ALL ABOUT AERIALS

PRACTICAL TELEVISION

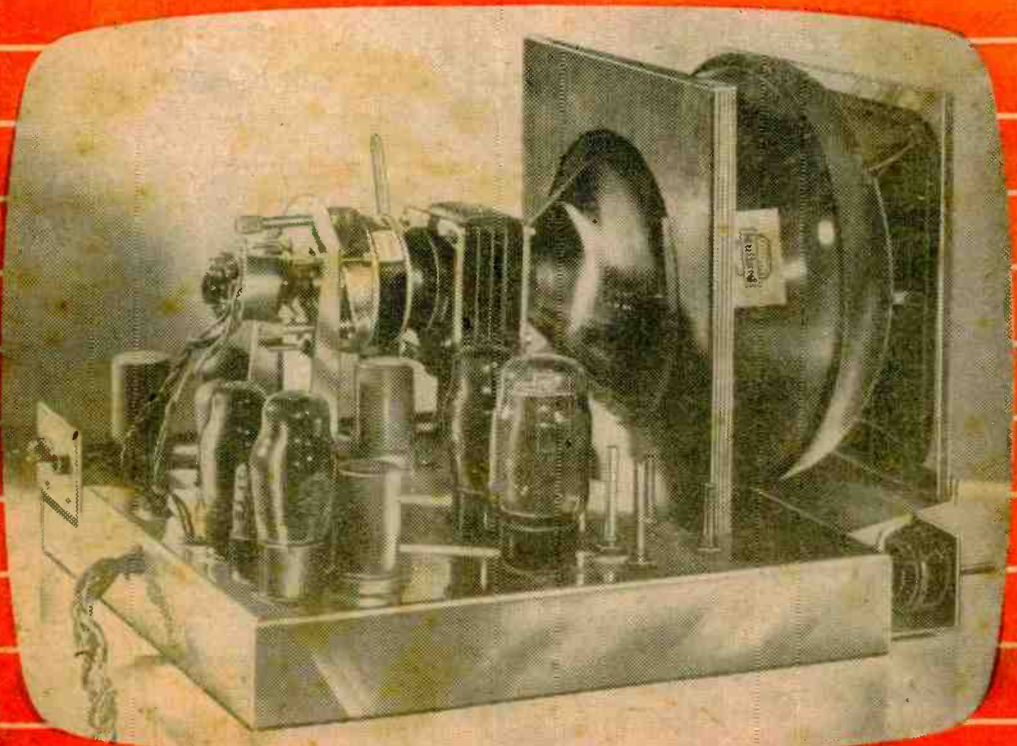
9D

EDITOR F. J. CAMM

& "TELEVISION TIMES"

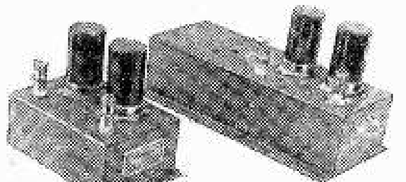
Vol. 1 No. 8 JANUARY 1951

A NEWNES PUBLICATION



IN THIS ISSUE

Television at 200 miles



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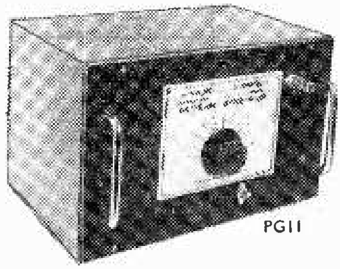

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This unit includes the VCR97 Tube, Tube Fittings and socket and a 6in. PM Moving Coil speaker with closed field for Television.

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PRACTICAL TELEVISION
& "TELEVISION TIMES"

Editor: F. J. CAMM

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Televiews

Amateur TV Broadcasts

WE are glad to note that the P.M.G. has adopted one of the suggestions we made in a previous issue, by authorising the use of special frequency bands for amateur television broadcast experiments. As reported elsewhere in this issue the bands are 2,300 to 2,450, 5,650 to 5,850, and 10,000 to 10,500 Mc/s. These bands are extremely high, but no doubt the P.M.G. has in mind the possibilities of changing the present frequency as used by Alexandra Palace if experiments prove that the higher frequencies provide better results.

We also made the suggestion, it will be remembered, that the B.B.C. should radiate special programmes for amateur experimenters, not, of course, on the existing frequency. This would enable many experimenters who could not afford a complete transmitting and receiving system to build experimental receivers. We hope that a little later on he will see his way clear to do this.

We also hope that once the amateurs have conducted vital experimental work the P.M.G. does not sequestrate the frequencies at present allocated to amateurs as was done in the case of radio. There are thousands of skilled technicians in this country keenly interested in television, and they can, without cost to the B.B.C., conduct experiments on a national scale which the B.B.C. itself could not possibly afford to do. The results will enable the B.B.C. to plot a television reception map of the British Isles which would be of enormous assistance to them when selecting the location of future stations, and the results would also be of use to their own designers.

A large amount of credit for the excellence of our radio transmission is due to the amateur transmitter and experimenter.

TV TIREDNESS?

THE recent criticism by school-teachers that children were arriving at school in the morning tired-eyed through looking-in to television programmes at night does not reflect the intelligence which one should be able to associate with school-teachers. Presumably the scholars prefer the TV programmes to homework, and it is nonsense to suggest that homework does not make them feel tired. Are we expected to believe that an entertaining TV programme tires them out, whereas homework does not? Or is the criticism intended to convey the impression that the programmes are so bad that they send people to sleep?

U.H.F. TELEVISION TRANSMITTER

A NEW type of transmitter that will aid in opening additional air lanes for television has been announced by Stanford Research Institution, California. It has been designed for transmitting signals in the ultra-high-frequency region of 475 to 890 Mc/s, recently authorised by the Federal Communications Commission for experimental television broadcasts.

It is adapted to the present needs of the U.H.F. Experimental Station at Longheath. As installed, the transmitter operates on 530 Mc/s and it radiates an entirely standard, amplitude modulated picture signal of high quality. At present it is radiating only 150 watts of power, but it is capable of being amplified by radio-frequency amplifiers to a much higher power. It is believed that this is the first time that phase-to-amplitude modulation has been applied to television. The heart of the transmitter is the phase modulator unit, which serves to advance the phase of one of the two signal channels by exactly the same amount that it retards the phase of the second channel.

Another innovation is a vacuum tube which does the modulating work of several conventional tubes.

The perfection of this transmitter is a step towards the opening of the U.H.F. region for commercial television programmes, which we hope one day to have over here.

The Stanford Institute have also developed a converter for bringing U.H.F. signals to V.H.F., which is the standard for commercial receivers.

"BUILDING THE P.T. RECEIVER"

A REMINDER that readers who missed the details for building the television receiver designed and built in our laboratories may now obtain for 3s. 6d. a reprint of those articles in booklet form. Copies may be obtained from or through any newsagent, or direct from us for 3s. 9d. Orders should be addressed to the Publisher, Geo. Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.

F. J. C.

MAINS HUM

The Effects of Poor Smoothing in Modern Television Receivers

By BERNARD BARNARD

IT seems very likely that every experimenter who embarks upon the thorny path of home television construction has, at some previous time, built at least one mains-operated radio receiver and, in this case, it is equally probable that he has had to deal with the problem of getting rid of mains hum.

The problem of mains hum in television is one which underlines the fact that the human eye is one of the most intolerant of organs and whereas in sound radio an appreciable amount of hum is ignored by the ear, in vision only complete elimination is acceptable.

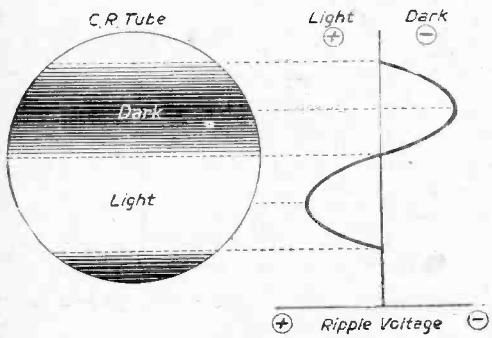


Fig. 1.—50 cycle ripple voltage and its effect on the picture. (Compare with Fig. 3.)

The visual indication on the C.R. tube of the presence of 50 or 100 cycle ripple is not always as obvious and straightforward as is sometimes thought because, if only a small amount is present (which is usually the case), the effect may be to produce serious spoiling of the picture which is suggestive of an entirely different fault. For instance, I have known two cases of hum which had been quite wrongly assessed as being due to shadow on ex-Government VCR97 and 517 tubes.

