is positive. Now $\operatorname{cosec} \theta$ is positive if $\theta < 180°$, which is the only region in which we are interested, so that we always have, for negative feedback in the stable region, $\cot \phi > \cot \theta$ and, consequently, $\phi < \theta$. Negative feedback thus reduces the phase shift.

Similarly, for positive feedback, $|A|\, B$ is negative and therefore $\cot \phi < \cot \theta$ and $\phi > \theta$, so that positive feedback increases the phase shift.

This makes it more difficult to keep the overall system stable: let us look at some typical numbers. If we have a pair of stages giving a gain of 1,000 times, and we double this by means of positive feedback, the phase shift at the point where the response has dropped 6db will be 62°, compared with 60° without feedback, but at the point where the gain has dropped 20db the phase shift will be 97° instead of 88°, and it rises to a maximum and then drops back to 90°. Positive feedback thus swallows up the gain and phase margins, and if very much is used it can be very extravagant in these design parameters.

My own way out of this problem has so far taken two different forms. One is to restrict the positive feedback to a range over which it is particularly needed. If an amplifier is suffering from distortion at the low end of the frequency range, due to an output transformer containing too little iron, the positive feedback is applied only at low frequencies. This saves me having to worry about the stability margins at the top end.

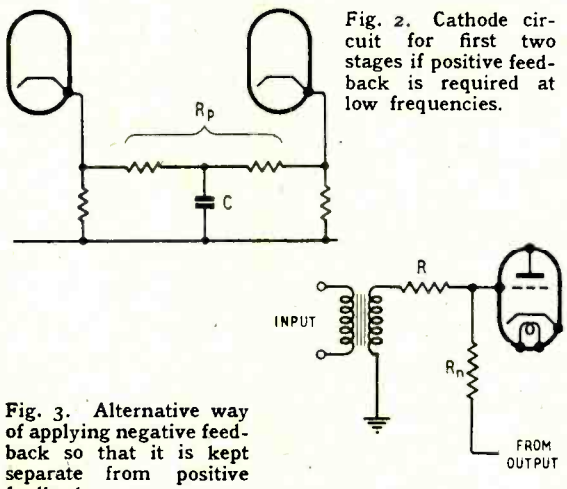


Fig. 2. Cathode circuit for first two stages if positive feedback is required at low frequencies.

Fig. 3. Alternative way of applying negative feedback so that it is kept separate from positive feedback.

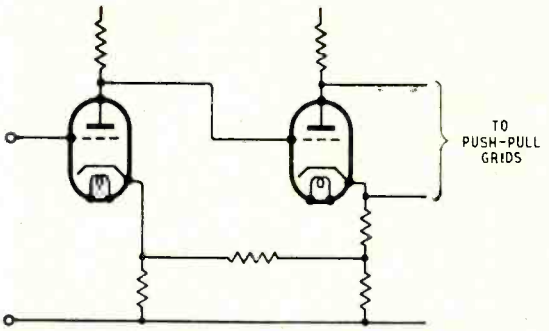


Fig. 4. Application of positive feedback to push-pull phase splitter.

For a real full-blooded, high-quality design, the output transformer is designed very carefully so that it just passes the required frequency range. A liberal air gap is used, so that the transformer performance is stable, and the preceding stages are then designed on a wide-band basis. Thus if the amplifier, is required to work down to 50 c/s into a 600-ohm load, the secondary inductance is made equal to $600/2\pi 50 = 1.9$ henrys: with 0.5MΩ grid resistors the coupling capacitance to the output stage is up in the region of $1/(500{,}000 \times 2\pi \times 5) = 0.07\mu F$, while the coupling capacitance inside the positive feedback loop is $0.5\mu F$. This sort of stagger gives enough margin for about 12db positive feedback and negative feedback corresponding to 20db in the absence of the positive feedback.

Practical Points

Fig. 1 shows the bare bones of the circuit, from which all decoupling has been omitted. The output valve may be a pentode or beam tetrode: so, of course may the other two valves. By a suitable choice of resistance values in the first two stages R_p may be made zero, in which case a double triode with a common cathode, such as the 6J6 may be used.

If the positive feedback is to be used only at low frequencies the cathode circuits of the first two valves can be designed in the way shown in Fig. 2. The capacitance C short-circuits the positive feedback at high frequencies, but allows the feedback to operate at frequencies at which the reactance is large compared with the resistances in the circuit. Capacitances of the order of $1\mu F$ are usually suitable when the requirement is merely that the positive feedback should be inoperative at more than a few thousand cycles per sec and operative below a few hundred.

There is one feature of the circuit of Fig. 1 which may cause some difficulty. The negative feedback cannot be introduced in parallel with the cathode resistor of the first valve, because the impedance here is affected by the positive feedback. Any attempt to introduce the feedback in the cathode will give trouble with the frequency response. As

Readers will note a slight reduction in the number of pages in this issue of WIRELESS WORLD. *This reduction has been necessitated by the withdrawal of overtime working by a section of the printing industry and has, in the circumstances, been unavoidable. We hope that it will be only temporary.*

an alternative to the circuit shown in Fig. 1 we may use the circuit of Fig. 3, which was discussed by Mr. E. Griffiths in *Wireless World*, March, 1950 (p. 111). This circuit has the disadvantage, in some applications, that a signal applied to the output can make its way through to the input, but this will not trouble most readers.

A rather interesting special application of positive feedback is shown in Fig. 4. This is a direct-coupled phase-splitter, for driving a push-pull output stage, and it will be seen that except where the stray capacitances have a controlling effect there is no possibility of instability. The tapping point on the cathode resistor is chosen so that the two ends of the feedback resistor are at the same potential, so that there is no d.c. through this resistor and it does not upset the bias conditions at the first cathode. Using a pentode in the first stage and a small triode in the second the gain can be pushed up as far as is desired. This feedback also has the effect of reducing the impedance at the anode and increasing it at the cathode. Where the following stage is being driven into grid current the positive feedback may be chosen to give equal generator impedances at both grids, thus avoiding the unsymmetrical drive which is otherwise obtained at high levels.

It will not have escaped the reader that he can use just a little positive feedback, using one resistor, instead of decoupling the cathodes of two stages, using two electrolytic capacitors. Provided he is not working near the performance limit the circuit shown in the article in the February issue (p. 49) can be used for this purpose.

Screen-to-Screen Feedback

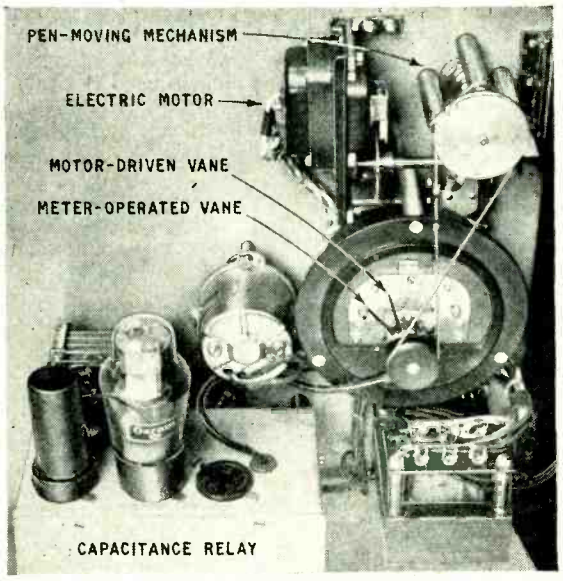
Circuits have been published showing the corresponding feedback from screen to screen, to avoid the use of a screen capacitor. I have tried this circuit, but found that it produced quite intolerable distortion. After a considerable amount of thought, the following conclusions were reached. Feedback from screen to screen can be used only in very low-level stages. If an attempt is made to feed back from the screen of a high-level stage the result will not be satisfactory. The reason seems to be this. The screen of a pentode, if not decoupled, behaves like the anode of a triode, and we may, for the moment, forget the pentode anode. This triode is easily overloaded, when the alternating voltage output becomes distorted. This distorted output, fed back to the screen of the preceding stage produces a quite excessive amount of distortion in the signal applied to the pentode grid.

The main purpose of this article has been to stir up the interest of the reader in the use of positive feedback. I must utter a word of warning. Unless he has acquired some experience in applying negative feedback he should not plunge into the complexities of mixed feedback. There are enough headaches lying in wait for the man who wants to apply 20db of negative feedback round three stages and an output transformer, without adding to them by using positive feedback from the beginning. The difficulties are counterbalanced by the considerable improvement in performance which is possible, but the price in design effort is high. After all, if you expect to reduce distortion by a factor of 10, using only one resistor, you must be prepared to pay for it somehow.

SERVO GRAPH RECORDER

A DIFFICULTY inherent in most conventional graph recorders is that of driving a pen across a paper surface with a very small electrical power input. In servo-operated recorders the problem is avoided by driving the pen with an auxiliary source of power and using the electrical input merely for control purposes; and an interesting development of this principle has recently appeared in the shape of the "Servograph," a new instrument by Fielden (Electronics), Ltd., of Manchester.

Here the current to be measured is arranged to deflect a normal meter movement and the pointer of the meter is replaced by a light vane which acts as one plate of a variable capacitor. The other vane of this capacitor moves in the same arc and is driven by an electric motor which also drives the recording pen. Thus, for the pen to reproduce faithfully the deflections of the meter, it is only necessary to make the motor-driven vane follow the meter-operated vane; in other words to maintain the vanes at constant spacing. This is done by an electronic capacitance relay which controls the electric motor according to the capacitance between the two vanes; an incremental movement of the meter vane produces a decrease in capacitance and this, by means of the relay, causes the motor-driven vane to follow up until the capacitance rises to its original value.



Rear view of a "Servograph" shown at the Physical Society's Exhibition. The recording chart is in the form of a rotary disc on the other side of the panel.

Record and Stylus Wear

Advantages of Compliant Stylus Mountings

By G. H. H. WOOD (*formerly with Cosmocord, Ltd.*)

WEAR on gramophone records caused by the reproducing points of the pickups which play them is a problem the solution of which has lagged far behind other developments in sound reproduction. Yet a solution is vital for sustained good reproduction from records. The evil of record wear is not simply the painful necessity for further expenditure on replacements; it is the gradual and therefore comparatively imperceptible deterioration in the quality of reproduction which inevitably accompanies record wear. There is never a given point at which the record is deemed unplayable. Instead, the ear becomes accustomed to a perversion of the real sound.

During the last few years, manufacturers have attempted to solve this problem by reducing the mass of their pickup heads and producing what are termed "lightweight" types. The theory is that the less weight there is on the reproducing point, the less wear will be caused on the records. However, the weight on the reproducing point when the pickup is static bears no relation to the actual pressure which is exerted when the pickup is in motion in the groove. This dynamic stylus pressure is related more to the needle tip impedance and the method of stylus mounting than to the mere static weight on the point. It is naturally desirable to have the lowest possible downward stylus-pressure, but this factor alone can only slightly reduce record wear.

Reproducing Points

Manufacturers of pickups have also turned their attention to the reproducing points themselves in their efforts to combat record wear. It is now generally accepted that neither steel nor fibre needles are satisfactory. If anyone has their doubts about this statement, particularly those who champion fibre needles, let them look at the devastating photomicrographs (Figs. 1 to 6) taken by Mr. C. E. Watts which were first published in an excellent book, "Sound Reproduction" by G. A. Briggs. These, unretouched as they are, provide indisputable evidence.

Fig. 1 shows a "miniature" type chromium-plated steel needle—recommended playing time 10 sides—after only *one* playing on a new 12in commercial record. Such a point will plough along the bottom of the groove creating excessive surface noise, and the "pinch effect" in the grooves will cause severe loss of top frequencies. Fig. 2 shows the wear caused by such a needle.

Fig. 2 shows two grooves of a new 12in commercial record after *one* playing with a steel needle. Already steel flakes can be seen embedded in the groove wall.

Fig. 3 shows a new fibre needle after one playing on a new 12in commercial record. The loss of top which is an inevitable consequence of this mutilation cannot be denied. Furthermore the fibre needle which becomes in effect a fluffy mop ideal for collecting dust and rubbing it into the record grooves is by no means blameless as regards record wear New records microscopically examined after playings with fibre needles show evidence of general wear, as if made by an abrasive.

Fig. 1. "Miniature" steel needle after playing one side of a new 12-in shellac disc.

Fig. 2. Record groove after one playing with steel needle, showing abrasions with steel flakes embedded in wall.

Left: Fig. 3. Fibre needle after playing one side of new 12-in record. Right: Fig. 4. Sapphire point after 250 playings of 250 new 12-in records with a "lightweight" pickup. Weight on point 25 grams.

Fig. 5. Sapphire point after 20 playings with a heavy moving-iron pickup on part-worn 12-inch records.

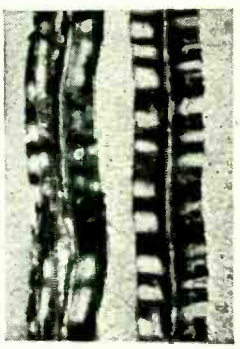


Fig. 6. Damage to groove of shellac record after 20 playings with heavy moving-iron pickup using sapphire stylus.

With the discrediting of steel and fibre points, progressive manufacturers have tended to adopt sapphire styli. Now in some quarters it is believed that the provision of a sapphire point having the correct radius solves all problems of record wear and good reproduction, while in other quarters their use is feared and abominated. There can be no doubt that prejudice against sapphire styli has been created by their misuse with pickups never designed for them, and to judge them fairly it is essential to watch their performance in pickups designed for their use.

Mr. Watts' photomicrographs again provide remarkable evidence. Fig. 4 shows the sapphire after 250 playings in a well-known lightweight magnetic pickup on 250 new 12in records, conditions far more favourable than normal usage, and yet the stylus is clearly worn.

Fig. 5 shows a sapphire point used in a heavier magnetic pickup after only 20 playings on part-worn records. Here the wear on the stylus is very pronounced.

Fig. 6 shows the wear which can take place after 20 playings with the latter pickup. There are already unmistakable signs of groove damage.

Inevitably one must come to the conclusion that neither low stylus pressure nor sapphire points which are dimensionally correct can provide, of themselves, a satisfactory solution to the problem of record wear. The advent of even harder points than sapphire, tungsten carbide and diamond, does nothing to solve the basic problem, for indeed if not used correctly, they merely provide a more deadly cutting tool

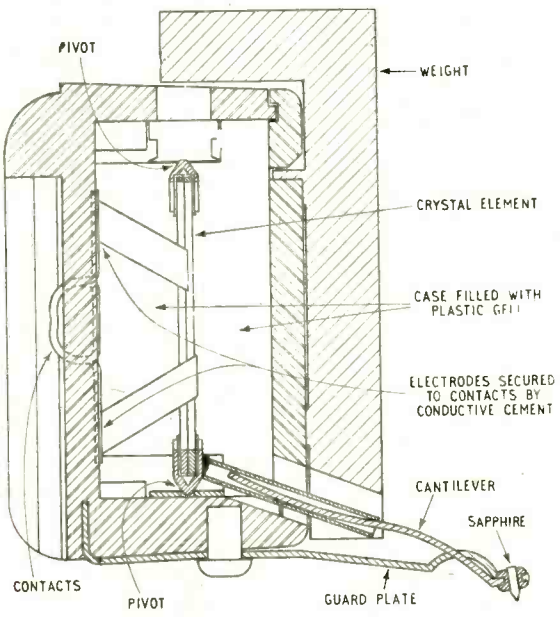


Fig. 7. Sectional drawing of Acos G.P.20 pickup.

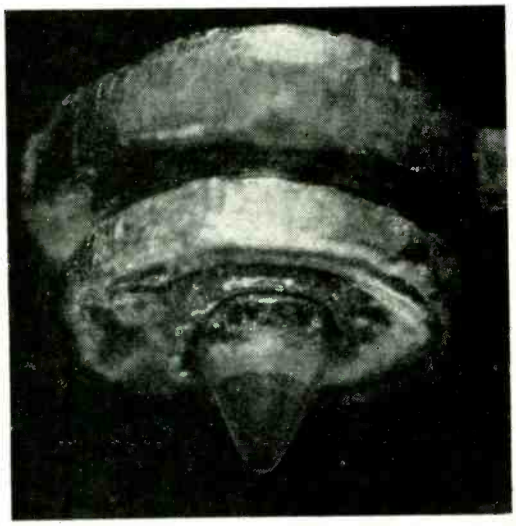


Fig. 8. Stylus of test pickup No. 1, before playing. Compare size of mounting with Fig. 7 (bottom, right).

Key to the Problem

The solution to the problem of record wear lies in some other factor, and it is the object of this article to demonstrate what this factor is, not merely from the theoretical standpoint, but by an account, illustrated by photomicrographs taken by Mr. C. E. Watts, of the actual performance of a pickup both with regard to stylus life and the wear it causes on records. The basis for the design of this pickup, the new ACOS G.P.20, was the belief that record wear is caused by lateral stiffness and lack of vertical compliance on the stylus mounting rather than weight on the stylus point. When the stylus in a pickup comes to that part of the record which has the same resonant frequency as the mass of the pickup head in conjunction with the stiffness, the head will tend to resonate and batter the stylus point in the grooves. When one considers the vast mass of the pickup head in relation to the tiny stylus point, one realizes how completely the resonating head may control the stylus movement. If a stylus is rigidly mounted the full force of the head's violence is transmitted against the groove walls of the record.

Distortion Due to Pinch Effect

The method of stylus mounting also bears directly upon another problem—distortion due to pinch effect. It has been recognized that the process of producing laterally cut records introduces, in a record modulated with a sinusoidal wave, a plurality of constrictions in the width of the cut groove due to the plane of the cutting stylus being always perpendicular to the axis of the modulated groove. These constrictions occur at twice the modulating frequency. When a stylus having a tip of correct radius to ensure a good fit in the unconstricted portion of the groove traverses the constricted portions of the groove it is forced upwards and as the constriction passes the stylus settles back in the unconstricted parts of the groove. This is known as pinch effect. For low-frequency signals where the wavelength is relatively large, pinch effect does not introduce serious distortion in the reproduced signal, but as the modulation frequency increases, the distortion introduced by the pinch effect can become very important. The distortion arises from the fact that the stylus does not maintain contact with both side walls of the groove at all times. At low frequencies the force of gravity on the stylus acts to maintain the stylus in contact with both groove walls, but at high frequencies the force of gravity

does not accelerate the stylus in a downward direction quickly enough and the groove support "drops away" from the stylus as the record turns, thereby causing the stylus tip to wobble loosely in the higher and wider portions of the groove. Thus this inability of the stylus tip to always maintain contact with both walls of the groove usually causes distortion of the reproduced signal. It will be seen that a stylus which is rigidly coupled in a vertical direction to the mass of the pickup head represents considerable inertia on the stylus tip.