It may be helpful to commence by enumerating the obvious effects of mains hum and then to analyse them and thus to suggest cures. The equipment used for the various experiments made in the preparation of this article was a home-constructed outfit using a VCR517 and the photographs were taken during actual transmissions; they have not been faked in any way but the ripple effects that they illustrate were deliberately put on by removing relevant smoothing gear.

The obvious effects of the presence of mains ripple are as follow:

(1) Dark bars across the picture.
(2) A sine-wave edge to the picture.
(3) Frame scan oscillator locking on the hum instead of the sync pulse.

Now let us examine these three effects in some detail in the order in which I have listed them. Firstly, dark bars across the picture.

This is caused by the electron beam through the tube being modulated by the ripple voltage in much the same way as the signal voltage produces the light and dark parts of the picture; since the frame sweep is occurring at 50 c.p.s. and the ripple voltage is alternating at either 50 or 100 cycles per second, the visual effect is a dark bar across the screen which will remain steady so long as the two frequencies remain the same. If either frequency drifts, the bar will move slowly up or down the screen.

The most likely electrode on the tube at which the mains ripple can modulate the electron beam is the grid; but it is not the only one. A.C. ripple at the cathode, focusing anode or even the final anode can produce the same effect since the beam passes in turn through the field of all these electrodes.

A Simple Test

When considering the effect of this on a television picture, it is necessary first of all to modify the description "dark bars across the screen." Figure 1 shows one cycle of 50 c.p.s. A.C. drawn in relation to the C.R. tube screen and it is readily apparent that in addition to dark bars (when the ripple voltage goes negative) we also have *light* bars when the ripple goes positive. And it is very often these light bars which have the most distressing effect on the picture because, if the brilliance control is adjusted to give reasonable detail in the dark areas, the light parts will be almost completely devoid of detail. This can be particularly noticeable in the

Fig. 3.—50 cycle ripple modulating the C.R. tube. (Compare with Fig. 1.) Ripple has spoiled interlace and frame linearity—lines are spread out towards top of picture.

fringe areas when the signal is weak and it is not readily apparent that the fault is due to hum.

If you experience this trouble and want to check definitely whether it is due to mains ripple, the following is a simple and reliable test. Reverse the mains plug: this will reverse the phase of the ripple voltage with respect to the frame sweep and, if the trouble is due to hum, those parts which were dark before will now be light, and *vice versa*.

This is perhaps a good point at which to stress that the amount of ripple voltage that is tolerable in a television receiver depends to a very large extent upon the strength of signal in the area in which the set is used. In the fringe areas it is quite possible for reception to be apparently hum-free during 90 per cent. of transmission time; hum will only show up on those pictures which are represented by a low degree of modulation and therefore are weak at the C.R. tube. The hum bar will then show up on these shots and somewhat mysteriously disappear when the signal goes back to normal level.

Another useful test which will give an indication of the actual hum level on any set is to adjust the brilliance control so that the raster is just visible, set the frame speed control to the usual position for reception and, with no picture transmission coming in, to notice the slight shadow which will be seen moving up or down the screen. This must be *slight* if the ripple is within acceptable limits and should disappear completely when the brilliance control is advanced.

Ripple Edge

Let us now turn to the second of the "obvious" effects mentioned above—the sine-wave edge to the picture.

This is perhaps the most straightforward of ripple troubles. The cause is mains ripple getting into the time base H.T. supply and, in particular, on to the deflector plates which are associated with the line scan. We then have a state of affairs within the tube where the frame deflector plates are receiving a 50 cycle voltage from the frame oscillator and the line plates, in addition to their normal function, are receiving a 100 cycle ripple voltage; the arrangement is exactly that of an oscilloscope giving a trace from the mains voltage and, if the line scan oscillator is disconnected, a single vertical line will be obtained showing two complete cycles of sine wave. The ripple frequency is almost certainly 100 in this case since the hum voltage is coming from the time base power pack which will be, in almost every case, a full-wave rectifier.

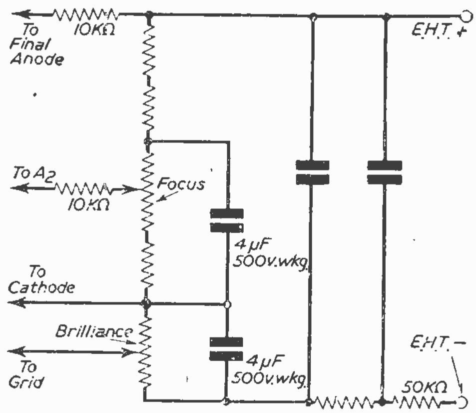


Fig. 2.—Additions to E.H.T. circuit which will help to remove 50 cycle ripple.

It is necessary to look very carefully at the vertical edge of the raster to ascertain if a small amount of this type of hum is present. It can be quite easily overlooked and will only be seriously noticed during rapid "pan" shots when the whole picture will appear to ripple. And in this way the trouble, due to inadequate time base supply smoothing, can mistakenly be blamed on lack of linearity in the raster.

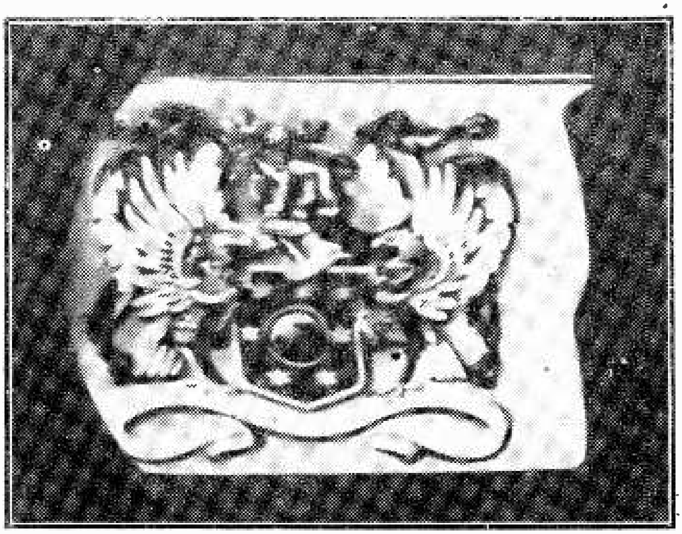


Fig. 4.—100 cycle in time base. Shift control has been adjusted to reveal right-hand vertical edge. Note two complete cycles of ripple indicating source as full-wave rectifier. Note also distortion of picture. Left-hand edge is similarly affected but is hidden by tube mask.

Hum Lock

The last of the effects that we have mentioned concerns frame synchronisation. Since the ripple voltage is the same or double the frequency of the frame sync pulses, it is quite possible for the frame oscillator to lock on the hum voltage instead of the pulses. This, of course, produces the effect of the frame dividing line showing on the screen and the frame fly-back lines will be brightly traced across the picture.

This kind of fault may be due to excessive hum voltage—indeed this is generally the case—but it can also be brought about by some fault in the receiver, such as lack of band width, which is causing the pulses to be extremely weak when they reach the time-base oscillator; the oscillator therefore triggers on the relatively stronger hum voltage.

Again, it is those receivers which are working in areas of weak signal strength which are most likely to suffer from this fault.

It can be most puzzling when pulse and hum volts are more or less equal ; a programme will be perfectly received until the fade out when, as soon as the new studio camera is faded in, the frame oscillator will slip from the pulse on to the hum. The picture will, from then on, remain out of position on the screen with fly-back lines showing until some other change in transmission brings it back again. A temporary remedy for this trouble is again the simple one of reversing the mains plug.

Finally, here are a few points which will help in tracing the point of entry of A.C. ripple volts into the set.

The first step is to make sure whether the ripple is 50 or 100 cycle hum. In the case of time base trouble (sine-wave edge) this is almost certainly 100 cycle and indicates the necessity of better smoothing in the time-base H.T. supply circuit.

In the cases of hum bars and frame sync troubles, it may be either frequency since the source may be the full-wave H.T. rectifiers or the half-wave E.H.T. circuit. If it is the former there will be two dark bars across the screen because the hum frequency is double the frame scan frequency.

E.H.T. Supply

However, in nine cases out of ten, it will be found that there is only *one* dark bar since it is nearly always the E.H.T. supply that is the cause of the trouble. The popular system of resistance-capacity smoothing for E.H.T. is seldom quite good enough where weak signals are to be handled and some elaboration of this circuit may be found well worth while. Illustration Fig. 2 indicates several points where extra smoothing can be added and which will materially reduce hum in the E.H.T. supply circuit. By the way, don't use electrolytic condensers in this circuit as their drain current adds considerably to the load on the rectifier and transformer and will upset the voltage values throughout the bleeder chain.

Voltage Multipliers for Television

Circuit Details of Some Modern Arrangements

By T. W. DRESSER

IN the May issue of PRACTICAL TELEVISION the writer outlined some of the technical requirements involved in voltage doubling, and presented a practical circuit for supplying a VCR97 from a 6H6 valve, using 1,000 volts input. Subsequently, in a later issue, the theory underlying doubler practice was considered in more detail and it was stated that doubler, tripler and quadrupler circuits have come into their own in television, in which they have many practical applications not always possible in ordinary sound radio. Events since then have confirmed that opinion. Of the TV receivers on sale in this country in kit form at least three use a doubling arrangement for obtaining the E.H.T., while, on the Continent, use is made of a triple circuit to provide up to 20,000 volts for projection type C.R. tubes, and in the U.S.A. many manufacturers are using some form of voltage multiplier to supply the H.T. required for time base and other circuits, although not for E.H.T. Flyback and R.F. methods of securing E.H.T. are now almost standardised over the Atlantic, and do not look like being ousted by any other known method.

There are many factors influencing this swing-over from normal full-wave rectification, not the least of them being the considerable saving in weight. Without an intimate knowledge of valve costs to the manufacturers it is difficult to assess whether or not there is a saving in cost, too, but presumably there is some. It is probable, however, that similar circuits will soon be incorporated in British TV sets, possibly in a modified form to suit our valves and circuits.

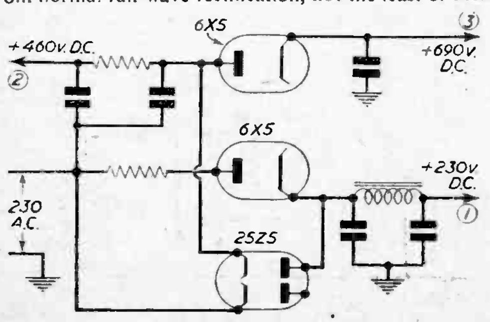


Fig. 1.—Obtaining various voltages without complicated networks.

Several Voltages

It is one of the advantages of multiplier circuits of this nature that several different voltages can be "picked off" without the necessity for potentiometer networks, dropper resistances or much de-coupling. Such an arrangement is shown in Fig. 1, in which a doubler and a tripler are used in a combined circuit to give three outputs: 1. Mains voltage less the drop through the rectifier V1 ; 2. Positive voltage twice that of the mains ; and 3. Positive voltage three times that of the input. Assuming such a circuit were in use on 200 volts mains, it will be seen that supplies would be available at around 195, 400, and 600 volts, very useful figures to have in any TV receiver.

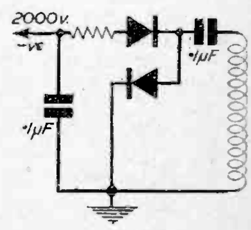


Fig. 2.—Two metal rectifiers used in place of a 6H6 or similar valve.

Another Scheme

Another simple circuit is that of Fig. 2, in which two metal rectifiers replace the 6H6 used in a similar arrangement in the May issue of PRACTICAL TELEVISION, while a quadrupler circuit is shown in Fig. 3. From the latter, supplies can be taken independently from each of the doubler sections, or in quadrupler form from terminals

2 and 3, but the load to which the supply is taken must not be earthed (see isolating condenser marked *).

Many other variations of multiplier circuits exist in which use is made of metal and valve rectifiers, either in combination as in Fig. 3, or separately, but all are based essentially upon the simple doubling circuit in which the 6H6 was used. Incidentally, the circuits shown in Figs. 1 and 3 are rated at 60 to 80 mA. output, but it must be remembered that the reservoir and smoothing condensers should be of larger capacity than in a full-wave circuit, and not less than 16 μF. in any case.

In all multiplier circuits it will be found that the regulation is poor—the voltage fluctuating with the load. This is particularly noticeable in doubler and quadrupler arrangements where a current flow of 60 mA. will drop the output voltage by 100 where the original off-load voltage was 450 and, similarly, will drop the doubler output by approximately 70 volts in the same conditions. The regulation in a tripler circuit is rather better than this because, although the input voltage has been multiplied three times, only one multiplying action has

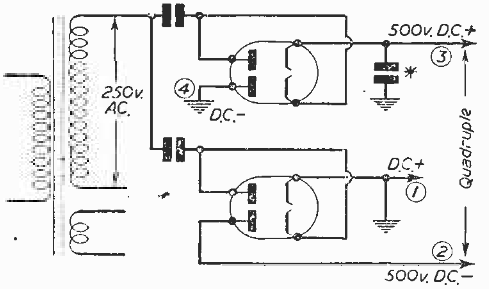


Fig. 3.—A simple quadrupler circuit.

taken place, and the other valve functioning as a "straight" half-wave rectifier, has helped considerably to stabilise the combined circuit (see Fig. 4). The poor regulation and the necessity for large chokes and condensers in the smoothing circuit are the principal objections to the use of multiplier circuits of the half-wave variety. The need for such large smoothing components arises from the fact that the ripple frequency in such circuits is that of the mains frequency.

The only multiplier in which this does not hold good is the full-wave doubler circuit, which was used extensively before the war in certain types of instruments, and in at least one popular midget receiver. The reason why normal chokes and electrolytics can be employed with this circuit is that its ripple frequency is twice that of the mains, as in normal full-wave rectifiers.

In all doubler circuits the value of the output voltage is largely determined by the capacity of C and C1

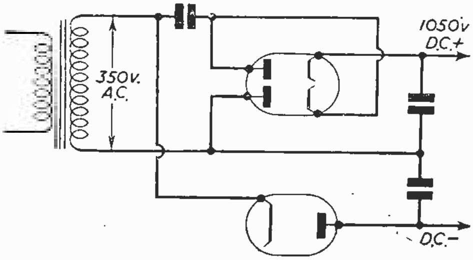


Fig. 4.—A half-wave rectifier used as a stabiliser.

(Fig. 5), as was indicated in the table of capacities given in the May issue; the larger their capacity the nearer the output approaches twice the peak input voltage.

Advantages

British TV enthusiasts, in general, have not so far used multipliers for ordinary H.T. supplies, but when their advantages are realised they will undoubtedly do so. E.H.T. supplies, however, are in a different category, and with the prices of R.F. and flyback units beyond the reach of most enthusiasts' pockets—and also having regard to a strongly-founded rumour that some

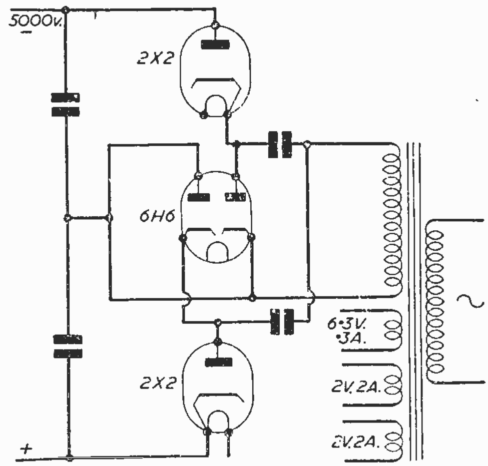


Fig. 6.—A circuit for providing E.H.T. voltages.

manufacturers are reverting to E.H.T. transformers due to excessive trouble in flyback units—a reasonable method of securing 5,000 volts for magnetic tubes can be a boon. Such a circuit is given in Fig. 6, and is essentially an adaptation of the original 6H6 unit, but making use of three valves, one 6H6 and two 2X2's in a form of quadrupler, similar to, and based upon, that in Fig. 3.

It may be a matter of surprise that three valves are used, and in fact it was proposed to use only two 6H6's originally. However, although the cathode heater insulation will withstand a potential difference of 2,500 volts it is rather unreasonable to expect it to stand up to 5,000 volts, and first tests on a unit using two 6H6's proved this by a breakdown of the cathode heater insulation and both filaments burning out. Before the actual mishap, however, the output voltage had reached 5,000 on the meter and remained steady for some seconds. In view of this it was considered much more logical to use three 6H6's as in Fig. 7, with the two outer ones having their anodes and cathodes paralleled and

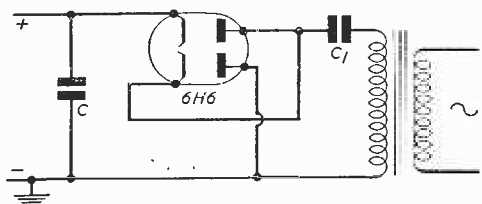


Fig. 5.—The values of C and C1 play an important part in the output rating.

the cathodes tied to the filaments. There could then be no question of cathode heater insulation breakdown, as they would be at the same potential. But it would mean that the filament transformer windings must be insulated to at least 6,000 volts. Such a unit was made up and functioned quite satisfactorily for the period of the test—one hour—and it is worth more prolonged test by those readers who are interested.