Cantilever Stylus

The G.P.20, as Fig. 7 shows, is designed so that a cantilever stylus, coupled to a crystal flexibly mounted in a compliant plastic gell, has the effect of decoupling the stylus tip in a vertical direction from the inertia of the pickup head. It is comparatively rigid in one direction so that it transmits lateral motion to the transducer through the driving means, but comparatively flexible in the vertical direction to prevent the vertical movement of the stylus being transmitted to the pickup head and *vice versa*. This system reduces the effective mass of the stylus to a very low order compared to conventional stylus systems.

As a result, damage to the groove walls caused by the huge mass of the pickup head controlling the stylus point is reduced to a minimum.

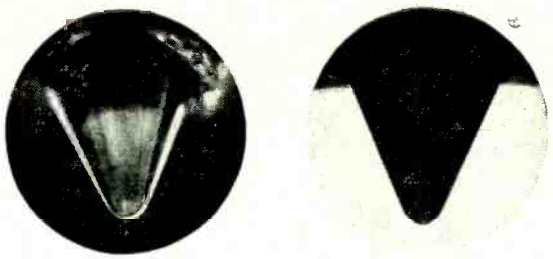
Fig. 8, which shows a G.P.20 stylus located in the bush fixing it to the cantilever arm, demonstrates pictorially this talk of huge masses in relation to the stylus point, particularly when one remembers that the diameter of this bush is only 0.045in. Below resonance, however, stiffness is the controlling factor. At resonance the mass is important, but the G.P.20 does not resonate in the upper register and this lack of resonance is the major reason for reduced record wear.

Evidence of this greatly prolonged stylus life and small record wear can be judged from the accompanying photomicrographs. A thorough investigation into the record wear produced by G.P.20 pickups elicited some remarkable information. Before these findings are stated it is advisable to make clear the conditions of the investigation.

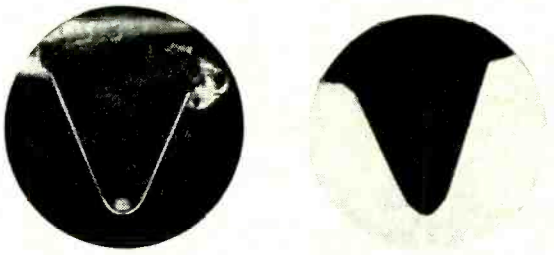
Conditions of the Investigation

Four G.P. 20 pickups were taken at random from production batches, so that they were representative samples of general production. Two of these (Nos. 3 and 4) had headweights which made their stylus pressure 14½ grams and two (Nos. 1 and 2) were without weights, reducing their stylus pressure to 7½ grams. The G.P.20 tracks at 7½ grams, but the manufacturers have added the headweight to allow an adequate safety margin when the G.P.20 is used with warped records, badly aligned turntables, or badly sprung motors. The pickups of differing stylus pressures were used so that the correlation between stylus pressure and record wear could be indicated, and the idea that stylus pressure is a vital factor at these low weights conclusively proved or disproved The styli in these pickups were never changed.

The pickups were then subjected to the following tests. G.P. 20 pickup No. 1 (stylus pressure 7½ grams) was played continuously for 2,000 playings on the second side of the "Danse Macabre" (Decca



Left : Fig. 9. Photomicrograph of No. 1 stylus after 800 playings of Decca "Danse Macabre." Right : Fig. 10. Shadowgraph of No. 1 stylus after 800 playings.



Left : Fig. 11. Stylus of No. 3 test pickup after 2,000 playings of the same heavy recording. Right : Fig. 12. Shadowgraph of No. 3 pickup after 2,000 playings.

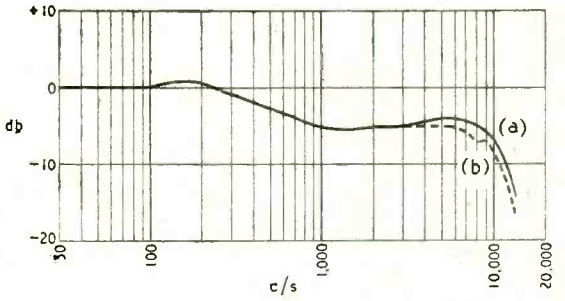
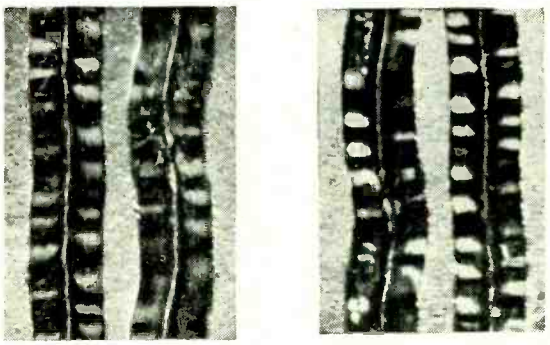


Fig. 13. Response of G.P.20 pickup (No. 1) (a) before and (b) after 2,000 playings with 7½ gm stylus pressure.



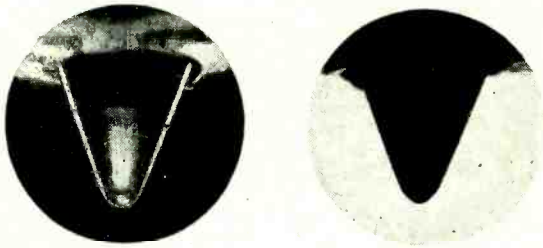
Left : Fig. 14. Record grooves after 100 playings with No. 2 pickup (7½ gm). Right : Fig. 15. Record grooves after 100 playings with pickup No. 3 (14½ gm).

K2069), which has a very heavy recording characteristic. Twenty sides of the "Danse Macabre" were used, each side being played 100 times. The records were changed after every ten playings, and the stylus was microscopically examined after every fifty playings up to 800 and every 100 playings thereafter. It was noted that the wear which took place occurred mainly during the first few hundred playings and continued in a decreasing ratio to the number of playings.

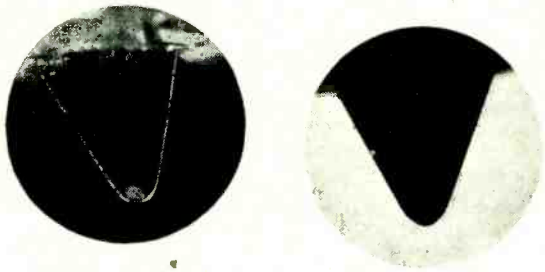
Fig. 9 shows the stylus after the first 800 playings and Fig. 10 the shadowgraph version after 800 playings. Two small flats are noticeable in the shadowgraph picture, but it is clear from Fig. 9 that the contour of the stylus is unchanged and the polish as high as ever.

Figs. 11 and 12 show the stylus after 2,000 playings, and it is again apparent that, although there is increased wear, it is not proportional to the number of playings. Fig. 13 shows the response of pickup No. 1 before the test and after the test. As can be seen, the only effect is a loss of some 2 to 4 db at 5,000 to 9,000 c/s. As this would cause no audible loss in top frequencies, the results can, without exaggeration, be claimed as revolutionary.

So far we have dealt with stylus life; now comes the even more important point of record wear. Fig. 14 shows the same grooves of the record depicted in Fig. 6 after 100 playings. G.P.20 pickup No. 2 ($7\frac{1}{2}$ grams stylus pressure) was used for this test. Fig. 15 shows the same grooves after 100 playings with the sapphire in G.P.20 pickup No. 3 ($14\frac{1}{2}$ grams stylus pressure) already played on 800 sides. These results are quite remarkable, for repeated playings have established that Mr. Watts' photographs show signs of record wear long before it is audibly apparent because both the records in Figs. 14 and 15 showed no audible deterioration at all. The importance of these results for gramophone users cannot be overstated.



Left: Fig. 16. Stylus of pickup No. 3 ($14\frac{1}{2}$ gm) after 800 playings of Decca "Danse Macabre". Right: Fig. 17. Shadowgraph of stylus in Fig. 16.



Left: Fig. 18. Stylus of pickup No. 3 ($14\frac{1}{2}$ gm) after 2,000 playings of Decca "Danse Macabre". Right: Fig. 19. Shadowgraph of stylus in Fig. 18.

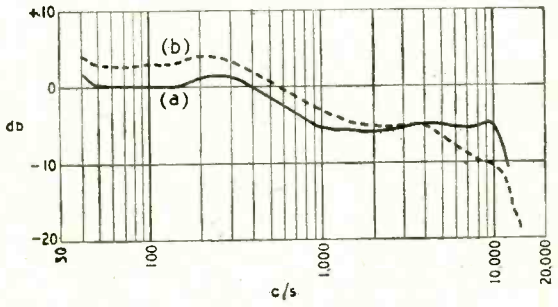


Fig. 20. Effect of wear on response of pickup No. 3 ($14\frac{1}{2}$ gm) after 2,000 playings of Decca "Danse Macabre". (a) before test run, (b) after 2,000 playings.

Relation of Stylus Pressure to Record Wear

The relation of increased stylus-pressure to wear both on records and styli was clearly demonstrated by pickups Nos. 3 and 4, both having stylus pressures of $14\frac{1}{2}$ grams. They were given exactly the same tests as Nos. 1 and 2. All that was noticed was a slight raising of the tempo of wear. For instance, Fig. 16 shows pickup No. 3 after 800 playings and Fig. 17 the shadowgraph version. Compared with Figs. 9 and 10 it will be seen that the flats are slightly larger. Figs. 18 and 19 show the stylus after 2,000 playings, and here again the wear is greater, but the sapphire still retains its contour and the polish is high.

Fig. 20 shows the effect of this wear on the response curve of the G.P.20 pickup No. 3.

The results of this investigation prove that sapphire styli, when manufactured correctly and used in crystal pickups of the Microcell type with a flexible stylus mounting, are capable of a much greater life than is popularly supposed. The reasons for their previous failure lie in the gramophone pickups, not in the styli themselves.

CLUB NEWS

Edinburgh.—Meetings of the Edinburgh Amateur Radio Club will be held fortnightly instead of weekly until the annual meeting in September. The club now has its own transmitter at the headquarters, 4, Hillside Crescent, licensed under the call GM3HAM. Sec.: D. A. E. Samson (GM3EQY), 56, Elm Row, Edinburgh, 7.

Southall.—Meetings of the West Middlesex Amateur Radio Club (G3EDH) are held on the second and fourth Wednesdays of the month at 7.30 at the Labour Hall, Uxbridge Road, Southall. The new secretary is P. F. Bloomfield, 213, Harrow View, Harrow, Middlesex.

Sunderland Radio Society is transferring its headquarters to the Y.M.C.A. in Toward Road, and will in future meet on Thursdays. Sec.: C. A. Chester, 38, Westfield Grove, High Barnes, Sunderland.

Warrington.—Forthcoming events in the programme of the Warrington and District Radio Society, which meets on the first and third Mondays of each month at the Sea Cadet Headquarters, include lectures on valves and communication on 3 cm. Sec.: J. Speakman, Dark Lane, Whitley, Warrington.

Weymouth.—New headquarters at 74, Franchise Street, have been secured for the Weymouth Radio and Television Club and a transmitter has been installed and licensed under the call G3GNU. The headquarters is open every evening and lecture meetings are held on the last Thursday of each month at 7.30. Sec.: J. Hubbard (address as above).

Choice of Television Standards

More Points in Favour of 405 Lines

DURING their recent stay in this country the delegates to the C.C.I.R. international television Study Group visited the B.B.C. research station where they witnessed several television demonstrations. One of these compared 405-line and 625-line pictures, both with a vision-frequency bandwidth restricted to 3 Mc/s— the economical limit for a $\frac{3}{8}$-inch coaxial cable. The equipment used in this demonstration was designed and built by the B.B.C. for studying the effects of such factors as bandwidth, number of lines, and phase distortion on picture quality. In the course of this study certain conclusions have been formed on the subject of television standards, and it was decided to offer for the delegates' consideration a summary of these conclusions. Since they may be of interest also to a wider audience, they are now being published in *Wireless World*.

The purpose of this short article is not so much to justify the decision made in Great Britain at the end of the war to restart the 405-line television service, but rather to show that in the light of existing evidence this choice of standards would appear to be fundamentally sound, both from an engineering and an economic viewpoint.

For those countries which are proposing to introduce for the first time a television service, the problem of deciding which of the many practicable standards shall be adopted is indeed formidable. The standard of perfection that might be closely approximated in a laboratory would at the present time be economically prohibitive for a practicable television service. On the other hand, some entertainment could no doubt be obtained from standards which would provide the bare minimum of information, all attempts at realistic reproduction being sacrificed for the sake of cost, but undesirability of such a choice is sufficiently obvious to warrant no further consideration.

Fortunately, the engineer has now gained enough knowledge and experience to be able to recognize broadly where the sensible limits apply, and his attention is now focused on the performance of what are considered practical standards which lie between relatively narrow limits. For television broadcasting no serious thought is being given to standards which will provide less than approximately 400 lines of vertical resolution at one extreme, or more than approximately 800 lines at the other. Indeed, it is now widely thought that 600 lines is a more reasonable upper practical limit, and since arguments will be put forward here to suggest that even this limit may be too high, we shall confine our attention to the limits of approximately 400 and 600 lines.

Practical Considerations

Nowadays one of the most important factors which must be considered when a system of communication is assessed is its bandwidth, and here, when we speak of economy we mean economy not only in cost (i.e., of transmitters, links and receivers), but also in the space available in wavelength allocations, which, it is perhaps well to remember, cannot be bought. The problem of national coverage resolves itself fundamentally into that of the number of channels which can be accommodated in a given band; and it is of paramount importance that broadcasting channels be used with the utmost efficiency, particularly television channels, where the bandwidth required is abnormally great compared with other forms of communication.

Again, there is the question of links. Whether these are of the permanent type required for simultaneous broadcasting, not forgetting the wider conception which includes the international exchange of programmes, or of the mobile type which are required for outside broadcasts, the cost and even the practicability of such links are intimately related to the bandwidth over which they are required to perform. On this question it must be noted that when a link is to be engineered to a given specification over a required bandwidth, we must think not only of the initial fulfilment of the specification, but also of the ease with which its performance can be maintained over long periods.

Finally, we come to the question of the receiver; and here we are concerned not only with its cost, but also with its performance, and what is most important, the ease with which it can be operated by the non-technical viewer to provide an acceptable standard of reproduction. While it is true that the standard of transmission should always be superior to the capabilities of the average receiver, it is also true that too large a gap is wasteful, unless there is good indication that the performance of the average receiver is improving at a very much greater rate than is the standard of transmission.

Comparisons of Standards

Here we shall discuss the merits of 405-line and 625-line television, assuming in each case that the system is double interlaced with a 50-c/s field frequency. It is, of course, impossible to make valid comparisons in matters which are largely subjective without demonstrations, but demonstrations have already been given to delegates of the C.C.I.R., and can always be repeated.

Let us initially consider the capabilities of 405-line television. It is sometimes argued that such a standard once adopted would impose a serious limit to the degree of improvement which could be introduced with time. This argument underestimates the degree of improvement which can be applied to 405-line television as at present broadcast, and such as is frequently demonstrated. In this connection it is worth noting that the definition which is obtained using 35-mm film for cinema entertainment is on the average not vastly better than would be obtained at the theoretical limit with a 405-line picture. Some of the factors which hitherto have combined seriously to limit the performance of 405-line television, but

are now being eliminated, are enumerated below and discussed briefly.

1. *Contrast Ratio.* It is well known that a poor contrast ratio reduces considerably the subjective impression of definition, but by taking advantage of the latest developments in cathode-ray tubes an improvement of the order of 10:1 may be obtained, which will provide a contrast ratio comparable with that of the average cinema.

2. *Depth of Focus.* One of the most serious limitations of the simple iconoscope has been poor depth of focus imposed by the low sensitivity. With the wide apertures that have by necessity until recently been used in the studios, only a fraction of the total optical image on the mosaic has comprised detail requiring 400 lines to resolve it. With the introduction of more sensitive camera tubes this limitation will be completely removed.

3. *Resolving Power of Camera Tubes.* Only recently have camera tubes been introduced capable of fully resolving 400 lines in all parts of the picture. Using the latest development in amplifier design it will be possible to equalize fully the camera output signal, so as to produce 100 per cent modulation at the limit of 400 lines while still maintaining a good signal/noise ratio, and improved methods of scanning will provide a scanning beam free from astigmatism.

4. *Receiving Tube Raster.* The line structure is fundamental to all present-day systems of television, and naturally becomes more visible as the number of scanning lines is reduced. However, with the latest improvements in deflection coils an even focus is obtained over the face of the tube, and line broadening may be introduced at little cost to provide an even field.

It is to be noted that with the exception of Item 4, the defects listed above are not in any way diminished by an increase in the number of scanning lines, and indeed if the full advantage were to be gained by such an increase, a very considerable reduction in the magnitude of all these defects would be absolutely necessary. However, the question to be answered is: with the defects removed it is worth while increasing the number of scanning lines beyond 400? At this juncture it is important to consider carefully what is meant by "worth while." To illustrate the need for this cautious approach, suppose that a fully exploited 400-line picture is compared with a fully exploited 625-line picture, and that the improved quality of the latter is noted. If the difference between the two systems could be expressed purely in terms of monetary cost, then the question to be answered is simply "is the improvement worth the money?"

Unfortunately, the cost cannot be so simply assessed since it involves the question of bandwidth with the many implications referred to briefly in the earlier part of this article. The ideal 400-line system would, for an aspect ratio of 4:3, occupy a bandwidth of almost exactly 3 Mc/s, based on the well-known assumption of equal horizontal and vertical resolution. The 625-line picture would on the same assumption require 7 Mc/s. Such a requirement would, of course, seriously limit the development of a service, particularly with respect to the use of cable links.

It may well be argued that to provide for the full horizontal resolution equivalent to 625 lines is not necessary, and that a horizontal definition equivalent to that of a 400-line picture would be adequate, and would require a bandwidth of only 4.5 Mc/s. In this case, the only advantage gained by increasing the number of lines is an increase in the vertical resolution. This improvement, although not great, might be considered worth while if judged on the basis of a laboratory experiment, but when dealing with a practical system of transmission it may well be found that any advantage gained is more than offset by the fact that some of the distortions which are inherent in any practical system will be far more perceptible, owing to the increased velocity of scan. For example, with a 625-line picture a given error in the arrival time of components of the signal will result in a disturbance which will occupy a space along a line 1.5 times as great as it will with a 405-line picture, and therefore in general it will be more visible. This will apply not only to many of the short-term echoes that are introduced frequently at the receiving point, owing to the proximity of buildings or a mismatch of the aerial feeder, but also to the type of "overshoot" often produced by inaccurate alignment of a receiver.