But it was felt that a doubt existed whether the unit would stand up to long usage and it was finally altered by the substitution of 2X2's, high-voltage rectifiers, for

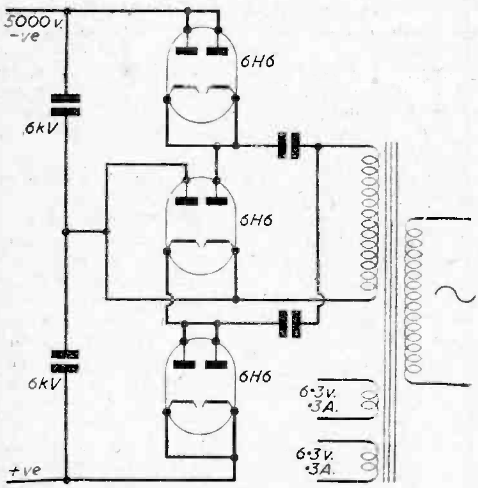


Fig. 7.—A development using 3 6H6's.

the outer 6H6's. In this form the unit is hardly any more expensive, as there are plenty of 2X2's on the surplus market, and it is absolutely reliable. Moreover, the input voltage is still the same as in the original circuit, i.e., 1,000 volts from a 500/500 H.T. winding. Quite probably a 450-0-450, earthing one end and omitting the C.T. would suffice, as theoretically it should supply 5,040 volts without allowing for losses.

The Transformer

A transformer suitable for the unit can be homewound provided the builder has patience or has constructed the coil winder described in PRACTICAL WIRELESS some time ago. The necessary data, laminations, wire gauge, insulation, etc., are given in Fig. 8.

Obviously if such a transformer is purchased it will not be exceedingly cheap and will probably cost around thirty shillings, but that, together with the cost of other components, will be decidedly cheaper than a commercial E.H.T. unit and quite as satisfactory.

Transformer Data

T.P.V.6 Laminations: M.E.A. 29a: 1in. stack

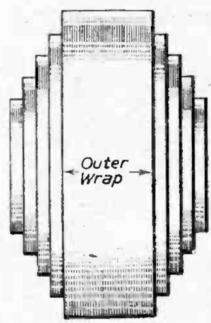


Fig. 8.—In construction the windings should be progressively stepped back as the windings go on, as in the illustration.

Primary.
210v. : 1,290 turns
230v. : 1,410 ,,
250v. : 1,530 ,,
32 s.w.g. enamel wire.
Insulation: 6 turns oiled cotton.
6.3v. heater winding; 40 turns 36 s.w.g.
Insulation: 6 turns oiled cotton.
H.T. winding: 6,200 turns 45 s.w.g. enamel.
Insulation: 6 turns oiled cotton.
2v. heater winding: 14 turns 20 s.w.g.
Insulation: 6 turns oiled cotton.

2v. heater winding: 14 turns 20 s.w.g.
Final wrap: 6 turns oiled cotton.

1950 Radio Amateurs' Examination

THE number of entries for the 1950 Radio Amateurs' Examination showed a slight decrease as compared with former years. The general standard of candidates' work in the 1950 examination, both technically and the method of approach to the questions, was fairly high. Practically all questions were attempted by the candidates. A report on each question follows:

Year	Number of candidates		Number of passes	Number of failures	Percentage of failures
1950	Home	823	653	170	20.6
	Overseas	10	7	3	30
1949	Home	885	628	257	29
	Overseas	13	8	5	38.3

The following general report is given on the papers as a whole and is not necessarily applicable to the work from individual schools.

Question 1 (Transmitter)
Well done by most candidates. A small number of the candidates in their diagrams of single-ended power amplifier stages indicated incorrectly the method of neutralisation by showing the neutralising condenser connected directly between the anode end of the coil and the grid and the high tension supply connected to the end of the anode coil.

Question 2 (Receiver)
Very well done by practically all candidates.

Question 3 (Non-interference condition of licence)
Well done by most candidates.

Question 4 (Heterodyne frequency meter)
Fairly well done by most candidates.

Question 5 (Aerial radiation)
Well done by practically all candidates.

Question 6 (a) Classes of amplification or, alternatively, (b) Neutralisation

About 75 per cent. of the candidates chose the first alternative which practically all answered very satisfactorily. The remainder of the candidates who chose (b) satisfactorily described the procedure for neutralising a power amplifier, but a fair number of the candidates showed incorrectly in their diagrams the position of the neutralising condenser and the high tension lead (see report on Question 1).

Question 7 (Calculation)
Well done by practically all candidates.

Question 8 (Frequency, wavelength and propagation)
Well done by practically all candidates.

PROJECTION TELEVISION—2

Report of a Lecture Given to the Institute of Practical Radio Engineers to Honour the Memory of the late Mr. D. F. Harrison

By EMLYN JONES, B.Sc., A.M.I.E.E.

PROCEEDING in the other direction everything gets smaller and more convenient, so obviously the aim should be to make the C.R. tube face as small as possible. The Mullard system is the smallest commercial projection television system at present marketed.

In reducing the diameter of the tube two limitations are found :

(a) The spot-size must be small enough to enable 405 lines to be resolved in the distance the picture height occupies on the tube face ;

(b) The tube face must be capable of dissipating enough power to produce the required total amount of light from the phosphor. If this heat is dissipated in too small an area the glass may crack.

Now the first difficulty can be met by increasing the E.H.T. voltage applied to the tube and decreasing the current, leaving the power in the beam unchanged, and to a first approximation, the light output unchanged. Provided it is not carried too far, this process will eventually result in a small enough spot, and the second factor is then the limiting one.

With a tube diameter of $2\frac{1}{2}$in., the maximum safe power in the tube face is found to be $6\frac{1}{2}$ watts, and the equipment must be so designed that this figure is never exceeded. To allow for tolerances in components, and fluctuations of supply voltage, the design is based on a somewhat lower figure, about 5 watts. The nominal extra high tension voltage (E.H.T. voltage) is 25 kV., and at this figure the spot is more than small enough for the British 405 line system.

The phosphor efficiency is 2.3 candles per watt, giving 11.5 candles at 5 watts. With a picture 12in. by 16in. this gives a mean brightness of 20ft.-lamberts on a screen having a "gain" of 5 (screen gain will be explained when dealing with viewing-screens). Higher *peak* brightnesses are obtainable because there are always some black areas on the picture, and the power which might have been dissipated on these areas can be used to boost up the brightness of the high lights without exceeding permissible mean power dissipation.

These brightness figures should not be considered very seriously at this stage, because they are only half the story. This point will be dealt with fully later.

The Cathode-ray Tube

Fig. 9 shows a sectional drawing of the MW6-2 projection tube, and is largely self-explanatory. The scanning angle is only 38 deg. as against the 50 deg. usual for directly-viewed tubes. This is one reason why the scanning power is only about 25 per cent. greater than that required for a directly-viewed tube operating at 7 kV. The end of the tube is made of a special glass which does not suffer from discoloration under X-ray or electron bombardment. The phosphor has a colour-temperature of 6,500 deg. K., which approximates to daylight. The aluminium backing provides many advantages. It prevents ionburn, increases the available contrast ratio, prevents screen "striking," and, in conjunction with the earthed outer coating, provides a capacitance of 450 pF. to ground which is a useful final smoothing condenser.

Fig. 10 shows the anode-current and brightness curves of this tube.

Fig. 11 shows the upper limit of permissible E.H.T. supply curves. This is so chosen as to restrict both the maximum potential, and maximum screen power dissipation, to safe values.

Now it will be apparent that all work described so far depends on the E.H.T. unit. Unless a simple, compact, safe and reliable unit can be designed, to give the characteristics shown in Fig. 11, the development of a small and efficient C.R. tube and optical unit will be of no avail.

E.H.T. Supply Methods

There are many ways in which a 25 kV. power unit can be made. The most obvious is the standard 50 c.p.s. transformer, rectifier, and smoothing condenser. This is both a dangerous and an expensive method. It is dangerous because adequate power can be drawn from the mains to administer a fatal shock. It is expensive because both the transformer and smoothing condensers are heavy and costly items.

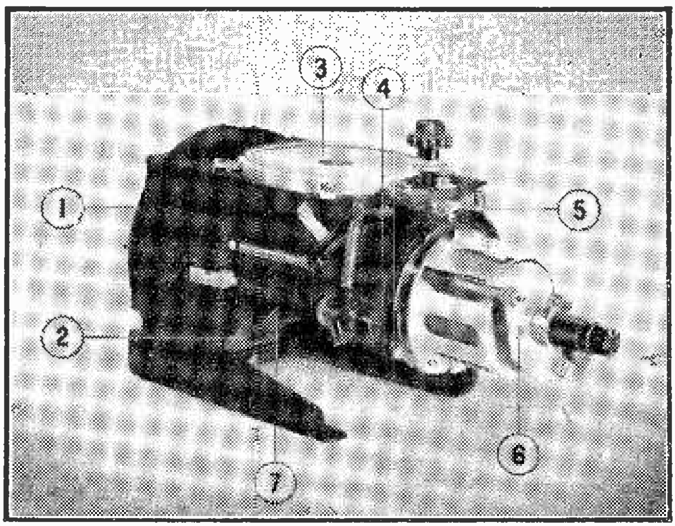


Fig. 8.—Optical unit of the system. 1. Spherical Mirror ; 2. Plane Mirror ; 3. Corrector Lens ; 4. Yoke carrying the tube mounting, focus and deflection coils ; 5. Yoke locking plate ; 6. Focus coil locking screw ; 7. Dust-proof grommet.

A much better method is to use a radio frequency oscillator and high-frequency transformer, rectifier, and smoothing condenser. The extra cost of the oscillator valve is more than repaid by the cheaper transformer and smoothing condenser. Because the power output is limited by the valve, and the high impedance of the tuned circuits, the equipment can be designed so that it is impossible to obtain a fatal shock. However, there are certain disadvantages. Corona is much more troublesome at high frequencies, the unit must be carefully shielded to prevent R.F. interference with the receiving circuits, or with other broadcast receivers, and a great deal of care must be taken in designing high-efficiency tuned circuits. This, in turn, means that the shielding must be well spaced from large diameter coils, so the unit tends to be bulky.

In directly-viewed sets it is often possible to obtain the E.H.T. supply of about 5 to 8 kV. from rectification of the peaks of high voltage appearing on the anode of the line scanning valve. In the projection receiver this is rather difficult because of the comparatively large power (5 watts) required. Moreover, when the set is unsynchronised the voltage at the anode of the line scanning valve may increase considerably, the amount depending on the tightness of synchronisation, so the projection tube would be overstressed during these periods.

The method used in the present equipment is, in effect, an adaptation of that just described. We shall call it the Pulse type.

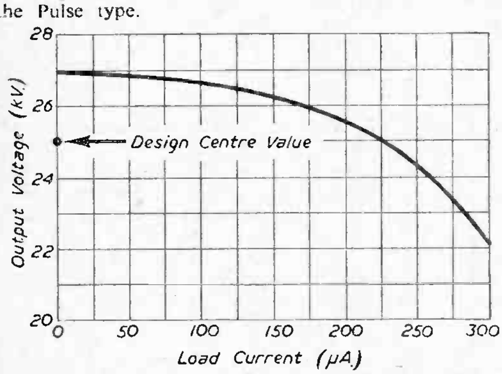


Fig. 11.—Limiting regulation curve of E.H.T. supply.

The Pulse Type E.H.T. Unit

Fig. 12 shows a simple circuit in which the anode-current of a pentode valve flows through an inductance L. Suppose the grid voltage of the valve is increased in such a manner that the anode current increases linearly, i.e. its rate of change is constant. The voltage-drop across the inductance is L times the rate of change of current, and is therefore also a constant. By choice of L this can be made equal to the difference between the H.T. supply-voltage and the "knee" of the pentode I_A—V_A characteristics, i.e. the potential difference E in Fig. 13(a). Since E is constant the operating point will follow the vertical straight line BC. Now we have assumed a uniform rate of rise of current, therefore equal increments along BC represent equal intervals of time, so we can find the grid voltage waveform required to produce this uniform rate of rise by plotting the grid voltages —6, —4, —2, etc., against the times which correspond to their intercepts on BC. This curve is shown in Fig. 13(b), which, it will be seen, is curved in the same sense as the waveform obtained from a simple time-base circuit such as a blocking-oscillator.

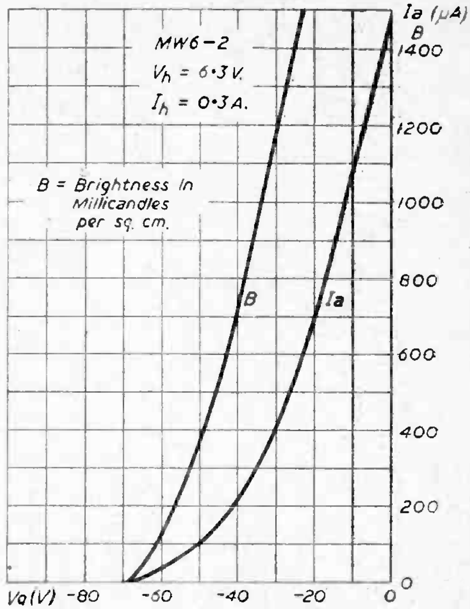


Fig. 10.—Anode-current and brightness characteristics of the MW6-2 Projection C.R. Tube.

Assuming, then, that a blocking-oscillator is used to supply our pentode valve with the required grid voltage waveform, the operating point will follow the line BC. At point C, before the working-point enters the knee of the valve, the "flyback" should occur, cutting the valve off. Now a certain amount of energy is stored in the inductance L at this instant and this cannot be

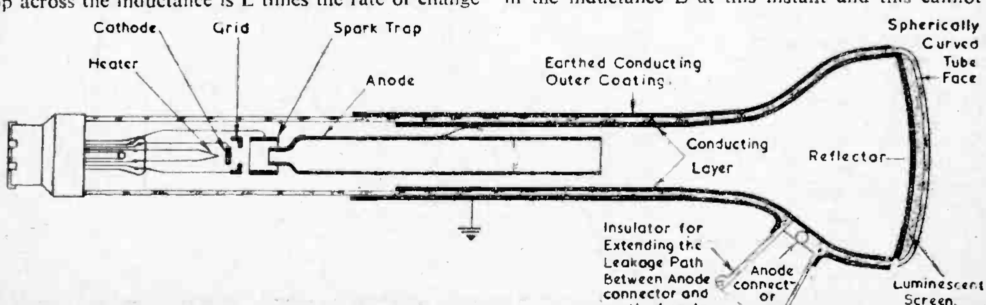


Fig. 9.—A sectional drawing of the MW6-2 tube.

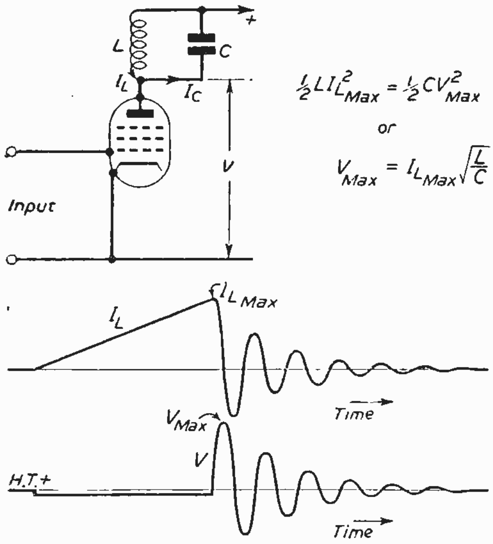


Fig. 12.—The "Ringing Choke" circuit.

suddenly destroyed. An oscillation takes place in the resonant circuit formed by the inductance and the stray capacity across it, the current which was previously passing into the valve now being diverted into this stray capacity, charging it up to a high potential. The condenser then discharges through the inductance, and the oscillation continues until finally damped out as shown by Fig. 12. The first voltage peak is given approximately by the expression :

$$V = I\sqrt{\frac{L}{C}}$$

where V = peak voltage appearing across the stray capacity C.

I = current flowing in the inductance L at the instant the valve is cut off.

If typical values are inserted into this equation, such as I = 0.1 amp., L = 0.5 henry, C = 50 × 10—12 farad, the peak voltage will be found to be very high, in this instance 10,000 volts.