Most serious of all is the effect which occurs when a 625-line picture signal is transmitted over 3-Mc/s co-axial link, or for that matter through any apparatus which is efficiently designed for a 3-Mc/s band. Unavoidable distortion will be introduced at the cut-off frequency, which with a 405-line system will correspond with the limiting resolution of 400 lines, and will, therefore, produce a disturbance that is barely visible, even when of relatively large amplitude. A similar distortion presented on a 625-line picture will result in a disturbance pattern that corresponds with a 260-line structure, which will be clearly visible at any normal viewing distance.

Tests have been made, and demonstrations have been given, which show that the distortion which will inevitably result, due to transmitting a 625-line picture over a 3-Mc/s link, is such as to render the picture unacceptable. On the other hand, the distortion suffered by a 405-line picture transmitted over a similar link is scarcely visible. If the international exchange of programmes is to be put into effect, it is highly unlikely that links having a bandwidth greater than 3 Mc/s will be practicable, and the advantage to be gained by using a standard which will suffer no distortion due to this limitation is obvious, particularly when it is realized that the quality of the "local" picture is virtually unaffected by the choice.

Finally, it has been demonstrated that with a 3-Mc/s bandwidth and with 405 lines a highly satisfactory picture of very good definition can be produced even with the limitations of the present-day techniques. It is expected that an even better result will be obtained in the near future.

To summarize, it is considered that with the means which are now available, the capabilities of 405-line television will be fully exploited, and that when this has been accomplished, any small improvement that might be obtained by increasing the number of lines will be offset by the difficulties which will be encountered in maintaining the wider bandwidth required and in ensuring that the degree of overall distortion does not exceed the more stringent limits of tolerance. Without a substantial increase in bandwidth, nothing can be gained, and with the increased bandwidth the flexibility of the broadcasting system in terms of national coverage, exchange of programmes, and the improvization of outside-broadcast links might be adversely affected to a serious extent.

Impedance of R.F. Cables

Explaining Why Length Has Nothing to do With It

By "CATHODE RAY"

NOW that television is going ahead in a big way, more and more people are having to become acquainted with the fact that for connecting the aerial to the set one cannot just use any old bit of wire. One has to use a special sort of "feeder" cable, and it must have the right impedance. Now this is where I feel downright sorry for a lot of people. They have spent their youth learning Ohm's Law and getting used to the idea that the longer the wire the greater its resistance, and that impedance is the same sort of thing as resistance but applies to a.c. and is rather more complicated, but that undoubtedly the length ought to have a great deal to do with it. So when they are told that such-and-such television cable has an impedance of 80 ohms it is natural to ask "How long? Per 100 feet?" and it is grieving to be rewarded with a stare of contempt or derision.

Even if it is explained that the figure referred to is the *characteristic* impedance, it still doesn't seem to make sense that the length has nothing to do with it. If it is added that the resistance of the wire of which the cable is composed, and the frequency at which it is used, also have little or nothing to do with it, the mystery thickens. It may seem to clear when it is further explained that characteristic impedance is the impedance between the two conductors at one end when the other end is connected to an impedance of that value. Obviously, then, the resistance of the conductors is being neglected (which usually happens to be true), and it is the impedance at the other end that counts! But the newly-won self-esteem is liable to be punctured by the further disclosure that raising the impedance connected at the far end to, say, 160 ohms, may *reduce* the impedance measured at the near end to as little as 40 ohms, and that the characteristic impedance is still 80 ohms.

Any whose inquiries have taken them to that point and are tempted to give up are invited to have one more go and read on.

When first tackling this problem of r.f. cable impedance one might argue something like this. The capacitance between conductors in a typical coaxial television cable is 22pF per foot. So in a 100-feet length it would be 2200pF; and at the Sutton Coldfield frequency—say 60 Mc/s—that works out at 1.2 ohm. One would therefore expect nearly all the r.f. current from the aerial to be short-circuited through this capacitance, leaving very little to go into the receiver at the far end.

The flaw in this argument is the ignoring of inductance. One tends to think of inductance as something associated with coils, and of putting the out-going and return wires of a circuit close together as the best method of eliminating the small trace of inductance one does get in a straight wire. But at frequencies high enough to make the capacitance important, the small uneliminated inductance is important, too.

There are formulæ and graphs showing the capacitance and the inductance per foot or per metre of parallel-wire and coaxial cables, in terms of the diameters and spacings of the conductors, and of the permittivity of the spacing material if any. So finding the capacitance and inductance of a given length of cable is easy. The difficulty arises when it comes to calculating how they affect a signal passing through the cable, because although the inductance is in series and the capacitance is in parallel they are not in separate lumps but are thoroughly mixed up with one another all the way along. If we tried to reckon by ordinary circuit methods we would be faced with the question of whether to place them between generator and load as in Fig 1(a) or as in (b). It would make a lot of difference to the result. Neither, in fact, would give anything like the correct answer.

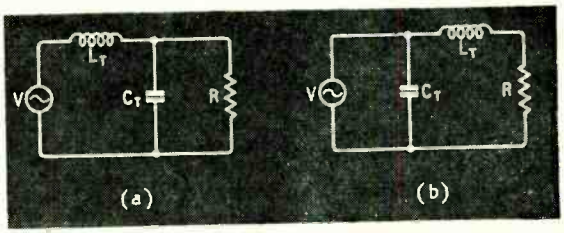


Fig. 1. Neither of these attempts to treat the total inductance and capacitance of a cable, L_T and C_T respectively, as components in a circuit is successful. They have to be chopped up small, as in Fig. 2, to simulate their distribution along the cable.

Fig. 2. Approximate electrical representation of a length of cable inserted between an a.c. generator (such as a television aerial) and a load resistance R (such as a receiver input).

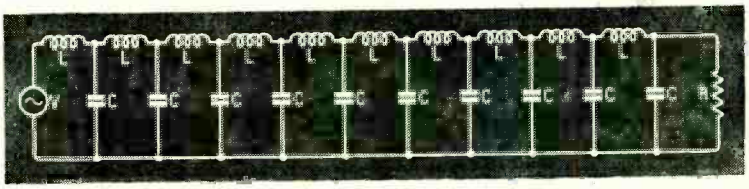


Fig 2 is a nearer approach to reality. It is even better in principle than might appear at first sight, because by splitting the whole inductance and capacitance into sufficiently small units we can get as near to the correct answer as we want. But of course the smaller the L and C units the more there are of them, and the calculation looks hard enough with two or three.

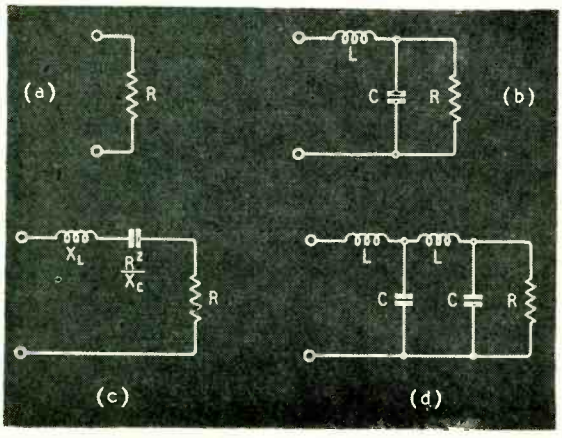
Readers who managed to follow my article on filters in the January 1950 issue may remember that the type of filter we concentrated on was the type shown here in Fig 2, and that the input impedance (Z_0) of an infinitely long chain of such sections was found to be $\sqrt{\frac{L}{C}}\sqrt{1-\frac{\omega^2 LC}{4}}$. So instead of the subdivision of L and C making the thing impossibly difficult, it actually makes it easier, because the mere assumption that they are infinitesimally small makes $\omega^2LC/4$ negligible; consequently the rather formidable term $\sqrt{1-\omega^2LC/4}$ becomes equal to 1, as near as makes no matter; and we are left with $\sqrt{L/C}$. The ratio of L to C in a uniform cable obviously does not depend on how little or how much of the cable is included, so it can be calculated or measured. And, as we saw in connection with filters, the infinitely long tail can be broken off anywhere and a concentrated impedance equal to Z_0 substituted for it without making any difference at the input end.

But if you think that picking out a formula from the middle of a previous and not particularly easy article is cheating, I quite agree with you; and to play fair I will now offer an alternative and much easier solution, starting more or less from scratch.

Actually we start from the receiving or load end and work backwards. For simplicity let us assume that the load to be fed by the cable is just a resistance, R, and that we reserve the right to make it any value we like. Fig 3(a) is a picture of it.

Suppose now that we have a very small capacitance, C, in parallel with R, and a very small inductance, L, in series with it, as in Fig. 3(b). The usual procedure in tackling a circuit like this is to replace C and R by their series equivalents; the circuit will then consist of three items all in series, which is quite easy. It happens that when the reactance of C is very much larger than R the formulae can be greatly simplified. The equivalent series resistance is practically equal to R, and the equivalent series capacitive reactance is equal to R^2/X_c (where X_c is the reactance of C). So we can replace Fig. 3(b) by (c) (X_L being, of course, the reactance of L).

Fig. 3. How Fig. 2 can be built up, using the principle of equivalent circuits.



Now if the two opposite reactances in series happen to be equal, they cancel one another out, in accordance with the well-known principle of tuned circuits, and we are left with Fig. 3(a). Let us investigate the condition for the two reactances being equal; that is to say

$$X_L = \frac{R^2}{X_c}$$

X_L is of course $2\pi fL$ and X_c is $1/2\pi fC$, so substituting these we get

$$2\pi fL = R^2\, 2\pi fC$$

which simplifies to

$$L = R^2C$$

$$\text{or } R^2 = \frac{L}{C}$$

$$\text{or } R = \sqrt{\frac{L}{C}}$$

Provided that we give R this particular value, then, the circuit shown in Fig. 3(b) appears to any measuring instruments connected to the terminals to be identical with Fig. 3(a), regardless of frequency. Though I say regardless of frequency, there is just this qualification—we must remember that the above result was obtained on the clear understanding that X_c is much larger than R. Suppose, for example, that R is 500Ω, C is 1 pF, and f is 1 Mc/s. Then X_c is about 150,000Ω, which one can reasonably say is much larger than R. But at 300 Mc/s it is only about 530Ω, which certainly is not. All we have to do to make matters right at the highest frequency we are likely to need is to make C a million times smaller.

Next, having found that the input impedance of Fig. 3(b) (when $\sqrt{L/C} = R$) is equal to R, we can substitute such a circuit for its own R, as in Fig. 3(d). The input impedance of this circuit is still equal to R. There is no reason why this substitution process should not be repeated as many times as we like (e.g., Fig. 2); as many times, in fact, as is necessary (even when each L and C is very small indeed) to build up the electrical equivalent of a cable. Thus we can say that the input impedance of such a cable would always be the same, regardless of its length and the frequency, provided that its far end was connected to a resistance equal to $\sqrt{L/C}$; and that this input impedance would also be equal to $\sqrt{L/C}$, and would apparently be a resistance. This is what is called the characteristic resistance, denoted by R_0.

It is, of course, purely a characteristic of the cable. The R at the far end, to which R_0 is equal, can be regarded as a substitute for an infinite length of cable, or succession of L and C units. L and C depend, as we have seen, on the diameters and spacings of the conductors, and on whether there is any material between them to increase C by its permittivity, κ. Thus, if C is, say, 20 pF per foot and L is 0.072μH per foot, R_0 is 60Ω. L and C can be calculated in terms of the conductor spacing and diameter, and from them are derived the curves in Fig. 4, giving R_0 for air-spaced lines of the two main types.

The only electrical difference between a real cable and our synthetic variety is that the real one is bound to have some resistance as well as inductance and capacitance. Oddly enough, introducing resistance into our Fig. 2 "cable" (made up entirely of re-

actances) has the effect of introducing reactance into our purely resistive R_0. So for a real cable one must, in strict accuracy, refer to its characteristic *impedance*, Z_0. But theory and experiment both prove that in good r.f. cables the loss resistance has very little effect on the characteristic impedance, so in this particular connection we shall continue to neglect it, and take R_0 as being a close enough approximation to Z_0.

Although Fig. 3(b) and (d) and Fig. 2 are all equivalent to Fig. 3(a) so far as can be detected by anything connected to the input terminals, they are not, of course, equivalent in every way. Consider the three-stage system shown in Fig. 5(a) connected to an a.c. generator. The substitition seen in Fig. 3(c) proved that the voltage across R in Fig. 3(b) is the same as that across the input terminals ; and of course the same holds good every time the process is repeated. So as regards magnitude, $V_1 = V_2 = V_3 = V_0$ in Fig. 5(a). This can only happen if there are phase differences between them, as shown in the vector diagram. Since the combination of C and R differs little from a resistance, the phase difference introduced by L is bound to be a lagging one. If, now, we suppose L and C to be very small and very numerous, the vector diagram approximates closely to a circle, in which the voltage is the same in magnitude wherever it is measured, but its phase changes in small jerks as the voltmeter is moved along. In the limit—a cable, for example—the voltage vector rotates continuously.

Time Delay

The physical meaning of this phase effect is that when the generator starts to generate at the input end, the voltage (or current) takes time to progress along the cable to the other end. True, it takes remarkably little time. It travels along an air-spaced line at very nearly the regulation 186,240 miles per second for electromagnetic waves in space. Along a solid-filled cable it is usually about 40 per cent, slower, but this still represents quite a useful turn of speed. However brief the period of the journey, the interesting thing to ponder is that during that period the generator is not in touch with the terminating resistance, R, at all. It has absolutely no means of knowing whether the condition $R = \sqrt{L/C}$ is fulfilled or not. So far as it, or you, or I can tell, somebody may have forgotten to connect R. Consequently, during the time the wave of current is travelling along the cable, R can have nothing whatever to do with how much current the generator is pushing into the cable. That can be determined only by $\sqrt{L/C}$, or R_0. If, then, the cable happens to have an R_0 of, say, 100Ω, and the terminal voltage of the generator is 200V (r.m.s.), the r.m.s. current must be 2A, no matter what is connected or not connected at the far end. And, since R_0 is a resistance, this current must be in phase with the voltage, so the generator is supplying power. During this short period before anything is coming out at the far end, the power is going exclusively into creating a pattern of electric and magnetic fields speeding along the line. For simplicity we shall assume that the generator waveform, and consequently the pattern, is sinusoidal.

This transient period can be likened to the situation in which some people find themselves, of having to pay income tax before the exact amount due has been agreed. In such cases it is necessary to make a tentative payment, subject to adjustment later if it should be found to be wrong. Similarly the generator has to pay current into the line before it knows how much the load resistance is due to take. Ohm's Law is, as it were, held in suspense until the current gets to the load.

If, when it does so, it finds that the load *is* a resistance, and that the ratio of line voltage to current happens to be equal to it (that is to say, $R = R_0$), then Ohm's Law is fulfilled. Our 2A passing through the 100Ω load sets up a back pressure of 200V, which exactly balances the line e.m.f. The power coming out of the cable is absorbed by the load at exactly the same rate as it is being pushed in at the generator end. The only effect of the cable, assuming it introduces no loss, is the time lag.

But if, when our 200V 2A arrives, it finds the load resistance is, say, 300Ω, then that's awkward. The breach of Ohm's Law is too gross to be concealed. Something will have to be done about it. Unlike the income tax collector, who may leave the taxpayer to find out for himself if he has paid more than he need, load resistances are infallible. A 300-ohmer is constitutionally incapable of accepting 2A under a mere 200V pressure. When, as in this case, an attempt is made to compel it, the back pressure across it

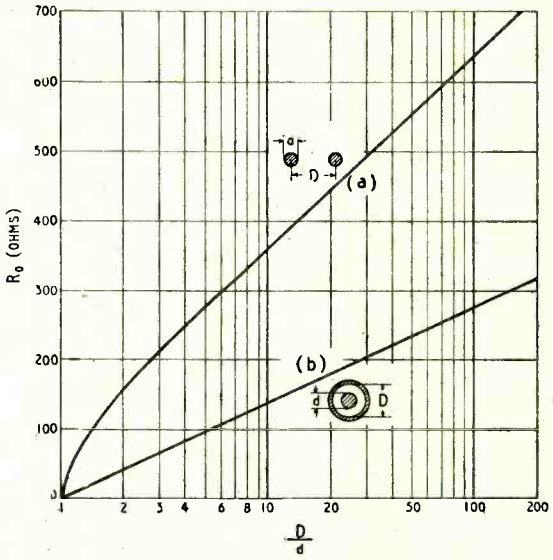
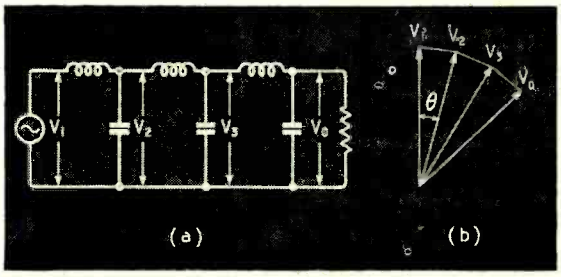


Fig. 4. Graphs of characteristic resistance (R_0) of air-spaced parallel-wire and coaxial cables in terms of their cross-sectional dimensions.

Fig. 5. (a) A few sections of Fig. 2. (b) Vector diagram of the circuit of (a).



rises above 200V and starts sending current back into the line in opposition. This back current reduces the current flowing into the load and so eases the situation. Since the cable (looking back towards the generator) is equivalent to a resistance of R_0 ohms, the ratio of the surplus voltage to the returned current must be equal to it. This is a very simple problem in algebra. Let I and V stand respectively for the current and voltage the generator is sending down the line. We know V/I must be equal to R_0. Let i stand for the returned current and v for the surplus needed to return it. So v/i is also equal to R_0. The net current going into the load $(I - i)$, and the total voltage across it $(V + v)$, must fulfil Ohm's Law. So $\frac{V + v}{I - i} = R$. Solving these simultaneous equations, we get

$$\frac{i}{I} = \frac{v}{V} = \frac{R - R_0}{R + R_0}$$

In our example, I = 2A, V = 200V, R_0 = 100Ω, and R = 300Ω. So i = 1A, and v = 100V. The voltage across the load, $V + v$, is 300V, and the current into it, $I - i$, is 1A, which is correct for 300Ω. The power arriving is 2 × 200 = 400 watts, and the power returned is 1 × 100 = 100 watts; so the power going into the load is 300W, which is the same as the figure one would get by the alternative process of multiplying $V + v$ by $I - i$. And so the discrepancy is put right, for the time being at any rate, in strict accordance with all the rules.

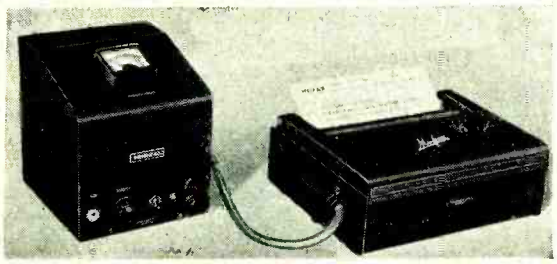
But it is by no means the end of the matter. Let us go back to the generator and study its reaction to the windfall when it arrives. Unless its own resistance happens to be the same as the cable's R_0, it cannot accept the return in full. (Unlike some taxpayers, an electrical generator's honesty is beyond reproach.) In our example, a generator resistance (denoted by r) equal to 100Ω would mean that its e.m.f. must be 400V in order to have maintained 200V at the terminals of the 100-Ω cable during the period before the return of the surplus power. In such a case, this returned power would be completely accepted by the generator and the net outgoing power would be 400 − 100 = 300W; equal to that being taken by the load. On a power basis this is delightfully neat and easy. But the phase lag due to the cable is likely to play Old Harry with the voltage and current. This is really a subject in itself, which will have to keep till next month.

NEW FACSIMILE EQUIPMENT

British System Employing Electro-Sensitive Recording Paper

Self-contained receiver, producing pictures 11 inches wide, requiring only an a.c. mains supply and connection to source of signals (land-line or radio).

"Mufax" telegraph receiver for high-speed facsimile reproduction of line drawings, typescript, etc.



THE photo-telegraphic transmitters and receivers developed by Muirhead & Co., Beckenham, Kent, have already established a reputation for high picture quality, and are used in many leading newspaper offices abroad, as well as in this country.

A less expensive system employing electro-sensitive paper has been evolved for small newspapers and gives resolution ample to their needs. No developing or processing is necessary and the formation of the picture can be observed in full daylight. The paper (which is supplied in 100-ft rolls) is treated with electrolyte which is voltage-sensitive and produces a blue-black stain when a current passes through it. The lines are scanned by a rotating wire helix mounted on a horizontal roller behind the paper, which is pressed forward against a knife edge. The point of intersection between the helix and the knife edge travels rapidly across the width of the paper at each revolution, and as it does so a modulated current is passed through the "contact" point.

The value of this new development to newspaper staffs is that pictures can be appraised and the necessary alterations to make-up set in motion before the picture is actually finished. Also a continuous record of all pictures arriving by wire or wireless is available.

In addition to complete and self-contained "Mufax" receivers giving pictures 11 inches wide, there is a monitoring attachment, giving the same size of picture, for Art Editors' desks, and a smaller monitor for mounting on the receiver rack of existing Muirhead photo-telegraphic installations. All the new machines conform to C.C.I.T. standards and operate from 200-250 V, 50 c/s mains.

Another interesting development along these lines is the "Mufax" telegraph transmitter and receiver, which give picture quality suitable for reproducing diagrams, handwriting or typescript at much higher speed. The system has great possibilities for the exchange of information between branches of engineering works, banks, meteorological services where facsimile diagrams of formulæ, signatures and maps can be of greater value than the spoken word. The time of transmission of a diagram 28 sq in in area is only 90 seconds, scanning 100 lines to the inch at 4 revolutions per second.

Sound Reproduction

Equipment at the B.S.R.A. Exhibition

THE Exhibition organized by the British Sound Recording Association in London on 20th and 21st May was supported by twenty-two firms. The large attendance of visitors, at both the Saturday and Sunday sessions, provided further proof—if such were needed—of the widespread interest in high-quality recording and reproduction, and of the community of interest between the amateur and the professional in this field.

The firms exhibiting represented a very fair cross-section of recording and audio engineering, and in addition to disc, magnetic wire and tape and film recorders there were many examples of amplifiers, loudspeakers, pickups, microphones and the more basic components of a.f. equipment.

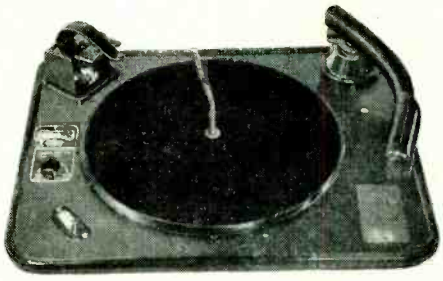
Long-playing Records.—Considerable interest was shown in apparatus for long-playing records in view of Decca's announcement that their 33⅓ r.p.m. pressings (hitherto available only for export under the name "London") would be on the British market within a matter of weeks. Giving 20 to 22 minutes' playing time per side, the Decca Gold and Red label 12-in discs have been provisionally priced at 37s 6d and 32s 6d each (actually a lower cost per minute than 78-r.p.m. recording), while "Brunswick" and "Capitol" 10-in records will be about 23s each. The records are pressed in polyvinyl resin ("Geon") and have a remarkably low surface noise; this is an essential prerequisite of microgroove recording, since with restricted maximum amplitude, the dynamic range can be maintained only by extending the lower limit into the region hitherto occupied by surface noise.

A wide range of equipment—from a simple 33⅓ r.p.m. open playing desk, for use with existing amplifiers and radio receivers, to a "Decola" high-fidelity reproducer fitted with alternative 33⅓- and 78-r.p.m. record-playing facilities—was shown by Decca. Crystal-type pickups with 0.001-in radius sapphire styli are used in the single-speed playing desks, and interchangeable magnetic pickups, suitably colour-coded for stylus radius, are provided with the two-speed motors. The weight of the head in conjunction with a spring-counterbalanced tone arm automatically provides the correct needle pressure. To protect both stylus and record, a spring-loaded roller safety device is incorporated in the new long-playing pick-up head. For the "Decola" a special transcription quality turntable has been developed, and another new production is the two-speed record changer taking ten 10-in or 12-in records mixed, which is fitted in the Decca Model 92 radio-gramophone.

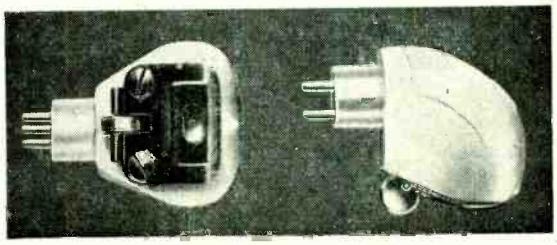
For some time now Garrard have been making gramophone motors, record changers and pickups for long-playing records, but these have been exported to America. Now that records are available, the Garrard models will be marketed also in this country. Among the machines shown on their stand at this exhibition were Model SM, a simple three-speed turntable for 33⅓, 45 and 78 r.p.m., Model M, on similar lines, but with provision for interchangeable pickups, and Model RC80, a most versatile record changer designed to play no fewer than six different types of record, including the 7-in 45 r.p.m. R.C.A. type with large centre hole. Model RC72 is a less expensive changer which is a modification of the RC70, with redesigned trip mechanism and a tone arm designed to accommodate a wide variety of pickup heads. As a record changer it will play 10in or 12in records (not mixed) at 33⅓ or 78 r.p.m. or 7in records singly at 33⅓ and 45 r.p.m.

Disc Recording.—The high standard of design and finish in direct disc recording equipment of British manufacture was well exemplified by this exhibition.

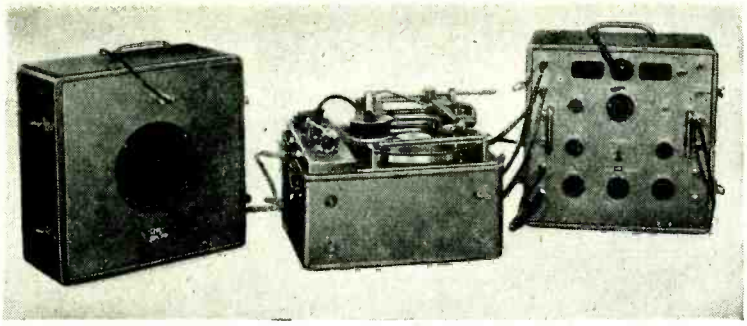
Studio and portable equipments for the professional were shown by M.S.S. Recording, who have introduced a new type (PR/6) with a specification intermediate between the simple 4-watt Type PR4/C



Garrard Model RC72 record changer for 10-in or 12-in 33⅓ or 78 r.p.m. discs. Single records of 7-in diameter or 45 r.p.m. can be played.



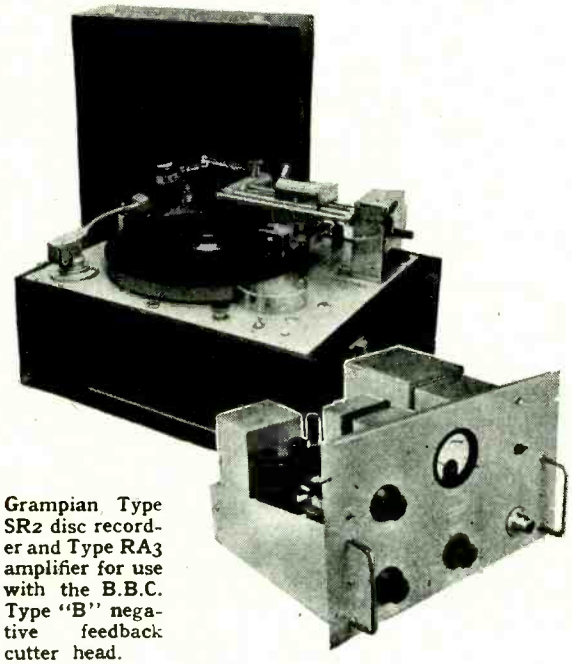
Decca record changer for standard or long-playing records fitted in the Model 92 radio-gramophone and pickup for long-playing records showing roller safety device. Pickups are colour-coded for stylus size.



M.S.S. 10-watt portable disc recording equipment, Type PR/6.

combined recorder and player and the 30-watt twin-turntable Type SP/2/1 studio portable equipment. The Type PR/6 has a 10-watt output, is substantially flat to 10 kc/s and can be adapted for micro-groove recording if required. Two microphone channels with separate controls are provided and the output can be switched to either of two machines for continuous recording. Facilities are provided for automatic radius compensation when making long-playing records.

Another interesting development shown by M.S.S. is in connection with speech therapy. The use of recording in the treatment of speech defects has been known for some time, but one of the difficulties has been the introduction of distortion through playing back at a level differing from the original sound. The consequent modification of the tonal balance due to the Fletcher-Munson characteristics of the ear can cause serious confusion and delay the rate of recovery. In the Type STR/1 equipment, developed in co-operation with the Moor House School, Hurst Green, Oxted, the recording microphone is used to monitor the playback in conjunction with simple controls and a level meter calibrated in decibels.



Grampian Type SR2 disc recorder and Type RA3 amplifier for use with the B.B.C. Type "B" negative feedback cutter head.

Grampian Reproducers were showing their Type SR2 disc recording machine, which can now be supplied with a negative feedback cutter head made to the specification of the B.B.C. Type "B" head. The Grampian Type RA3 rack-mounting amplifier has been developed for use in conjunction with this head and gives provision for up to 30 db of feedback. Frequency response is up to at least 20 kc/s with distortion only 0.5 per cent at 1,000 c/s at normal recording levels. Power outputs of 40 and 70 watts are available from the RA3 and RA3A amplifiers respectively. A 10-watt recording amplifier is also available (Type RA2), with four input channels and a built-in monitoring and playback loudspeaker.

A wide range of equipment and accessories for disc recording on the stand of Simon Sound Services included a professional recording console for film studio work as well as a twin-channel transportable system with four-channel electronic mixer unit, and provision for operation from 12-V d.c. supplies.

Although not a disc machine, the "Memobelt" recorder shown by Dictaphone can be conveniently considered under this heading. It is essentially a business dictating machine and makes use of a flexible band of ethyl cellulose, 12in in circumference and 3½in wide on which the sound is recorded by swaging in a continuous helical groove. The groove pitch is 200 per inch and a playing time of 15 minutes is provided by each record. Both the recording and transcription machines are remarkably compact and contain all the relevant amplifiers, etc. Continuous recording apparatus is also available, and a time-speaking clock for interjecting time intervals between messages—say, in records of air traffic control—was demonstrated.

Magnetic Recording.—Wire recorders were shown by Wirek (Electronics) and Simon Sound Service. The Wirek Model "B" is designed for recording music as well as speech and has a frequency range of 70 to 7,000 c/s ±3 db with a linear wire speed of 2ft/sec. A heavy capstan flywheel gives constancy of speed and in the case of the Model "B1" is surmounted by a 78 r.p.m. turntable and pickup for recording from discs. Control is by means of a series of interlocked push-button switches. A lightweight version (Model "C") has been developed for business dictation and a complementary transcribing machine is available.

No fewer than seven firms were showing tape recorders. Samples of the new G.E.C. magnetic tape, made in two grades, were on view with full information regarding characteristics, and the G.E.C. console high-quality tape recorder was shown. This is fitted with three heads and separate amplifiers for recording and reproduction.

Wright and Weaire gave demonstrations of the British Ferrograph tape recorder. This machine makes use of the "Tape Deck" and records two tracks side by side on standard ¼-in tape.

At 3¾in/sec the playing time is two hours with a frequency response of 70-4,000 c/s, while at 7½in/sec the response is 70-8,000 c/s, ±3 db, with an hour's duration. In one demonstration a comparison

British Ferrograph magnetic tape recorder incorporating the Wearite "Tape Deck."

machine was fitted with two identical amplifiers to give instantaneous changeover switching between an incoming radio programme and the same signal immediately after recording on the tape; there was no apparent difference either in quality or background noise. Another machine was modified to record simultaneously on the twin tracks, and excellent stereophonic effects were obtained, using two microphones with separate amplifier channels.

A business dictating machine, the "Recordon," using a spiral track on a disc of flexible oxide-coated material, was shown by Thermionic Products, who were also demonstrating their "Soundmirror" tape recorder. This is a versatile self-contained machine with an 8-in p.m. loudspeaker and a high-quality non-directional microphone, and is made either as a portable or with polished wood finish for the home.

The tape recorder developed by Simon Sound Service is interesting, among other reasons, for the fact that alternative tape speeds of $7\frac{1}{2}$ and 12in/sec are provided. The latter is a non-standard speed, but has been chosen to give a substantial extension of high-frequency response above the limit of 7 to 8 kc/s usually associated with $7\frac{1}{2}$in/sec, without reducing playing time, with standard spools, below the 20 minutes considered optimum for long-playing musical recordings.

A "personal" tape recorder operated entirely from dry batteries and weighing only 15lb was shown by Wirek (Electronics). It is designed for reporters and commentators and has an endurance of 10 minutes at 15in/sec (the speed required for immediate playback on studio equipment). The "Reprocorder" made by the same company is a mains-operated general-purpose recorder with the three standard tape speeds of $3\frac{3}{4}$, $7\frac{1}{2}$ and 15in/sec and is substantially built for continuous professional use.

Sound on Film.—This branch of sound recording was ably represented by the exhibit of Leevers, Rich and Company, who specialize in studio and mobile recording on 35 mm and 16 mm film. In addition to direct photographic recording on film this firm has developed a transportable magnetic recorder for high-fidelity pre-recording of film sound effects, for subsequent printing on the edited film. Both recorder and film camera can be operated independently from batteries, and a system is being developed in which a synchronizing tone generated by the camera will be recorded alongside the sound track on the magnetic tape.

Also shown was a neat hand-operated sound track reader, for editing film, with a self-contained light source, photocell, amplifier and loudspeaker. A number of interesting test films for both sound and vision in 16 mm equipments were demonstrated.

ACCESSORIES AND COMPONENTS

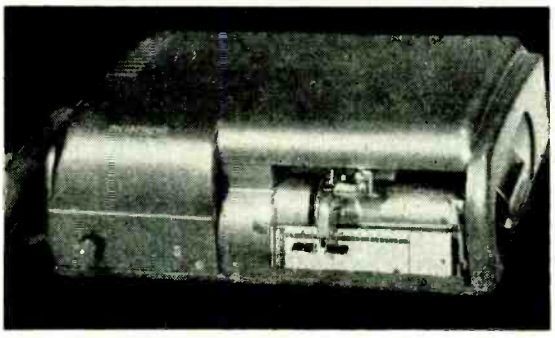
Components for the amateur constructor of tape recorders were the centre of attraction in the exhibit of Audigraph, Ltd. These included tape heads for recording, playback and erasure, coils for bias oscillators, etc. Also shown were complete recording and playback amplifier units and prototypes of tape mechanisms and complete recorders.

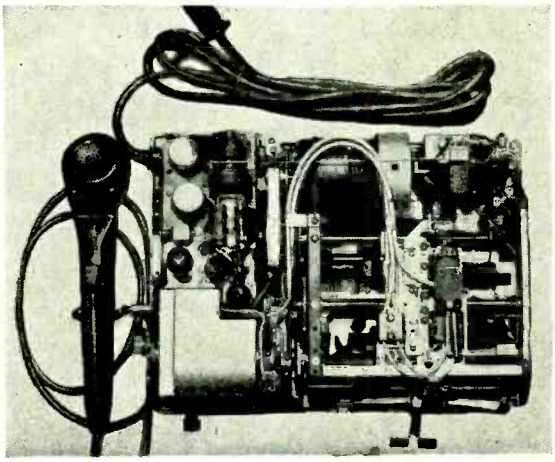
Well-made audio-frequency and mains-frequency iron-cored components formed the exhibit of R. F. Gibson, who showed a wide range of designs in a variety of tropical finishes—including the latest solventless varnishes. Also shown were screened pickup and microphone transformers and an output transformer to the specification of D. T. N. Williamson.

Loudspeakers.—A very wide range of types was covered by the half-dozen firms showing loudspeakers. These ranged from cone chassis to complete cabinet reproducers.

From the comprehensive display of Wharfedale units we noted the Super 12/CS/AL and Super

Dictaphone Model TMT telephone recorder and dictating machine. The electromagnetic microphone serves also as a miniature loudspeaker for playback.





8/CS/AL. These loudspeakers have low fundamental resonances and the cloth surrounds provide effective damping at the cone periphery; speech coils are aluminium-wound, and coil apexes are bakelized.

Grampian Reproducers showed a 12-in permanent magnet unit (Type 3512/15) with curvilinear cone capable of handling 15 watts and with a very good axial response curve. The Vitavox display, in addition to giving full information on the "Klipschorn" horn-loaded corner cabinet, included many examples of pressure units and multicellular horns for public address work.