Now, although high, this voltage is not high enough for our purpose, and it is necessary to use a voltage doubling or tripling rectifier circuit to obtain 25 kV. In the present instance it was decided to use a tripling circuit, so the current I was adjusted to produce 25/3 kV. or 8.5 kV. approximately. The valve is tapped down the inductance L in order to reduce the peak voltage on its anode, and its current is increased to keep the stored energy the same. These modifications are shown in Fig. 14, which also shows the tripling circuit and the waveforms for three cycles of operation.

The Tripling Circuit

The tripling circuit is most easily understood by considering it as three quite separate half-wave rectifiers, the D.C. outputs of which are added together because from the D.C. point of view they are in series. From a high-frequency point of view, however, the three rectifiers are in parallel across the inductance L since the reactance of the coupling capacitors is low at the ringing frequency. Thus each rectifier will produce a rectified output of 8.5 kV. D.C., and the total voltage will be 25.5 kV. when no current is being drawn from the unit.

Voltage Regulation

If the C.R. tube is allowed to draw current, as it must when in operation, the rectifiers draw energy from the resonant circuit during their instants of conduction, i.e. during the + and — voltage peaks. This reduces the peak amplitude of the voltage as shown in the lower part of Fig. 14 so that the rectified output drops from its original value to some lower figure.

Obviously if the energy stored in the resonant circuits is large, the effect of this energy drain will be small, i.e. the voltage will not drop far, and vice versa. However, the energy stored in the inductance is dissipated each cycle, and must be re-supplied from the valve, so that a high storage of energy involves a large power supply to the equipment, which is undesirable.

It can be shown that the effective source impedance R

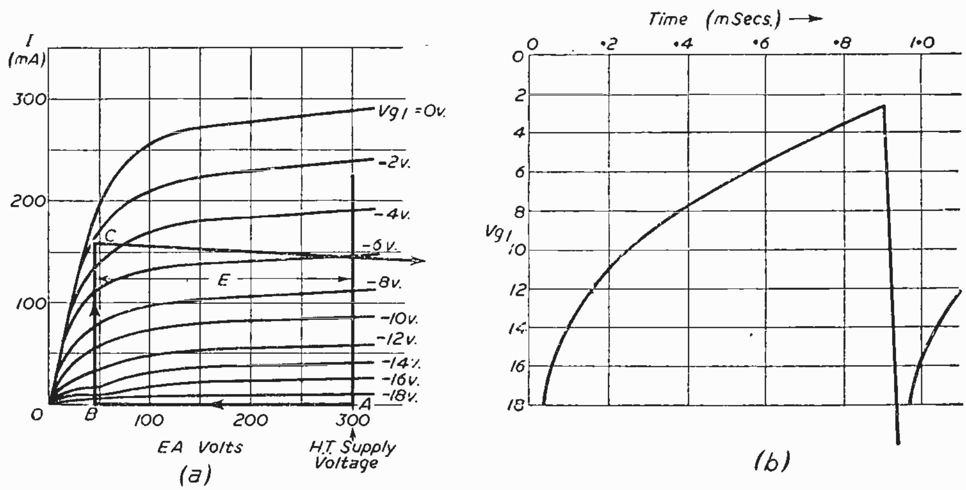


Fig. 13.—(a) Typical Anode-Current Anode Voltage diagram for a "Ringing Choke" circuit. (b) The required grid-input waveform if the working point is to follow the line B.C.

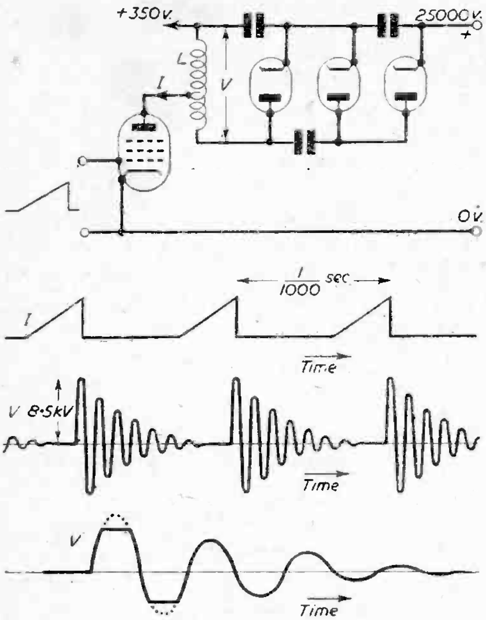


Fig. 14.—The voltage tripling circuit, waveforms of input voltage, and anode voltage.

of the present unit is related to the power input P by the approximate formula

$$P=\frac{V^2}{2R}$$

which expresses in symbols the relationship between anode input power and voltage regulation just described. A satisfactory source impedance would be, say, 5MΩ, giving a drop of 1 kV. in 25 kV. for the full load current of 200 μA. Inserting these values in the expression gives an input power of 62.5 watts, which is much too large. On the other hand, a more reasonable power input, say 20 watts, produces a source impedance of about 15 MΩ, which is too high. These curves are shown dotted in Fig. 15, in which the power indicated has been increased slightly to allow for screen current. The maximum permissible voltage curve has been re-drawn from Fig. 11 for comparison.

Despite this dilemma a satisfactory solution has been found as shown in the lower full-line curve, and the way in which this has been achieved will now be described.

Automatic Voltage Stabilisation

In Fig. 16(a) the tripler circuit and the load have been represented by a variable resistor R of value equal to the equivalent damping imposed on the resonant circuit by the load current. This resistor is not, of course, present

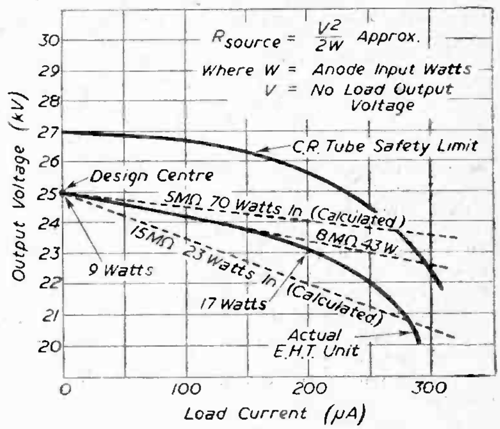


Fig. 15.—Various regulation characteristics for the E.H.T. supply unit. For clarity, the vertical scale covers only the range above 20 kV. This makes the curves appear rather worse than they really are.

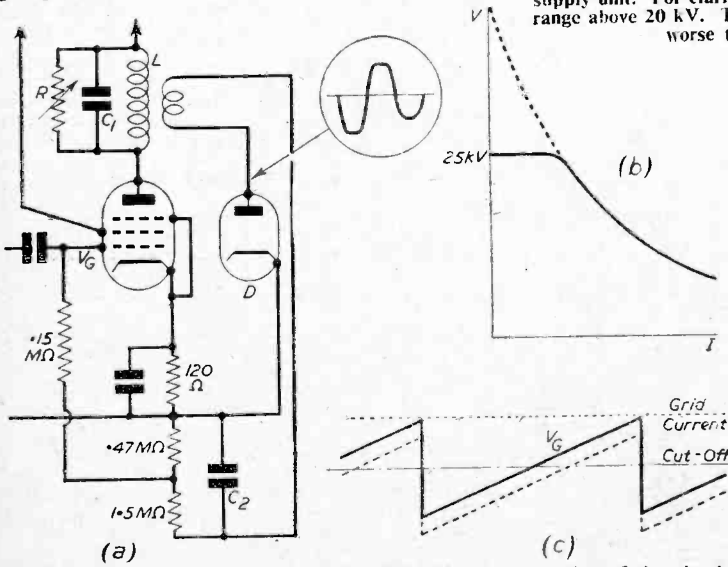


Fig. 16.—The voltage regulation circuit. (a) The relevant portion of the circuit. (b) The I-V diagram. (c) Grid waveform for sloping portion (full lines) and flat portion (dotted lines) of the I-V diagram.

in the actual circuit. The capacitor, C_1, represents unavoidable stray capacity.

A coupling winding has been introduced which applies to the anode of a diode D, a potential which is a replica of that appearing at the anode of the pentode but reduced in magnitude and reversed in sign. The waveform of this voltage is shown in the small circle, and it will be seen that the diode rectifies the second half-wave and builds up a potential across the condenser C_2 which is proportional to it, and hence proportional to the first negative voltage peak on the anode.