Among high-quality reproducers the "Corner Ribbon" shown by the Acoustical Manufacturing Co. created considerable interest and discussion. Decca were showing a sectioned model of the dual concentric horn unit used in some of their record-playing equipment and also a new corner horn incorporating one of the latest Wharfedale 8-in units.

Microphones.—Much progress has been made in the reliability and sensitivity of microphones of the moving-coil and ribbon types, and this has been due in no small measure to the adoption of new methods of pressing one-piece Duralumin diaphragms of extreme thinness.

In the Grampian Type DP1 moving-coil microphone the diaphragm and aluminium coil weigh only 560 milligrams, and acoustic cavities are formed in the die-case spherical housing to produce a level response between 60 and 9,000 c/s.

Another interesting design at the Show was the Reslo Type RV ribbon microphone in which the output is maintained at a high level, though the overall size has been very considerably reduced; the cylindrical case measures only 2in in diameter and 2⅜in long. The ribbon is only 2 microns thick, but can be easily replaced as it is mounted in an interchangeable bakelite sub-frame. Response is flat within ±2 db from 40-8,000 c/s.

Amplifiers.—The 12- and 25-watt audio amplifiers made by H. J. Leak were the subject of considerable interest, not only for their performance but also for the high standard of workmanship in their construction. Feedback is applied over three separate paths and a stable amplification, level within ±0.1 db between 20 c/s and 20,000 c/s, is obtained. The amplifier is, in fact, being sold as a stabilized-gain laboratory instrument, as well as for high-quality recording and reproduction in which the low average distortion (0.1 per cent) fully meets modern requirements. A single-valve remote-control pre-amplifier with tone control effected by non-resonant negative-feedback circuits was also shown.

Recent modifications to the design have increased the frequency range of the Grampian Model 491 (10-watt) and 492 (4-watt) amplifiers for record reproduction and they now cover 50 to 20,000 c/s with distortion at full power of less than 1 per cent. It was also announced that a kit of parts for a 15-watt amplifier is being put on the market by Grampian Reproducers, together with full constructional details.

G.E.C. were showing a "quality" version (BCS2430) of their standard 30-watt P.A. amplifier in which a response flat from 40 to 12,000 c/s is obtained with less than 0.4 per cent distortion.

Test Equipment.—A comprehensive display of measuring gear for audio-frequency work was exhibited by Dawe Instruments and included their Type 1400 sound level meter, the Type 400 series of wide-range RC oscillators, the Type 6138 valve voltmeter (1 mV to 300 V, 10 c/s to 1.5 Mc/s), and a high-speed level recorder (Type 1406) for microphone, loudspeaker and amplifier frequency characteristics. The record is made by a stylus point on 50 mm waxed paper, and full traverse of the pointer occupies only 0.12 sec. Either linear or logarithmic scales can be recorded and the response is flat from 50 c/s to 200 kc/s ±1 db, or 500 kc/s ±3 db.

RECORDING VANS

Mobile sound recording vans visited the exhibition and were on view in an adjoining street. They provided a striking demonstration of the importance of recording in broadcasting and in the film industry.

The B.B.C. were showing the eight-channel recording van designed for the simultaneous recording of sports commentaries in foreign languages. First used in conjunction with the 1948 Olympic Games, this van is equipped with eight wire recorders, each remotely controlled by switches incorporated in the associated microphone. Cue lamps are mounted on each microphone and indicate that the machine is working; also that the supervising engineer wishes to talk to the commentator, which he can do by using the commentator's electrodynamic microphone as a loudspeaker.

Radio Luxembourg showed a recently completed recording van which is designed primarily for concert and theatre work. It was supplied by E.M.I. Factories and contains two BTR/1B studio-type magnetic tape recorders, and a disc recording machine by S. G. Brown.

Sound tracks for film have to be recorded at places remote from mains, and in the Associated British Pathe van a 60-volt battery with a capacity sufficient for two days' working is carried. This van, which is equipped with the latest R.C.A. sound-on-film camera, can be blacked out for film changing. Comprehensive equalization and volume compression circuits are provided, and the latest type of galvanometer, biased for noise reduction, is used in conjunction with ultra-violet light exposure.

Comprehensive power supplies—including batteries—are also a feature of the Leevers-Rich mobile recording unit, which incorporates an acetate disc recorder in addition to a 35 mm studio-type film recorder with bilateral variable area track. Designed for hire work, this van is very fully equipped with cables, microphone booms, intercomm telephones and all the paraphernalia inseparable from film recording.

VALVE VADE MECUM

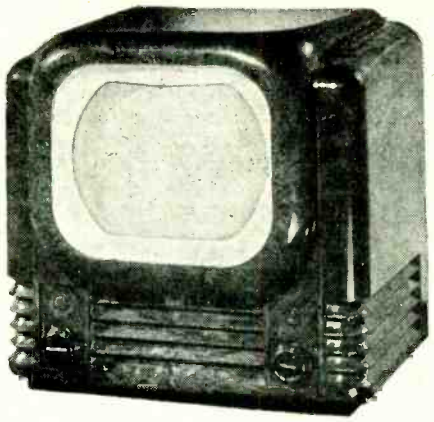
PUBLISHED in Antwerp by P. H. Brans the Vade Mecum has expanded edition by edition and has now become one of the most comprehensive valve data books available. In this 8th edition the general index, data tables and valve bases are contained in a single volume which, in many respects, is more convenient than the two volumes of the past few editions.

The total number of valves listed cannot be less than 15,000. Most of the latest types of British, Continental and American valves are included and details are given of special television valves, c.r. tubes and of some of the rarer types of valve, such as nonodes, phasitrons, and accelerometers. In all there are some 508 pages of valve data.

Copies of the 1950 Vade Mecum can be obtained from Bailey Bros. and Swinfen, Ltd., 26-27, Hatton Garden, London, E.C.1, and the price is 24s including postage.

All-Station Television Receivers

Adjustable Tuning in New Bush Models



Bush Radio Model TV22 television receiver.

THE most striking feature of the new Bush Radio sets is that they are provided with adjustable tuning so that they are suitable for any station in the television band. The same model is, therefore, suitable for any district and in the areas of overlap between two stations, the choice between the two can be effected by a trial on site. The sets are available in two forms—a table model (TV22) with a 9-in tube and a console (TUG24) with a 12-in tube. Apart from the difference of tube size the receivers are identical.

The set is a superheterodyne having two signal-frequency circuits and an oscillator circuit. The latter is tuned by a movable composite core, part metal and part dust-iron, so that at one extremity the inductance is reduced and at the other it is increased. This is adjusted by a knob at the back of the set and it is necessary only to turn the control for maximum sound signal. The signal circuits are similarly variable by movable cores, but are of the screwdriver-adjustment type accessible at the back of the set. They are adjusted after the oscillator for maximum vision signal. The aerial used must, of course, be appropriate to the desired station.

The circuit of the frequency-changer is unusual in that a pentode is used as a combined oscillator and mixer, as shown in Fig. 1. The signal-frequency circuits are L_1 and L_2 and the oscillator is L_3, being a Colpitt's circuit with the valve capacitances acting to provide the capacitive tap for the cathode. The signal from the r.f. valve V_1 is fed into L_3 at a nodal point to minimize coupling between L_2 and L_3. The i.f. output at 19.5 Mc/s for sound and 16 Mc/s for vision is taken from the anode of V_2, the tuned circuit being L_5 and circuit capacitance. C_1L_4 is a trap tuned below the vision channel to eliminate possible interference from the sound channel of an adjacent transmitter.

The vision i.f. amplifier has two stages, the first being common to both vision and sound channels and having a combined sound-channel rejector and sound pick-out circuit. There are a diode detector, one v.f. stage, feeding the cathode of the c.r. tube, and a diode noise limiter.

On the sound side there are two i.f. stages, the first having a.g.c. bias, a diode detector, a series-diode noise limiter, and a pentode output stage.

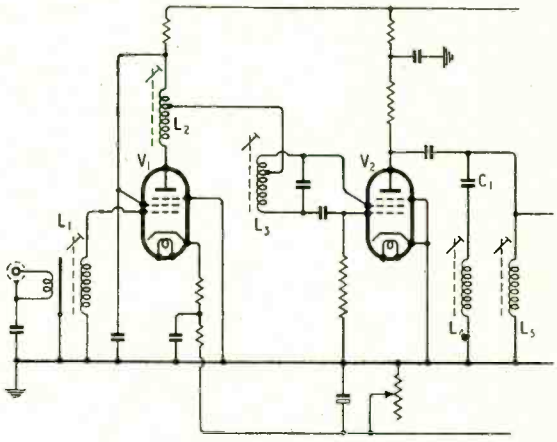
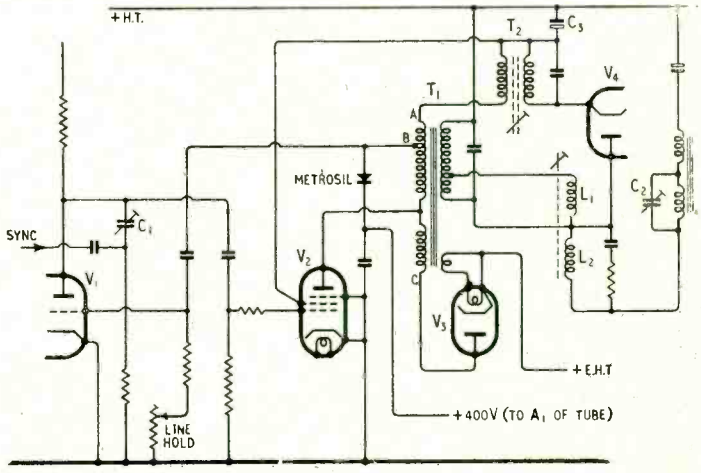


Fig. 1. The signal-frequency and oscillator circuits are shown here. A single-valve pentode frequency-changer is used with the screen-grid acting as the anode of a Colpitt's oscillator.

Fig. 2. This diagram shows the line-scan circuit which includes a current-saving diode V_4. It also provides h.t. boost. The first and second anodes of the tube both derive their voltages from the line fly-back



In the synchronizing and scanning circuits economy is effected by using triode pentodes. In one the pentode section acts as a sync separator while the triode is part of the line time-base and in the other the triode is the frame blocking oscillator and the pentode the frame-scan output valve.

The line output valve and the triode referred to above form a multivibrator for generating the line saw-tooth. This is shown in Fig 2, and it will be seen that V_1 and V_2 form a normal type of multivibrator; C_1 is the capacitance across which the saw-tooth is developed, and is adjustable as an amplitude control, while R_1 provides a sharp pulse on fly-back. The total voltage across A and C of the transformer T_1 reaches about 9 kV on fly-back and is rectified by V_3 for the tube supply, the reservoir capacitance being provided by the capacitance between the internal and external coatings of the tube itself. A portion AB of the transformer voltage is rectified by a Metrosil unit to provide about 400 V for the first anode of the tube.

A "damping diode" V_4 is used to give both current saving and h.t. boost. It is controlled by a voltage developed in T_2. For efficiency in this type of circuit it is necessary that V_2 and V_4 should conduct alternately, V_4 over the first part of the scan and V_2 over the second part. Some overlap is necessary to avoid critical adjustments, of course, but V_4 should be non-conductive for the major part of the time that V_2 is functioning. Accordingly T_2 introduces into the cathode circuit of V_4 a voltage derived from the anode current of V_2 which ensures that the diode is cut off over the proper interval and that its operating conditions are controlled during its conductive period. The latter is necessary for a linear scan and T_2 has an adjustable core which forms the main linearity control, a second control being afforded by C_1 in controlling the saw-tooth amplitude applied to V_2. The mean "automatic-bias" voltage of the diode is developed across C_3 and applied as h.t. boost to the pentode V_2 so that this valve operates at a considerably higher voltage than that of the h.t. line.

Picture width is controlled by L_1 and L_2, which have ganged cores so that the inductance of one is increased as the other is reduced. L_1 is in shunt with a tapping on the secondary of T_1, and as it is reduced it absorbs more and more current from the deflector coil. L_2 is in series with the deflector coil and maintains the total effective inductance substantially constant so that changes in picture width do not affect the fly-back time, the e.h.t. voltage, the focus or the linearity. In order to reduce radiation the whole of the line-scan valves and transformers are screened.

The frame coils have their centre tap "earthed" through a resistance. The line coils have one of the pair shunted by the capacitor C_2. This provides a balance condition and minimizes shock excitation of the frame coils by the line fly-back and prevents a damped sinusoidal current from being developed in them to produce a spurious deflection.

The set has series-connected heaters and a half-wave rectifier and is designed for a.c. or d.c. mains of 200–250V. It has 15 valves, of which five are double-types, so that there are 20 electron streams. The panel controls are Sound Volume, with a combined on-off switch, and Picture Brightness. Frame and Line Hold controls also appear on the front, but as pre-set controls with coin slots. The other pre-set controls are visible at the back.

In a bakelite cabinet with a 9-in tube the set is priced at 42 gns, including tax. In a wooden console cabinet with a 12-in tube it costs 76 gns.

Amateurs and Television

WITH the extension of the television service the problem of interference from amateur transmitters has again caused great concern to both amateurs and viewers. At the instigation of the Radio Society of Great Britain, a meeting of R.S.G.B. and Post Office officials was recently held and a review of the present position, including the recommendations of the Post Office, is given in the May issue of the *R.S.G.B. Bulletin*.

The two aspects of the problem of T.V.I., as amateurs call it, which are causing concern are (a) where the interference is due solely to energy radiated on frequencies within the licensed bands and (b) where the television field strength in the area is so low that no known technique can reduce the harmonic level to a degree where interference would be insignificant.

Examples in the first category are:—(1) receivers having a second channel within an amateur band; (2) sets with little or no protection on the i.f. which may be in an amateur band; and (3) sets having so little selectivity that inter-modulation can be produced by a signal in one of the amateur bands. It is stated that "The Post Office recognizes the force of the Society's argument on this aspect of the case; in fact, it is known that whenever an example of types (1) and (2) is encountered a standard form of letter is sent to the viewer suggesting that he should approach the manufacturer and ask for the receiver to be modified."

Where interference is caused with sets in areas of low field strength the view is taken by the Post Office that "where normally a 'reasonable' picture is obtained an amateur must close down during programme hours until he has reduced the interference to a satisfactory level." The figure of 100 μ V/m at a height of 30 ft was suggested by the R.S.G.B. but the P.O. expects amateurs to avoid interference "in areas where the normal field strength is as low as 20-30 μ V/m."

Commenting on this "unfair and unreasonable demand" the writer points out that this ruling means that "amateurs who live in the [television] fringe areas are expected to reduce the harmonic radiation from their transmitters to a level which is much less than that required by international agreement for commercial circuits." The situation should, of course, be eased considerably when the national television network is completed, and the R.S.G.B. suggests "the exercise of a little more patience by the general public until the television service is in full operation in their districts."

Improving a Loudspeaker

Simple Modifications Which Extended the Frequency Range by Three Octaves

By C. F. BROCKELSBY, A.R.C.S., B.Sc., A.M.I.E.E.

THE design and construction of a really first-class loudspeaker is an undertaking which only a few enthusiasts would care to tackle at home, but improving the performance of an existing low-grade speaker is a different matter. This note describes simple modifications which extended the frequency response of a particular small speaker by about three octaves.

A cheap 8in permanent-magnet speaker, which had been in use as a "temporary makeshift" since 1939, recently met with an accident, in which the corrugated surround of the felted cone was torn for a length of about 1in. A repair made with rubber gum was not successful; there were still unpleasant buzzes. It was decided to try more radical treatment before scrapping the cone completely. The cone proper was undamaged, only the corrugated surround being torn.

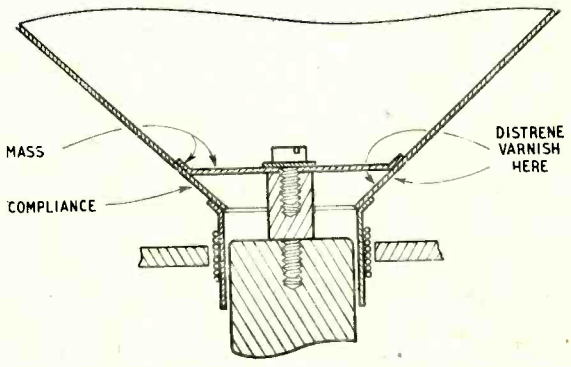
Without removing the cone from the chassis, it was cut away from the surround with scissors; the surround was removed and replaced experimentally by four short pieces of sticky tape. This demonstrated that the centring was unaffected and that the major resonance had dropped from its original figure of about 120 c/s to something below 50 c/s. A surround, made of strips of old twill sheeting, was then fitted by means of rubber gum, and the performance was checked on a b.f.o. The major resonance—now determined simply by the centring spider, of the "arms of Man" type—was just above 30 c/s; fortunately the coil was a good deal longer than the depth of the gap, so that a fair increase in amplitude was permissible. There was considerable non-linearity at large amplitudes, as shown by an asymmetrical resonance curve, but at amplitudes corresponding to normal working conditions this was not marked.

The speaker had been housed in an open-back cabinet 1ft 6in square and 1ft deep, which was now inadequate. The back of the cabinet was therefore closed with a well-fitting piece of $\frac{5}{8}$in composition board, which resonated furiously at 50 c/s until it was stiffened by nailing—very thoroughly—to a piece of 1in plank 6in wide, extending right across the back.

A volume of only $2\frac{1}{4}$ cu ft is very small for an "infinite" baffle, but the audible results were much more satisfactory than with the open-back box. A check was also made by putting the speaker on a 4ft square flat baffle: again the result was inferior. The cavity resonance of the box, with the speaker removed, occurs at about 80 c/s; this resonant frequency is reduced when the speaker is inserted, because the mass of the cone is added to the air column vibrating in the opening. The cone and dust jacket of the speaker and the silk covering the hole damp the resonance quite heavily, so that it was not annoying, being perceptible only as some coloration of a few deep-pitched male voices. Some further damping of this resonance was, later, secured by putting about a quarter of a pound of teased-out cotton wool inside the box. Although the fundamental resonance occurs not far below 80 c/s, the response continues down to much lower frequencies because the baffle is "infinite."

After these modifications, the hum from the receiver was objectionable (because of the extended bass response) and extra smoothing had to be fitted. A b.f.o. check also showed that the receiver output was deficient in the bass; this was corrected with the aid of additional negative feedback, so that the measured receiver response was flat from 30 c/s to above 12 kc/s.

The improvement in the bass response was quite surprising, but, as might have been foreseen, the tone balance was not very good. Critical listening showed that the h.f. response was adequate for speech, but inadequate for music, suggesting a cut-off at about 8 kc/s; a check with the b.f.o. revealed a sharp drop, beginning at 7 kc/s, in the speaker output. The reason for this cut-off was obvious as soon as the centring arrangement of the speaker (see sketch) was examined. The spider was stuck to the front of the cone by a thick ring at a distance of about $\frac{3}{16}$in in front of the junction of the speech coil and the cone. This left a ring of soft-felted material, providing the compliance—while the centring arrangement provided the mass—for a low-pass filter. The cure was obvious: the apex of the cone was given two generous coats of Distrene varnish, to stiffen it and to join the speech coil more or less rigidly to the ring of the centring spider. The increase in bandwidth was immediately obvious to the ear, not the least noticeable effect being the increase in the 9 kc/s whistle. A check with the b.f.o. showed that the sharp fall above 7 kc/s had indeed been cured, the



Extension of high-frequency response resulted from reinforcement of the cone between speech coil and centring spider.

response being fairly well maintained up to 12 kc/s. On speech, the change produced no noticeable effect, but there was a definite improvement in the reproduction of music (especially on percussion instruments) and the tone balance was satisfactory. In addition to the extension of the frequency range, the changes —presumably mainly the cloth surround—seem to have resulted in a general smoothing of the response.

It took something of a mental effort to bring oneself to make the first cut in the cone with the scissors, and the experiment would probably never have been tried had the speaker not been damaged. No real difficulty was, however, met at any stage. At one point a drop of Distrene varnish fell into the gap, threatening to stick the coil permanently to the pole piece, so that the original plan of leaving the centring undisturbed had to be rapidly abandoned. This proved to be an advantage, for in re-assembling the centring device it was possible to improve the symmetry of the forward and backward cone travel by putting in extra washers. Centring was found very easy: the locking screw was tightened while the cone was vibrating through about $\pm \frac{1}{16}$in at 50 c/s. This adjustment has "stayed put" now for some months.

The modified speaker is not, of course, in the first class: the magnetic field is too weak for really good transient response, a further extension and levelling of the "top" response is desirable, and a baffle with a cavity resonance at 30-40 c/s would be better. But the improvement over the original performance is very real, and this for the expenditure of only a few pence and some hours work.

SHORT-WAVE CONDITIONS

May in Retrospect : Forecast for July

By T. W. BENNINGTON (*Engineering Division, B.B.C.*)

THE average day-time usable frequencies for these latitudes decreased considerably during May, while those for the night-time continued to rise.

Day-time working frequencies were therefore relatively low, and long-distance propagation of the higher short-wave frequencies was infrequent, particularly in east-west directions. The 28-Mc/s amateur band, for example, though alive with African and South and Central American stations for most of the month, was well above the m.u.f. for transmission to the U.S.A., and North American amateurs came in very infrequently. Night-time working frequencies were such that 15 Mc/s was usable till well after midnight and 11 Mc/s was generally the lowest frequency necessary at any time of night.

A feature of the month was the very noticable prevalence of Sporadic E, which was evidenced both in the vertical incidence measurements and by activity on the higher frequencies. Very strong 28-Mc/s signals were often receivable in southern England from Continetal amateurs—notably from Germany and Italy—as well as from stations in Scotland. The Sporadic E, as is its nature, often appeared to be patchy and short-lived, and on 28th, for example, several Scottish amateurs came in very strongly for quite a time and then became inaudible within a minute or two. Frequencies up to 50 Mc/s were often receivable by way of Sporadic E over medium distances.

Sunspot activity was, on the average, somewhat lower than during the previous month and, compared with the same month of last year, it was considerably lower, indicating that the sunspot cycle is now well on the wane.

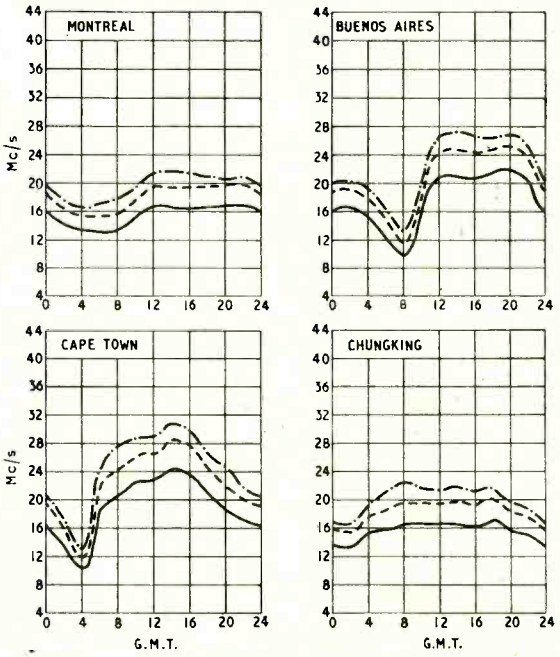
May was considerably less disturbed than was the previous month, though some ionospheric storms did occur. The most severe of these were during the period 1st-5th, 22nd-24th and 27th-30th. Thirteen Dellinger fadeouts were reported during the month, of which the worst took place at 0940-1017 on 22nd.

Forecast.—There should be very little difference in either day-time or night-time m.u.f.s during July as compared with those for June.

Working frequencies for long-distance transmission should be relatively low by day and high by night, and long-distance propagation on the higher short-wave frequencies is likely to be infrequent. Medium-high frequencies—like 17 Mc/s—should, however, be usable for a large proportion of the total time, and frequencies below 11 Mc/s should seldom be really necessary at night.

The E or F_1 layer should control medium-distance transmission—up to about 1,900 miles—for a large part of the day and, in these cases, the working frequencies will be at a seasonally high value. Sporadic E is likely to continue prevalent and should facilitate medium-distance transmission on exceptionally high frequencies at times. Ionospheric storms are not usually particularly troublesome during July.

The curves indicate the highest frequencies likely to be usable over four long-distance circuits during the month.



WORLD OF WIRELESS

Video Standards • B.B.C. Television Plans • European Broadcasting

International Television

AT the conclusion of the international television conference held in London in May, which brought the series of demonstrations in Europe and America to a close, a statement was issued announcing that "the representatives of Austria, Belgium, Denmark, Italy, The Netherlands, Sweden and Switzerland, declared themselves in favour of the 625-line system." The French, U.K. and U.S.A. representatives confirmed the continued use of their present standards and the previous proposal to unify the standards of the London and Paris transmissions on 405 lines was reiterated. It is understood that unanimous agreement was reached on five technical characteristics, but the details of these are not yet available.

It should not be taken from these findings that any decision has yet been reached on standards to be used throughout Europe. The delegates were not plenipotentiaries but were simply members of the International Radio Consultative Committee (C.C.I.R.) studying the world's television systems preparatory to submitting a report to the Committee.

To facilitate the possibility of exchanging television programmes between the B.B.C. and Radiodiffusion Française the Radio Industry Council has offered, subject to the approval of the Postmaster-General, to establish, with its own resources, coast stations on each side of the Channel, to connect existing communications in England and France, and to maintain the link for a trial period of 12 months.

Television Progress

DETAILS have now been given of the plans for the development of the White City site of thirteen acres acquired by the B.B.C. some months ago to provide a home for television when the lease on the Alexandra Palace expires in 1956. Government limitations on building projects make it impracticable to complete the proposed new buildings in time and the erstwhile film studios in Lime Grove, Shepherd's Bush, about half a mile from the White City, were acquired to bridge the gap.

Tests are still continuing for sites for the five low-power transmitters which are to serve the Southampton, Plymouth, Newcastle, Aberdeen and Belfast areas. Equipment for both the 5-kW vision and 2-kW sound transmitters for three of these stations has been ordered from Marconi's.

Work on the Kirk o' Shotts site for the Scottish transmitter has begun and an order has been placed with B.I. Callender's Construction Co. for the supply of a 750-ft mast similar to that at Sutton Coldfield.

Two sets of camera equipment each comprising a mobile control room with three operational image-orthicon cameras and associated equipment, which will be used initially at the Festival of Britain, have been ordered from Marconi's and Pye. Each of the companies is also supplying camera equipment providing three operational cameras with control gear to use at the Lime Grove studios.

European Broadcasting

SOME thirty pages of the first issue of the *Bulletin* of the new European Broadcasting Union (U.E.R.), published on 15th May, are devoted to a survey of the European broadcasting situation following the introduction of the Copenhagen Plan. The conclusion of the writer, H. A. d'Auriac, who is director of the Technical Centre of the U.E.R. in Brussels, is that, despite the fact that some ninety transmitters are operating on frequencies not allocated to them, the "conditions of reception of European broadcasting have improved." Of the ninety unscheduled frequencies in use, twenty-four are in the U.S. Zone of Germany. It is pointed out that whereas eight shared frequencies were allocated to Germany, plus four for the occupying Forces, the number now in use is thirty-seven.

It appears that all the twenty-five signatory countries have applied the Plan. Although the proportion of non-signatories to signatories (10:25) may appear somewhat high, it is pointed out that the geographical position of a number of the non-signatories—on the periphery of the European broadcasting area—has mitigated the trouble.

The same issue of the *Bulletin* outlining the constitution of the European Broadcasting Union.

P.A. Exhibition

MANUFACTURERS of components and accessories as well as of complete public-address installations were well represented at the exhibition organized by the Association of Public Address Engineers in conjunction with their annual general meeting on 31st May. Seventeen firms were showing, and demonstrations—within the limitations of the hall—were given.

The Association, which has been formed to foster the interests of manufacturers and operators of public-address equipment, runs a journal for members in which technical and business matters are discussed. The secretary is A. J. Walker, 394 Northolt Road, South Harrow, Middlesex.

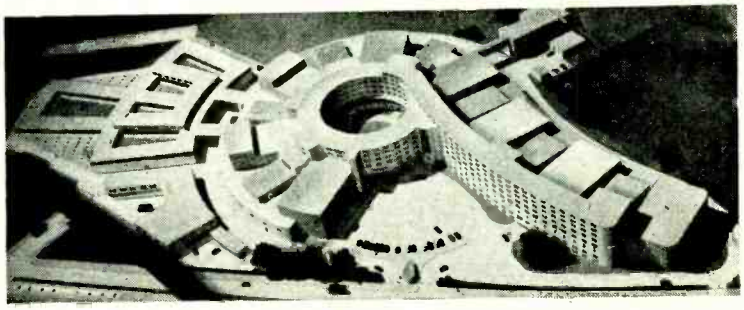
1951 *Exhibition*

RADIO will be included, and in some cases featured, in a number of sections of the 1951 South Bank Exhibition and in the various travelling and static exhibitions being organized for the Festival of Britain to be held from May to September next year.

Selection of the exhibits of contemporary radio, communication and television equipment to be included in the various sections of the exhibitions will largely be from what is called the Stock List, which is an illustrated index of manufacturers' current products. To keep this up to date manufacturers are urged to continue to submit particulars of their new and proposed products.

HONOURS

Sir Ben Lockspeiser, F.R.S., who last year succeeded Sir Edward Appleton as Secretary of the Department



MODEL of the proposed B.B.C. scheme for the development of the White City site. The seven main television studios, which radiate from the central "ring," and the ancillary buildings, will be completed first.

of Scientific and Industrial Research, has been appointed a K.C.B. in the King's Birthday Honours.

George M. Wright, B.Eng., M.I.E.E., Engineer-in-Chief of Marconi's W.T. Co., has been made a C.B.E. He joined Marconi's in 1912 and at the outbreak of the 1939/45 war joined the Admiralty and became successively Assistant Director of Scientific Research and Chief Scientist at the Admiralty Signal Establishment. He was appointed a member of the D.S.I.R. Radio Research Board in November, 1948.

Denis C. Espley, D.Eng., M.I.E.E., Senior Telecommunications Engineer, at the G.E.C. Research Laboratories becomes an O.B.E. He joined the Laboratories in 1930 and has been concerned with a number of special research activities for the Government—including radar. He was responsible for the design, development and installation of the London-Birmingham television radio relay link. Dr. Espley is vice-chairman of the I.E.E. Radio Section.

P. A. Florence, Engineering Establishment Officer of the B.B.C., is made an O.B.E.

H. J. Perkins, who was general secretary of the Radio Officers' Union for twelve years, prior to his retirement in 1949, is among the new O.B.Es.

R. P. Richardson, co-founder of Vidor, Ltd., and Managing Director of Burndept, Ltd., becomes an O.B.E.

Among the new M.B.Es are:—

H. J. V. Cox, Assistant Superintendent, Admiralty Civilian Shore Wireless Service;

C. V. Lane, Signals Officer, Ministry of Civil Aviation; and

H. J. Marshall, who has been Superintendent of Muirhead's Electrical Department for more than twenty years. He joined the company in 1905.

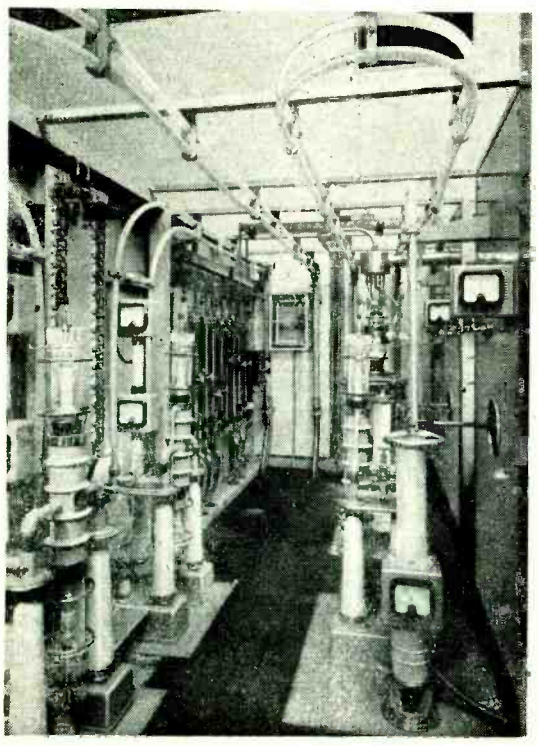
PERSONALITIES

Sir Edward Appleton, F.R.S., has been awarded the Albert Medal for 1950 by the Royal Society of Arts for "outstanding services to science and industrial research." Sir Edward was Secretary of the Department of Scientific and Industrial Research from 1939 to 1949 and is now Principal and Vice-Chancellor of Edinburgh University. He has been President of the International Scientific Radio Union (U.R.S.I.) since 1934.

L. W. Brown, Ph.D., has been appointed chief engineer of the radio department of the Metropolitan-Vickers Electrical Company in succession to A. K. Nuttall, who has transferred to Newton Victor, Ltd., the X-ray subsidiary of Metro-Vick. Dr. Brown joined the B.T.H. Co. in 1943, where he has been responsible for radar development. He was previously a scientific officer at the Telecommunications Research Establishment, Malvern. He received his Ph.D. for work on radio pulse investigations of the upper atmosphere.

R. E. Burnett, M.A.(Oxon), A.M.I.E.E., has been appointed manager of Marconi's Education Department and Principal of the Marconi College at Chelmsford in succession to N. C. Stamford, M.Sc.Tech., M.I.E.E., who has joined the British Electricity Authority as Deputy Education and Training Officer. Mr. Stamford joined Marconi's in 1929 and went to Manchester University as lecturer in 1933. He returned to Marconi's in 1944 and became principal of the college the following year. Mr. Burnett was in charge of the mathematics, physics and electrical engineering side of the Technical and Scientific Register of the Ministry of Labour.

William Dubilier, who, with W. H. Goodman, the present chairman, founded the Dubilier Condenser Co. in 1912, has been awarded the Chevalier Cross of the French Legion of Honour in recognition of "his contribution to the development of the French and international electrical industries." He is now technical director of the Cornell-Dubilier Electric Corpn. (U.S.A.) and acts as the Dubilier Company's American Advisor.



VALVES for the new transmitter at the B.B.C. station at Washford, Somerset, supplied by Standard Telephones and Cables. On the left are the two modulator valves, and on the right the penultimate r.f. amplifier valve. The transmitter consists of duplicate 100-kW units which can be used singly or in parallel.

M. H. Hall is to be Engineer-in-Charge of the new B.B.C. Television Studio Centre at Lime Grove, Shepherd's Bush, London, W.12. He joined the B.B.C. in 1927 and was a member of the original staff at Alexandra Palace when the television service opened in 1936. During the war he was assistant engineer-in-charge successively of the Start Point and Woofferton transmitting stations. With the reintroduction of television in 1946 he returned to Alexandra Palace.

E. N. B. Hammond, who has been with the B.B.C. for sixteen years, has been appointed Engineer-in-Charge of the Corporation's Norwich transmitting station. He was Engineer-in-Charge of the Clevedon station from 1943 to 1947.

Charles Pinkham, who has been manager of the publicity organization of the G.E.C. for 23 years, is retiring at the end of June after 37 years with the company. He is succeeded by M. R. Neville, M.A., M.I.E.E.

OBITUARY

Vice-Admiral C. S. Holland, C.B., who on his retirement from the Navy in 1946 joined the board of A. C. Cossor, Ltd., died on May 11th at the age of 60. During his Naval career, which began in 1905, he specialized in signals and, having held various staff appointments, he was Director of the Admiralty Signal Department for a short time during the 1939-1945 war.

We also record with regret the death, at the age of 61, of **W. G. Richards,** Publicity Manager of Marconi's W.T. Co., who joined Marconi's in 1920 as an assistant in the Publicity Department under the late Arthur Burrows, and took charge of the department in 1923. His work has not been limited to the activities of his own company for he has been an ardent worker for the radio industry, having represented it on many committees.

IN BRIEF

Licences.—Although an increase of 18,850 television licences was recorded during April by the Post Office, the total number of sound and vision licences in the United Kingdom had decreased during the month by nearly 40,000 to 12,204,250. During the twelve months ended in April the number of television licences in the London Postal Region increased from 94,258 to 221,115.

Record Exports.—According to figures issued by the Customs and Excise Office, exports of the British radio industry for March were the highest so far recorded—£1,495,647. More than a third of this figure was accounted for by components and test gear, whilst just under one-third came from the export of transmitting and telecommunication equipment. There has been a gradual decline in the value of broadcast receivers exported during the past three years. The figures for the first quarter of 1948, 1949 and 1950 are £907,906, £847,610 and £573,034, respectively.

Aeronautical E.H.F. — Consequent upon the agreement reached at the European-Mediterranean Aeronautical V.H.F. Meeting of the International Civil Aviation Organization in Paris last November, a nineteen-channel e.h.f. plan for European civil aviation will be introduced on the 1st July. The frequencies range from 118.1Mc/s to 126.9Mc/s and will be used for control purposes.