As has been explained, this peak voltage is related to the amount of energy stored in the resonant circuit after the rectifiers have removed the amount necessary to supply the load.

(To be continued)

A "Spot-wobbler"

A Simple Accessory for any Receiver to Cut Out the Line Structure

By H. C. S.

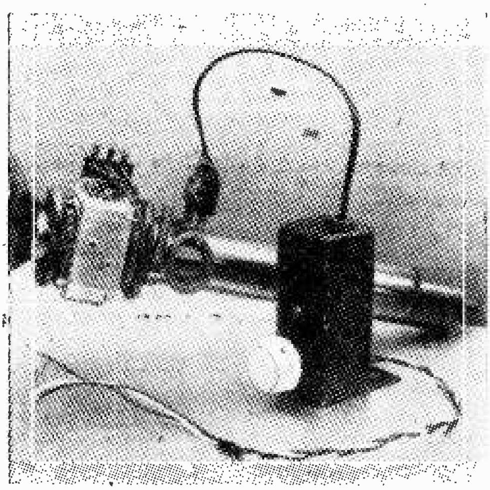
ONE of the problems of presenting a pleasing, and at the same time a sharply-defined television picture, arises from the tendency of a sharp focus to accentuate the line structure on which the picture is built. A method, known as "Spot Wobble," has been used by the leading laboratories for some years in order to obviate this defect in high-class pictures, but only recently has it commanded more general attention. Very briefly, it is a method of filling in the space between the lines with no loss of definition. The desirability of attempting this is shown up by the number of viewers who deliberately de-focus their pictures until the lines are no longer separated, preferring to accept the attendant loss of definition.

Spot Wobble

Fig. 1(a) shows a large scale view of a portion of a typical line structure, the spot on the cathode-ray tube being focused to as small a size as possible. If the spot is made to travel up and down as in Fig. 1(b) it will be appreciated that the lines can be apparently broadened in the vertical direction only. In order to preserve definition, the frequency of the up and down travel must be several times that of the fastest change of picture tone. The highest frequency required for picture tone change is 3 Mc/s in the present system of transmission, so the spot must be deflected at least 10 Mc/s.

Deflection

The electron beam which causes the spot can be deflected by either an electric or a magnetic field. If the former method is used, a pair of plates is arranged as in Fig. 2(a) and connected to a voltage alternating at 10 Mc/s. This voltage requires to be adjustable in order to obtain the right amount of deflection. In the event of the latter method being used, coils are arranged as in Fig. 2(b) and an alternating current of the right frequency is passed through them. This current also requires to be adjustable. The plates or coils may be external to the cathode-ray tube, making a convenient add-on unit practicable. If electrostatic deflection is contemplated, attention must be given to the effect of the heavy coating of graphite found on modern tubes. An inconveniently high voltage will be necessary to overcome the screening effect of this coating, making this method of deflection more suited to older and unscreened types of tube.



The completed unit.

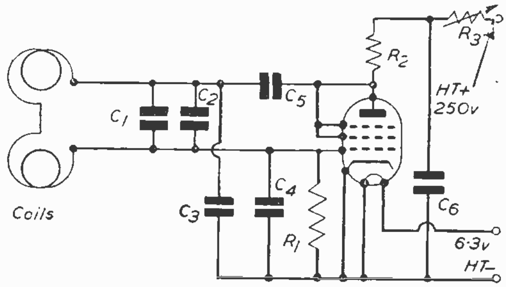


Fig. 3.—Circuit of the arrangement: R1 56 kΩ 1 watt; R2 10 kΩ ½ watt; R3 50 kΩ variable resistor; C1 100 pF; C2 50 pF variable trimmer; C3 50 pF; C4 50 pF; C5 500 pF; C6 500 pF; V—6F12, 8D3, 277, etc.

An Easily-constructed Unit

The photograph shows a unit built by the writer with its deflector coils in place on the neck of a cathode-ray tube. This unit has been equally successfully duplicated by a few friends, and no difficulty should be experienced in obtaining similar results. As will be seen, all of the components and the valve are contained within a standard coil can. Tapping the receiver for the small supply of H.T. and L.T. is the only modification needed. From the performance when working a 12in. tube, it is estimated that there is ample power to operate a 15in. tube if required.

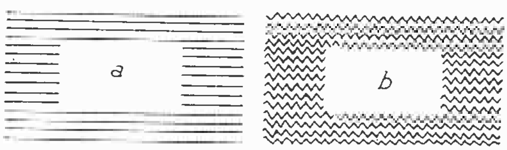


Fig. 1.—(a) Normal line structure, and (b) when the spot is 'wobbled.'

The Circuit

As will be seen from Fig. 3, the unit consists of a Colpitts oscillator feeding a pair of deflector coils, thus enabling it to be used with any type of tube. A miniature valve has been used in order to accommodate the whole within the can. This is not essential, however, if more room and a larger screening box are available, in which case a "surplus" VR65 type of valve may be used. The actual layout of parts is not important, other than ensuring short connections between components. This is best accomplished by mounting the components directly on the valve-holder and using only the wire ends of them for connecting links. The deflector coils used finally were a pair of low-impedance coils manufactured by Aren Radio and Television Co., of High Street, Guildford, designated "Deflector Coils Type W1." These were found to be superior to an earlier and awkward contrivance of heavy gauge wire and adhesive tape. The component values given have been evolved to give optimum performance using these coils.

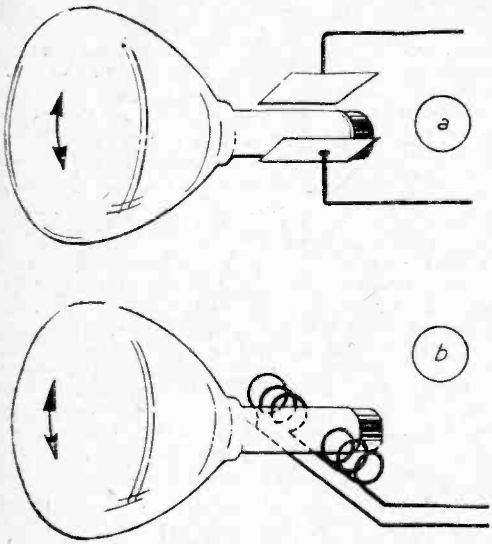


Fig. 2.—Arrangement of the main components for magnetic and electrostatic tubes.

Operation

After thoroughly checking the assembly for wiring errors, heater and anode supplies should be taken from the set or a suitable power pack, and the anode current measured. This should vary from approximately 1 to 7 mA according to the setting of the 50kΩ amplitude control. At this stage, either side of the trimmer condenser may be touched, and if this is accompanied by a change in anode current, satisfactory oscillation can be assumed. The coils may now be placed on the neck of the tube, preferably just forward of the electrodes, but in most cases room will only be found between the focus coil and the scanning coils. The former may have to be moved back a little, and its current increased by means of the normal focus control. Next, the trimmer should be adjusted (at some arbitrary setting of the amplitude control) to set the frequency of the oscillator to a value such that no harmonics will cause interference to the picture or sound signals. This is easily checked by inspection of the picture. It will be appreciated that whilst 10 Mc/s is suitable for Alexandra Palace transmissions, the 6th harmonic would interfere with those from Sutton Coldfield, so for reception of the latter a frequency about 9.7 Mc/s or 10.3 Mc/s will have to be used. The amplitude control should now be set at minimum, and the picture focused as sharply as possible, when the amplitude control may be increased until the line structure is only just filled up. This will give the best possible picture, and any increase of amplitude beyond this point will actually spoil the definition.

The writer hopes that this short description of an interesting technique will spur on those who have built their sets to get even better pictures, and to those who can devote an evening to making a simple unit which is adaptable to any set.

An Important Educational Aid

A CATHODE-RAY Tube Unit B100, with an associated Time-Base/Amplifier Unit B101, recently introduced by the Equipment Division of Mullard Electronic Products, Ltd., has been specially designed to meet the needs of educational establishments where a moderately priced instrument is required for the demonstration of A.C. theory and the various applications of cathode-ray oscillography in modern research.

Although of moderate price, the two instruments combined electrically embody most of the features of the higher-priced oscillographs normally used in industry and research. Among the wide range of demonstrations that can be made with this combined unit are: half- and full-wave rectification, magnetic hysteresis, harmonics, frequency determination, Lissajou figures, smoothing, etc. It can also be used for a great variety of tests in the laboratory.