Stereophonic Broadcast.—On June 19th the Radiodiffusion Française broadcast for the first time a play with stereophonic effects. Separate transmissions were made simultaneously for "left ear" and "right ear" channels through *Paris Inter* and the *Chaine Parisienne* groups of stations. Listeners able to put into service two separate receivers were in a position to judge the merits of stereophony in their own homes, and comments are awaited with interest

Outdoor or Indoor? is the question which has to be answered by most people when erecting a television aerial. To show that there are many factors which have to be taken into consideration before the type of aerial most suitable for any particular building or district can be decided upon the radio industry has issued a booklet, "Television Aerials—Outdoor or Indoor?" Published jointly by the R.E.C.M.F. and B.R.E.M.A. it is obtainable from the R.E.C.M.F., 22, Surrey Street, London, W.C.2, price 1s.

"Trader Year Book."—Abridged specifications of over 200 current television receivers and nearly 400 current domestic receivers, as well as base connections for over 1,000 valves and cathode-ray tubes, are included in the data section of the 1950 edition of the "Wireless and Electrical Trader Year Book." For ease of reference the directory sections—trade addresses, proprietary names and classified buyers' guide—are printed on distinctively tinted papers. It is published by the Trader Publishing Company and costs 10s 6d.

Business Radio.—According to figures given by the P.M.G. in the House of Commons there were 424 "Business Radio" licences in force on May 24th covering the operation of 3,507 stations. One of the latest undertakings to make use of radio for the control of a public transport service is the Manchester Corporation. The G.E.C. has provided a 20-watt fixed station and eight mobile transmitters working on frequencies around 70Mc/s. F.M. is employed for the two-frequency simplex system in which the main station uses one frequency whilst a second frequency is shared by the mobile stations.

Harbour Radio.—The ship-to-shore radio-telephone system at Liverpool, designed by British Telecommunications Research and R.G.D. (see this journal August 1949, p. 288), was handed over by Air Vice-Marshal Lywood, Director of the parent company, Automatic Telephone and Electric, to the chairman of the Mersey Dock and Harbour Board at a ceremony on June 1st on board s.s. *Galatea* while cruising in the Mersey. In our next issue we hope to give a description of the installation and details of the equipment used.

Radio Control.—Considerable interest was aroused at the recent Mechanical Handling Exhibition, at Olympia, by the application of radio to the control of overhead travelling cranes. Two companies were demonstrating prototypes, each of which was operating on frequencies around 27 Mc/s. Electronics for the control of the flow of materials, for switch operating and for counting, were also demonstrated at the exhibition which was organized by our associate journal *Mechanical Handling*.

Television Construction.—A display of home constructors' television equipment will be included in this year's Manchester Electronics Exhibition, the fifth to be organized by the Institution of Electronics. It will be held at the College of Technology on July 18th from 2.30 to 9.0 and on the 19th and 20th from 10.0 a.m. to 9.0 p.m. Tickets are obtainable from A. Hickson, 205, Parrs Wood Road South, East Didsbury, Manchester, 20.

Technical Education.—Two new colour filmstrips describing the basic principles of television transmission and reception have been produced by Mullard Electronic Products, Ltd. The first filmstrip (No. 7 in the Mullard series) comprises 18 frames, and the second (No. 8) comprises 30 frames. The two filmstrips, which are intended primarily for senior classes in secondary schools, are available, complete with summarized lecture notes, from "Tartan" Filmstrips and cost £1 each. Detailed lecture notes are obtainable from Mullard's.

British Wireless Dinner Club.—At the 27th annual dinner of the club, at which Sir Robert Watson-Watt was the guest, the following officers were elected:—president, Major Gen. St. John D. Arcedeckne-Butler, C.B.E.; vice-president, G. M. Wright; chairman of committee, Capt. B. R. Willett, C.B.E., D.S.C., R.N.

B.S.R.A. Officers.—At the annual general meeting of the British Sound Recording Association, C. E. Watts (M.S.S. Recording) was elected President for 1950-51 and M. J. L. Pulling (B.B.C.) and B. C. Sewell (Director of Sound, Gainsborough Pictures), vice-presidents.

R.E.C.M.F. Officers for the ensuing year are: L. H. Peter (Westinghouse), chairman, and H. V. Slade (Garrard), vice-chairman.

Pye Colour Television equipment is to be installed experimentally for three months at St. Thomas's Hospital, London, where it will work on a closed circuit.

Old Students.—We are asked by the honorary treasurer of the Finsbury Technical College (London) Old Students' Association to announce that it is proposed to wind up the affairs of the association and to distribute the balance of the various funds. It is planned to hold a meeting for this purpose in the early autumn and old students are asked to communicate with the treasurer, W. B. Thompson, "Elleray," Regent Road, Altrincham, Cheshire.

BUSINESS NOTES

International Aeradio, Ltd., has been granted a licence by the Jamaican Government to operate the aeronautical wireless services at the Palisadoes and Montego Bay airports for seven years.

Photo-telegraphy system of the Unit Telephoto Co. of West Nile Street, Glasgow, has been acquired by the General Electric Co. The manufacture and sale of the equipment will in future be undertaken by the G.E.C.

Marconi "Transarctic" transmitter-receivers providing both radio-telephony and radio-telegraphy facilities, and sound reproducing equipment have been ordered for six new vessels now being built for the British Electricity Authority.

H.M.V. export receivers are being made available in limited quantities for the home market. They are the all-wave superhet Models 5106 (a.c.) and 5209 (a.c./d.c.) and cost 33 guineas plus £7 10s 2d purchase tax.

Berry's (Short-Wave), Ltd., advise us that they supplied the "Q-Max" All Dry Four receiver used in the 25-foot yacht *Virtue XXXV* which recently crossed the Atlantic from Lymington to New York.

Still Available, but not at the price shown. Due to a typographical error the price of the Wee Megger in the Clydesdale Supply Company's advertisement on page 67 of June issue was printed as 19s 5d instead of £5 19s 6d.

Amplifiers, microphones and transformers are being made available in limited quantities to amateurs and experimenters at special prices by E.M.I. Details are available from the Amateur Division, E.M.I. Sales and Service, Hayes, Middlesex.

I.M.R.C.—An order for seven radio beacon transmitters and accessories has been received by the International Marine Radio Co., of Croydon, from the New Zealand Posts and Telegraphs Department.

An Enquiry has been received from a Peruvian firm desirous of communicating with British manufacturers of broadcast receivers, radio-gramophones and domestic electrical equipment. Manufacturers interested in exporting to Peru should write to José A. Martinez Castañeda, Jirón Lima 358, Lima, Peru.

E.H.F. Communication Equipment is to be supplied by Marconi's for two new Customs vessels which will operate

RADIO-CONTROLLED motor launch, designed as a high-speed bombing target for the R.A.F., receives orders by means of different a.f. tones which modulate a carrier frequency transmitted from the parent vessel.

round the coasts of the U.K. In addition to the transmitter-receiver fitted in the vessels, the fast launch carried by each of them will be equipped with a transportable "Harbatone" set for communication with the parent ship.

NEW ADDRESSES

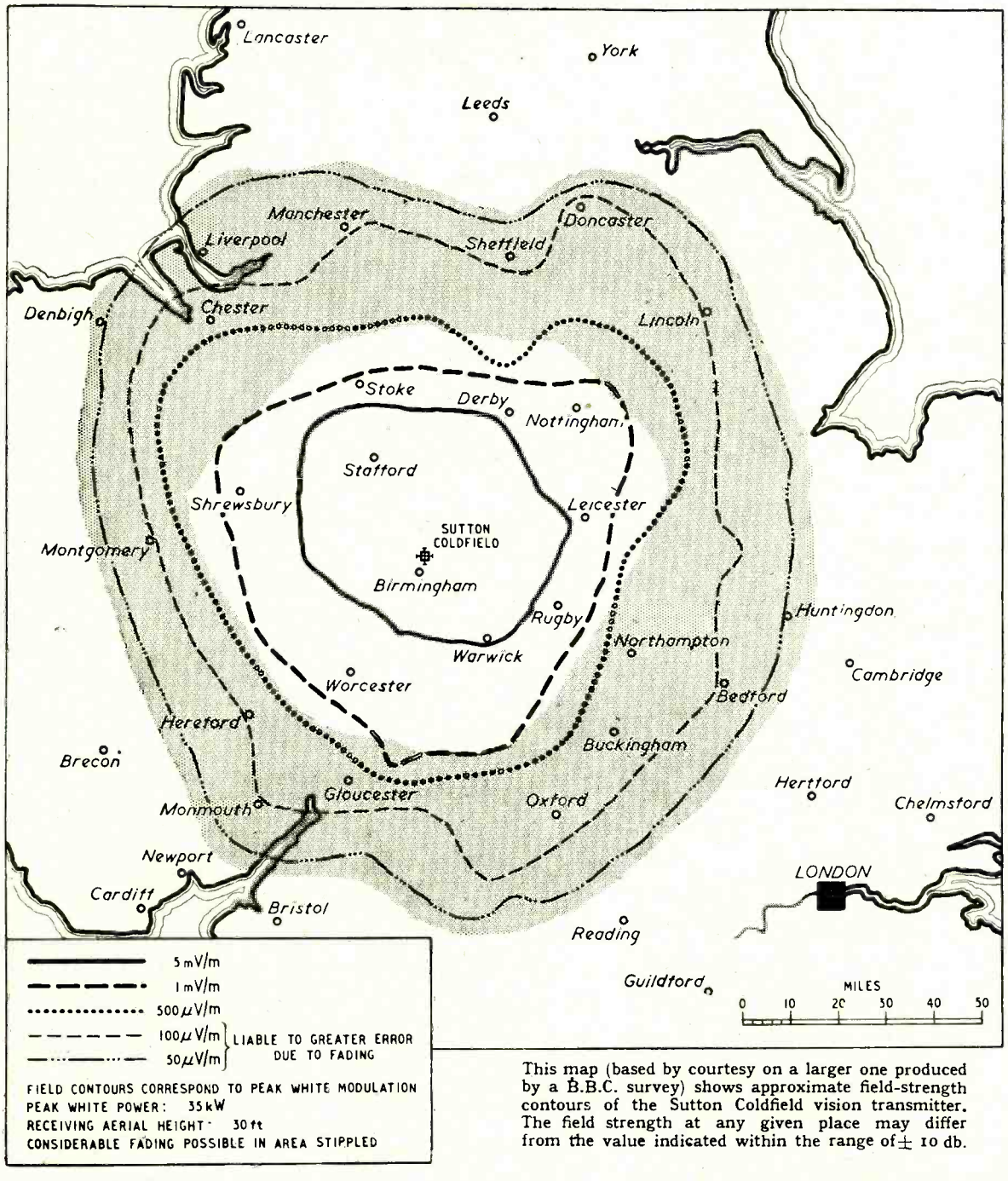
D.S.I.R.—Headquarters of the Department of Scientific and Industrial Research are now at Charles House, 5-11 Regent Street, London, W.1. Telephone number is unchanged—Whitehall 9788.

Society of Relay Engineers.—The offices of the society, of which T. H. Hall, M Brit.I.R.E., is secretary, have been transferred from 23, Dalkeith Place, to Albion Road, Kettering, Northants. The telephone number remains unchanged—Kettering 3422.

Stability Radio Components, Ltd., have moved their offices from 14, Norman's Buildings, Central Street, E.C.1, to their new factory at Commerce Estate, Woodford Avenue, London, E.18. (Tel.: Buckhurst 6501.)

Ardente Acoustic Laboratories, Ltd., are moving to 62, Horn Lane, London, W.3. (Tel.: Acorn 1282.) The sales office is at 309, Oxford Street, London, W.1. (Tel.: Mayfair 7917.)

MIDLANDS TELEVISION AREA



This map (based by courtesy on a larger one produced by a B.B.C. survey) shows approximate field-strength contours of the Sutton Coldfield vision transmitter. The field strength at any given place may differ from the value indicated within the range of ± 10 db.

Manufacturers' Products

New Equipment and Accessories for Radio and Electronics

Export Receivers

THE Ekco Model A100 superhet export receiver is suitable for use in medium tropical conditions, and will work on a.c. mains of 100-135 volts and 200-250 volts. It has one medium-wave band and four short-wave bands, with bandspreading on 13, 16, 19, 22, 25, 27, 31 and 38 metres. The firm has also produced an export radio-gramophone for the above mains voltages, Model ARG90, having an automatic record changer and a record storage compartment. Four short-wave bands and one medium-wave band are provided, with bandspreading on 11, 13, 16, 19, 25 and 31 metres. The twin p.m. 10-in moving-coil loudspeakers are tropicalized and dust-proofed to prevent deterioration. Makers are E. K. Cole, Ltd., Southend-on-Sea, Essex.

Television Vibrator Unit

FOR supplying a.c./d.c. television receivers in areas where only low-voltage supplies are available, Valradio have produced a vibrator power unit that will deliver 250 watts at 240 V d.c. with less than half a volt of ripple. The unit is specially designed for Pye universal a.c./d.c. receivers and Ferguson 941-T, 951-T receivers, and can be supplied in two types, one for 50-V and the other for 110-V d.c. input. A self-rectifying vibrator is used, running at 60 c/s, but the mechanical noise level is sufficiently low to permit the unit to be placed near the receiver. Makers are Valradio, Ltd., 57, Fortess Road, Kentish Town, London, N.W.5.

Television Focus Units

PERMANENT-MAGNET focus units having a focus-adjusting control accessible from the rear are additions to the range produced by Haynes Radio, Queensway, Enfield, Middlesex. The control operates by adjusting the width of the air gap.

Two separate controls give picture shift and are claimed to operate independently of the focus control. There are two models: the PM15A for tetrode and the PM20A for triode tubes. The price is 36s.

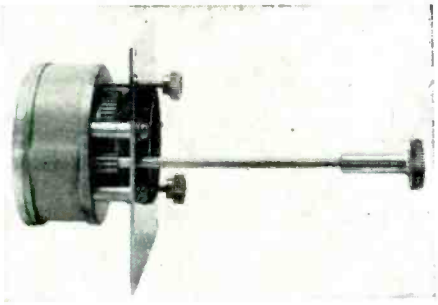
Electronic Relay by Labgear, Ltd., of Willow Place, Cambridge, requires a controlling current of only 20-50 μA. The instrument contains a Post Office-type high-voltage relay which will work at speeds up to 10 operations per second and can be used for switching power circuits up to 1 kW.

Television Camera Cable designed for mobile cameras by The Telegraph Construction & Maintenance Company, 22, Old Broad Street, London, E.C.2. In addition to carrying the video signals from the camera, the cable also provides various lighting, signalling and control circuits necessary in television transmission.

High-Voltage Tester suitable for television, consisting of a glow discharge tube and chain of resistors housed in an ebonite tube. A testing range of 350 V to 12 kV is possible, the voltage being estimated from the brightness of the glow. The "T.V. Testoscope" is made by Runbaken Electrical Products, 71-73A, Oxford Road, Manchester, 1.

Extension Speakers, a new "Bafflette" range by Richard Allan Radio, Ltd., Caledonia Road, Batley, Yorkshire. The "Baby Bafflette," price 39s 6d, transformer 6s extra, measures 9¾in × 7¾in × 3½in; the "Minor Bafflette," price 52s 6d, transformer 6s extra, measures 11in × 9½in × 3¾in; whilst the "Major Bafflette," price 65s, transformer 8s 6d extra, measures 14in × 11¾in × 5in.

Cathode Ray Tube with a long-persistence screen suitable for P.P.I. radar systems has been announced by Mullard Electronic Products, Ltd., Century House, Shaftesbury Avenue, London, W.C.2. This is the MF31-22, a 12-in aluminized tube with electro-magnetic focusing.



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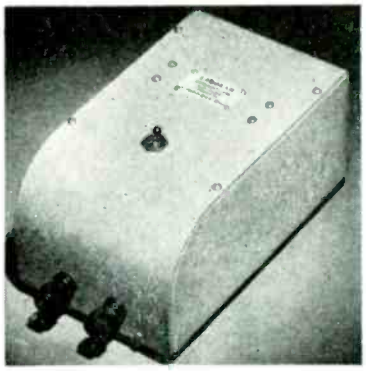

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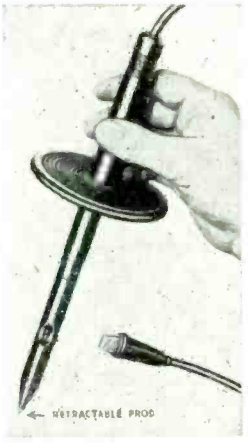

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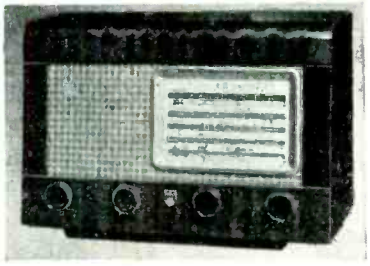

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1.—Permanent-magnet focus unit by Haynes Radio.

2.—Labgear electronic relay for switching up to 1 kW.

3.—"T.V. Testascope" for high voltages by Runbaken.

4.—Ekco Model A100 mains superhet export receiver.

UNBIASED

By FREE GRID

"*Autre Pays, Autre Moeurs*"

I MUST crave your indulgence for copying the proverbial fools to whom King Solomon draws our attention. I feel that I cannot allow to pass unchallenged some remarks made in *Electronics* (May, 1950) about the investigations into television interference which, as I duly reported in *Wireless World* (January, 1950) I undertook a few months ago.

Briefly, I pointed out that serious "snowstorms" were being caused on television screens in the vicinity of a large and well-known girls' public school by the sudden and sharp removal at bedtime of hundreds of pairs of nylon stockings.

The *Electronics* writer seems to regard it as phenomenal that such interference was ever noticed in the particular circumstances. It is quite clear that the Editor of this highly reputable American technical journal, or the particular "galley" slave of his who wrote the commentary on my words, is under the false impression that the B.B.C. had its television cameras in one of the dormitories giving a sort of "documentary" of a modern and female version of "Tom Brown's Schooldays." If such had indeed been the case I can well imagine that it would certainly be, in the writer's own words, "a surprising thing that the interference was ever noticed" as viewers would be far to engrossed in the programme to observe it.

Such a misapprehension is, of course, pardonable as we must not forget that ethical standards in the field of entertainment in other countries are not the same as those of the B.B.C. This is equally true in departments of life far removed from that of entertainment. If, for instance, I dwelt in certain countries east of Suez I should be allowed to keep Mrs. Free Grid in triplicate and still be accounted a worthy and upright citizen; here in England I should find every door, even that of the *W.W.* offices, barred to me by "Cherubim, and a flaming sword which turned every way."

"*Eyes Have They, but They See Not*"

WE seem to have heard much less nonsense lately about the so-called electronic brain with its alleged superhuman memory and other mental faculties. The whole business is strangely reminiscent of the robot craze of some twenty years ago, except, of course, that this present machine when stripped of all the dramatic rubbish that has been written about it in the popular Press, really does exist and also does do some of the things claimed for it, and is, in fact, a marvel of ingenuity.

It seems to be forgotten, however, that it is merely a creature of man and in no way approaches the mental capabilities of even the most dull-witted of us. The machine possesses a marvellous "memory," but so does a gramophone record which, if treated as it should be treated, never fails to recollect anything that is scratched on its surface. But, again like the gramophone record, the electronic brain—more accurately described as an electronic computer—is quite incapable of seeing a joke and can be moved neither to laughter nor to tears. Undoubtedly the Psalmist gave about the best description of it in this respect (Psalm CXV.4 *et seq.*).

I am fully aware, of course, that this electronic computer has a "memory" in a very special sense, differing entirely from that of a gramophone record. No doubt it could beat Mrs. Free Grid in producing an exact and impartial account of what happens to her house-keeping allowance, but could it compete with her in wheedling an overdraft from a strong-hearted bank manager?

This machine is, in fact, just a machine responding to certain stimuli and is nothing more. So, of course, is the human body if we accept the view of the out-and-out materialist, but even if we take this utterly pessimistic view of our vain-glorious selves, surely we are a far better sort of machine. The human brain has produced an electronic brain, but has an electronic computer produced a human being or even an amoeba? Should it ever do so it will still be the human brain behind it which will have made it capable of so doing.

"*. . . and so ad Infinitum*"

IN all spheres of human activity it is usually the most eminent men who are the least dogmatic and who are most ready to confess how little they really know. No one of less stature than a Judge of the High Court would humbly ask "Who was Tosi?" as one did when d.f. was under discussion in the courts many years ago. A petty local magistrate would, I feel sure, have been in no doubt about the matter but would have promptly

identified Bellini's co-worker as the then popular and famous composer of Tosti's "Good-bye," and would probably have sharply corrected what he regarded as the witness's mispronunciation.

I was not altogether surprised, therefore, when in a recent issue of *W.W.* (May, 1950) one of the stars of the first magnitude which glitter in the firmament of radio made no bones about letting us know that there was no certainty that electrons were not composed of still more elementary units; as he rightly said, "so far as we know they aren't."

Exactly the same thing could have been said about the atom in the heyday of Queen Victoria's reign. But as we know now it would have been more appropriate to have named it the "anatom." I feel sure that the passing years will fully justify the eminent *W.W.* contribution in tacitly acknowledging that there are more secrets hidden in the womb of time than ever came out of it. Speaking personally, I have little doubt that before we are many years older we shall find that the electron and all the other members of the ever-growing "tron" family will be found as complex in their structure as the atom.

LETTERS TO THE EDITOR

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

Airmet Service

AN almost incredible situation persists whereby all the many interests which depend in some measure on complete, accurate and up-to-the-minute weather information have been deprived of the only means of obtaining it—the Airmet service.

Enquiries in various quarters have produced different reasons for the failure of our representatives at Copenhagen to obtain a frequency allocation for it, and these may be divided into two principal categories. One suggests that the Conference considered Airmet to be outside the scope of broadcasting and therefore beyond their powers in respect of frequency allocation, while the other, held by the Ministry of Civil Aviation, denies that the matter was omitted but states that it was voted by the Conference as of less importance than ordinary broadcasting and therefore not entitled to an allocation.

Whatever the real reason, the situation is now that, officially, there seems little or no chance of Airmet again being transmitted on a frequency within the new long and medium wave bands, and but a remote hope that, when all the technical and interdepartmental difficulties have at last been resolved, we may have Airmet, possibly on a frequency such as 2,000 kc/s.

Efforts are being made by several bodies representing yachting interests to have the service reinstated as soon as possible, but this would seem to be the time for all bodies representing those who depend on weather information — including farming, building and civil engineering industries, outdoor sporting promotions and the general public which naturally wishes to make the best use of its limited time for open-air recreation—to lend their weight in bringing all possible pressure to bear with the same end in view.

It is suggested that a considerable improvement in the situation could easily result if the Ministry of Civil Aviation and the G.P.O. were convinced, by pressure from all sides, of the urgent necessity for a service such as only Airmet has hitherto provided. The B.B.C. weather forecasts are so demonstrably incomplete, inaccurate and often misleading (possibly because they are not issued frequently enough, and seem to be based on information which is practically out of date at the time of each broadcast in some cases) that they do not come into the same classification as Airmet and certainly cannot be accepted as an effective substitute.

It is suggested also that the proposed new frequency of about 2,000 kc/s (150 metres) would be unsuitable for practically all receivers except those carried by trawlers and similar vessels and by coastguard stations. If the service could be brought in again on some frequency in the range 20 to 120 metres, however, it would at least be capable of being tuned by the majority of commercially manufactured receivers having a short-wave range. The needs of all interested bodies in this respect should be impressed on the departments concerued without delay.

D. de GUERIN.

Richmond, Surrey.

Pickup Design

IN his letter in the June issue Mr. Brierley gives an elementary and perfectly correct reasoning of the relationship between output voltage and induced hum voltage in pickup generating systems using one turn and multiple turns, but he is the victim of a simple fallacy—that all the hum pick-up is induced in the actual single turn of the moving generator. This single turn is much smaller than the loop which is formed at the ends of the turn by the terminal connections and also by the leads running along the arm. The signal/hum ratio is also worsened due to the resistance of the leads being higher than the resistance of the single generating turn. As the omission of these facts from Mr. Brierley's theoretical considerations may not bring home to your readers their significance in terms of practical results, I give below details of simple experiments which anyone may check, with, I am sure, similar results.

A new single-turn ribbon pickup was mounted on a motor-board with a "Connoisseur" single-speed motor in a normal floor cabinet, the motor-board being the usual operating height of 28in from the floor. The power amplifier was placed outside this cabinet, the mains transformer being 37in from the pickup head. The motor was switched on and the pickup transformer positioned on the motor-board for minimum hum, which necessitated the use of a special angle bracket. The volume control on the amplifier was adjusted to give an output of 2½ volts at 1,000 c/s across a good 15-ohm loudspeaker system, the source being Decca frequency record K1804B. This setting gave loud signals from

Decca "Scheherazade" AK1982, and the hum induced in the pickup from the motor could be heard above the music except on the loudest passages. With the pickup lifted $\frac{1}{16}$in above the record level, to eliminate the masking effect of the surface noise, the hum was very audible indeed. A further serious increase in hum was noticeable when the amplifier was moved into the cabinet, the mains transformer then being within 2oin of the pick-up head. The pickup was then replaced by a dynamic pickup of multiple-turn construction, and the amplifier was moved into the cabinet. The transformer was screwed to an unselected position on the motor-board and not rotated. The output was again adjusted for $2\frac{1}{2}$ volts from the frequency disc, and the musical output from "Scheherazade" was as before, but hum was quite inaudible even with the pick-up lifted just above the record, and the measured hum level was 19db lower than when using the single-turn pickup.

I therefore repeat my statement that I prefer the multi-turn as it is less liable to hum pick-up I speak of things as they are, but it should be possible to reduce the hum pick-up on single-turn coils by adopting new methods of construction.

Mr. Brierley says that "the ribbon design, utilizing the principle that the moving conductor is either self-supporting or substantially so, will obviously have, for a given performance, a better signal/hum ratio than a moving coil since the "waste" mass of the supporting coil-former can be transferred to the effective working mass of the moving conductor." This is, of course, true. One reason why we do not get this benefit in practice is that in the single-turn pickup under consideration, the ribbon is, of necessity, firmly cemented to a platform and needle-holding device which has a mass, on inspection, many times that of the ribbon. The platform is essential in order that the single-turn ribbon shall move so as to generate voltages substantially the same in waveform as the inscriptions in the record traced by the stylus point. This platform is, of course, a coil-former, and the ribbon is the coil, and the ribbon is most certainly not "substantially self-supporting." The mass of the moving parts (stylus, coil-former and ribbon coil) is 35 milligrams, as against 48 milligrams for the moving parts of the multi-turn pickup. High-frequency resonance occurs on the multi-turn dynamic pickup at 26,000 c/s and it should therefore be somewhat higher on the single-turn ribbon.

With reference to Mr. Berry's letter, I restate my findings as regards tungsten carbide as a stylus material:—

(1) Those grades of material which wear longer than the corundums (ruby and sapphire) show surface pitting which causes record wear.

(2) Those grades of material which show no pitting do not wear as long as the corundums. Further information has been sent to Mr. Berry regarding the origin of the materials used and of the findings of another worker in this field.

In the absence of evidence to the contrary, I maintain my statements, but I assure Mr. Berry and anyone else interested in the manufacture of tungsten carbide that I am very anxious to find a stylus material more durable than the corundums and approaching diamond in excellence, but at much less cost than the latter. If any manufacturer cares to submit samples of *wear-tested* styli, giving full particulars of conditions of test, I will be pleased to comment. I see no reason why advances should not be made, but quite clearly more development work is needed, or if it has been carried out it has not, to my regret, come to my attention.

H. J. LEAK.
H. J. Leak & Company.
Acton, W.3.

Beauty and the Beholder

DO you and your readers know that, in the year A.D. 1286, precursors of the Council for the Preservation of Rural England entered a strong protest against growing defacement of the skyline by "these ghastly new-fangled windmills"? And longshoremen of a much earlier epoch are on record as grumbling about the lubberly practice of hoisting unsightly contraptions of sticks and matting above dugout canoes. "Documentation, please" you say? Well, I can't turn it up offhand, but my facts are right, for all practical purposes.

My real point is that aesthetic standards are impermanent. Windmills and sailing craft are now held to be the embodiment of beauty. Who knows but that in A.D. 2000 we shall be earning dollars by conducting parties of American tourists to view the "olde worlde" gasometers behind King's Cross Station at dawn on mid-winter mornings?

May I, with great humility, commend these thoughts to the gentlemen of Town and Country Planning, to Borough Surveyors and Architects, to landlords and to all the other people in authority who, on aesthetic grounds, are now putting obstacles in the way of the erection of radio aerials, especially for television and e.h.f. amateur beam transmission? I know that, to almost everybody, a lopsided H aerial is an offence, but already, to the mid-20th-century eye, a trim and workmanlike aerial system has become far less offensive than it would have been, say, when radio started in Queen Victoria's days. A generation may soon arise to whom it will be actually a thing of beauty. "RADIOPHARE."

Spot Wobble

THE letter of E. G. O. Anderson in your May issue raises a point which the writer does not make clear. By using spot wobble, he says, we have "luminescence in parts not normally excited" and "the light output is increased" as a result.

The light emitted from the screen is produced by the energy of the electron beam arriving at the screen. The total light would therefore appear to be a function of the beam current, and of nothing else. Any method of deflecting or distributing the energy of the beam should therefore not affect the total light output, and should affect merely the distribution of light over the screen.

I do not know whether your correspondent has conducted, or has knowledge of, experiments in the measurement of total light output, *as light*, both with and without spot wobble. This would, of course, clinch the matter. But if we are really getting greater illumination from the same electron beam by using spot wobble, it would seem we are getting something for nothing, which, to say the least, is unusual. H. S. CHADWICK.
Worksop, Notts.

Television Tests

WOULD it be possible for the B.B.C. to radiate the test card on Sundays as well as in the week? It would be a great help to a lot of people, including myself, who are building their own sets, to line them up properly. L. STANNEY.
Boston, Lincs.

"American Insularity"

I HAVE been noting the caustic comments in *Wireless World* about the tendency of Americans not to give adequate credit in our publications for work done abroad.

I do not believe that this is due to any desire to belittle our fellow engineers and scientists abroad, or to toot our own horns, or—as one of your commentators says—"to see their own land first in everything."

It is my sincere belief that most of the statements (or lack of statements) to which your contributors

object are due solely to ignorance on the part of our writers. I don't think many of them deliberately belittle the work done elsewhere; they just don't know about this work, and probably never give the matter any thought at all.

KEITH HENNEY,
Consulting Editor,
New York, *Electronics*,
U.S.A.

Life of Electrolytics

I RECENTLY purchased an electrolytic condenser from a retailer. On test it showed an internal short, so I sent it to the makers. I heard nothing for ten days, so wrote again. The makers then informed me that the condenser had been made in 1945 and had deteriorated through storage; they disclaimed responsibility for condensers "that had been years on a retailer's shelf." There appears to be no date on the condenser. Manufacturers of photographic films and other perishable articles mark the goods "use before such and such a date."

The position seems unsatisfactory, and there should be some protection for the purchaser.

J. COOPER.
Bishop's Stortford, Herts.

MANUFACTURERS' LITERATURE

Lightweight Alkaline Accumulators, working on the silver-zinc reaction, described in a pamphlet from Venner Accumulators, Ltd., Kingston By-Pass Road, New Malden, Surrey.

Components and Accessories; the 1950 catalogue from Belling & Lee, Ltd., Cambridge Arterial Road, Enfield, is now available to manufacturers, government and professional organizations. Copies will be sent automatically to those who already have previous editions.

Valve Price List with Mullard equivalents, printed as a wall-chart, is being distributed to the trade by the Mullard Valve Sales Department, Century House, Shaftesbury Avenue, London, W.C.2.

Receiver Model 500, a walnut-cabinet version of the "Melody Maker," described in a specification from A. C. Cossor, Ltd., Highbury Grove, London, N.5.

"Modern Solders" booklet describing the properties, methods of testing and widespread applications of Ersin- and Arax-fluxed solders, from Multicore Solders, Mellier House, Albemarle Street, London, W.1.

Recording Amplifier Type RA3 for use with B.B.C. Type "B" feedback recording heads; the technical details from Grampian Reproducers, Hanworth Trading Estate, Feltham, Middlesex.

Resistance Wires and strip in "Telconstar" (nickel-copper). Tables of their physical and electrical constants from the Telegraph Construction and Maintenance Co., 22 Old Broad Street, London, E.C.2.

RANDOM RADIATIONS

By "DIALLIST"

Safety First

ONE WAS GLAD TO SEE the Electrical Trades Union come out strongly in favour of the enforcement of the I.E.E. regulations governing the wiring of buildings and the design of electrical apparatus. One morning during my holiday I was watching a sturdy young house-painter at work. The downlead from the aerial being in his way, he caught hold of it to move it aside —and received a shock severe enough to knock him out for some minutes. Luckily he was not on a ladder, or he might have had a bad fall. The downlead was connected to a universal receiver, operating on d.c. The set was switched off in the sense that it was silent and was drawing no current from the mains; but the switch was of the single-pole variety and happened to be connected to the neutral of the mains. Personally, I have always detested the a.c./d.c. set, regarding it as an electrical monstrosity. Before now I've expressed in these notes my opinion of sets of this kind (or of any other kind, for that matter) which have on-off switches in only one "leg" of the input from the mains. There are countless other electrical and electronic devices freely sold and widely used to-day which don't comply with I.E.E. regulations and are potential sources of danger. It would indeed be a good thing could these regulations, the fruits of long experience and of patient, disinterested work, be given legal force.

Dangerous Dabbling

One cause of minor—and sometimes major — accidents with receivers (which should be the safest and most foolproof of domestic appliances) is incompetent servicing. Anyone who can afford a small preliminary outlay is at liberty to take a shop and to put up over its front a sign proclaiming that he is an "Electrical, Radio and Electronic Engineer." He need have no qualifications whatever for the work undertaken. Here are a few of the electrical crimes committed by such folk that I've come across: the sale of an a.c./d.c. set to a customer with a.c. in his house who was not told that it was a receiver of that type, or warned that the chassis could be "alive" with the switch in the off position; trickle-chargers and receivers provided with 3-point plugs to the mains, but the leads so connected that the single-pole switch was in the neutral; dangerous connections to broadcast and television aerials; a 5-amp wall socket for a set T-ed into the power circuit in a house which had separate main switches for power and lighting circuits . . . I could continue the list for pages; but I refrain, for you have, no doubt, come across some of them yourself.

What is an Invention?

THE RUSSIANS, I see, have now decided that they invented television. Since they have already claimed to have been first in the field with radio, radar, the steam engine, the internal combustion engine, the motor car, the aeroplane and the cinematograph, the tale of national achievement is impressive —or, rather, it would be, did it rest on any sound bases. One does not invent a thing by hinting more or less vaguely that it may some day be possible. Leonardo da Vinci, for instance, who was an engineer as well as an artist, made "working" drawings of fantastic flying machines; but no one would suggest that he, or the much earlier Daedalus was the inventor of the aeroplane. Invention consists in planning the means whereby a conception ceases to be merely abstract and assumes a practical working form. Popoff undoubtedly realized and stated that radio waves might be reflected or scattered like those of light; but is this to say that he invented radar? I think not! If this were the stuff of which inventions are made, wondrous claims could be made for Nostradamus, Mother Shipton and H. G. Wells.

American Television

IN THE JUNE ISSUE of *Wireless World*, Mr. D. R. A. Mellis, writing from Passaic, New Jersey, asked what reasons I had for saying that our brand of television was a good deal better than that obtaining in the United States. So far as the quality of the images is concerned I based my remarks on the opinions expressed by American friends who had visited this country during the previous twelve months and had watched our television programmes with critical but appreciative eyes. Without exception, they said that our system gave better results than theirs—and I am quite sure that they were not just being polite! Anyhow, I shall have shortly the chance of collecting quite another set of views, for several of my British friends are now in the United States and I will make a point of getting their opinions when they return. I promise Mr. Mellis to record faithfully in future notes what they have to tell me.

Linearity and All That

Mr. Mellis also wonders how I got hold of the idea that the linearity of not a few American television transmissions was not all that it might be. I came to that conclusion after reading the sections of various American radio periodicals written for the benefit of television servicemen. One has read (a) that servicemen are likely to find some customers a bit fussy about the circles in test patterns (the fussiness consisting in a desire to see the circles presented on the screen as circles rather than as parabolas); and (b) that the serviceman is faced with a rather pretty problem since if he gets the circle circular on one station's transmission, it may be horizontally oval on a second transmission and vertically egg-shaped on a third. When one reads such things in American technical magazines, is one not justified in concluding that, taking it by and large, linearity in U.S.A. television is hardly up to B.B.C. standards? The truth of the matter is probably to be found only in realizing the number of alternative television services available to American viewers, particularly in the big cities in the Eastern part of the country. Those conducted by great concerns of international reputation are more than likely to be unexceptionable. But in many areas there are services from stations, rated at only a few hundred watts, and run by much smaller concerns, which may well be responsible for the egg-shaped circles.

We regret that the printing difficulties referred to on page 244 have necessitated the omission of advertisement pages 9-24 from every copy of this issue.