Another important feature of this combined instrument is that the amplifier section of the B101 unit can be used as a general-purpose voltage amplifier without modification. The frequency response is from 25 c/s to 30 kc/s and a stepped attenuator, in conjunction with a continuously-variable gain-control, gives a control of gain from zero to a maximum of approximately 1880 db.

Used in conjunction with the B100 Cathode-Ray Tube Unit, the vertical amplifier of the Time Base/Amplifier Unit gives a maximum sensitivity of 25 mV/cm. over a time-base frequency range from 25 c/s to 30 kc/s. The horizontal amplifier of this unit provides a sensitivity of 100 mV/cm.

The Mullard B100 Cathode-Ray Tube Unit is a simple instrument with its own supply unit. It embodies a 3in. C.R. tube, which is exposed so that the effect of magnetic deflection can be demonstrated. Both the vertical and horizontal deflection sensitivities are approximately 0.2 mm/V.

ALL ABOUT AERIALS

The Various Patterns Described, and Polar Diagrams Discussed

By E. ROULTON

WITH television spreading quickly across the country, a chief interest of every would-be set owner is the television aerial, and a great variety of types may be seen on the skyline in many southern and midland areas. Some of the assemblies seen on roof-tops to-day would only have been seen before the war, on the shack of some ambitious " ham," or upon some experimental centre.

This does not mean that there is anything " amateurish " about these arrays, but it proves, as in other fields, that amateurs have helped to bring the science to maturity, by free interchange of experimental data in the past.

This article is intended to show, as far as possible, some of the basic types of television aerials, and explain their advantages and uses. It should be borne in mind that conditions vary widely from house to house, so that trial-and-error installations are often essential.

Looking over the field, we see plain dipoles, " X " and " H " types, " V " and inverted " T " indoor aerials, three- and four-element arrays, some with folded dipoles, and even more elaborate stacked three- and four-element beam aerials. Added to this are tilted wire aerials and mains-lead built-in types.

As far as possible, Figs. 1 to 5 show the majority of contemporary styles, and they possess a variety of mechanical and electrical features.

Dipole

Fig. 1(a) is the plain dipole—regarded generally as the basic type, being approximately a half-wavelength long, and broken at the centre to connect to the down-lead. It is mounted to a wall, chimney, window or door-frame, skirting board, etc., and is, of itself, entirely non-directional, being constructed of metal tubing, copper braid, or twin feeder. In fact, most of the other types of television aerials are developed from the plain dipole, and its companion, the folded dipole, so that its properties are well known.

" H " Type

Fig. 1(b) is the popular " H " aerial, being a plain dipole with a parasitic reflector spaced between 0.1 and 0.25 wavelength behind it. I use the word " parasitic " to show that there is no electrical connection made to it (other than between its two halves), and all the power it develops is derived from the dipole in front. It can be regarded as " reflecting " this energy back to the dipole, thus greatly increasing the pick-up. The reflector length is usually 4 or 5 per cent. longer than the dipole, and its presence " loads " the dipole to a certain extent—a process very similar to two coupled tuned circuits with mutual inductance between them. Here also it is well known that one circuit must be detuned to secure maximum results.

Variations

Figs. 1(c) and (d) show variations of the dipole and " H " type respectively, the former being a plain dipole erected and bent so as to have directional properties, while the latter has a parasitic director, the two being positioned to give highly directional properties. (The

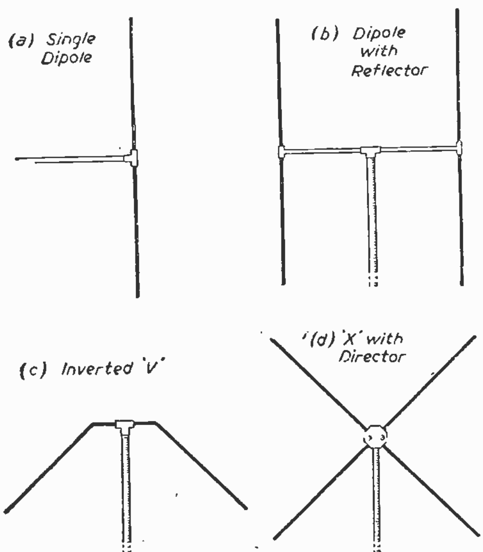


Fig. 1.—The four most popular types of aerial.

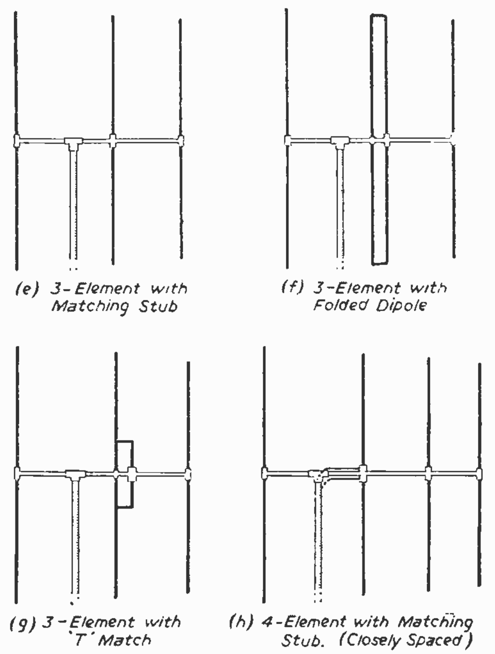


Fig. 2.—Elaborations of the dipole for more remote areas.

director behaves in similar fashion to a reflector, but is placed *before* the dipole and is 3 or 4 per cent. shorter in length).

Fig. 2(e) is a variation of the " H " type, having a director in front of the dipole as well as a reflector behind.

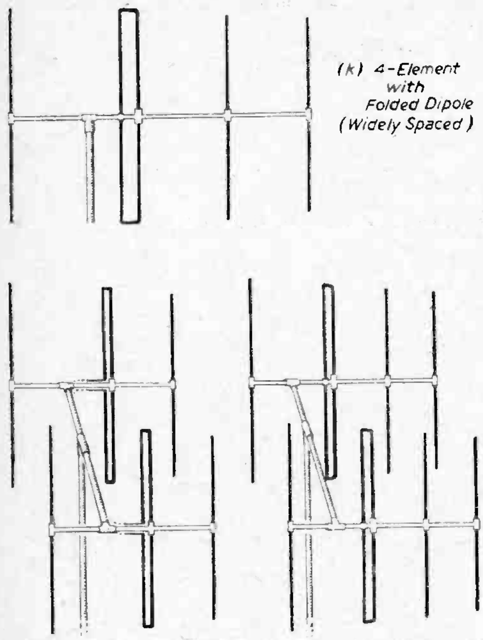


Fig. 3.—Multiple element arrays for use under difficult conditions.

No connection is made to either element, the downlead being connected to the dipole as before. Spacing between elements is the same as with " H " types, but the directional properties are much more marked than with the previous types, and the presence of the director further increases the pick-up and also " loads " the dipole still more. This type may also be seen with a folded dipole, as in Fig. 2(f), this expedient providing correct coupling to the downlead in view of the heavy " loading." Further methods of coupling in use to-day are the " Q "-section (a quarter-wave line of correctly-chosen cable inserted between dipole and downlead), the " T "-match (similar to the folded dipole but end-clamps brought further in as in Fig. 2(g)) and the " End-fed " arrangement being similar to the " Q "-section but of different cable.

Arrays

Fig. 2(h) shows the four-element array, being the same as Fig. 2(e), but with a further director spaced 0.1 wave in front. A " Q "-section is used to couple the downlead.

Fig. 3(k) shows a similar type but widely-spaced and using a folded dipole for correct coupling from dipole to downlead.

Fig. 3(m) shows two three-element aerials as in (f), spaced approximately a half-wave apart and connected together by " Q "-sections so that the signals add together.

Fig. 3(n) is similar except that twin four-element arrays are used as in (k).

Fig. 4(o) is the tilted-wire array, arranged so that the incoming wave travels up the wire at the correct speed. It is highly-directional and extends from chimney (or gutter) to some distance in the garden.

Fig. 4(p) is a variation of the " H " type, with two further reflectors positioned at the sides to provide further directional properties.

There are mixtures of the above types which do not warrant special description.

Electrical features of these aerials are given in Table I. on page 354 and a brief description of the parameters involved should suffice.

Formulae

Forward gain of any aerial = $\frac{\text{Received signal strength (power) from aerial}}{\text{Signal strength from plain dipole erected in same place}}$

This factor is usually expressed in decibels by the formula

$$\text{Forward gain (decibels)} = 10 \log_{10} \frac{P2}{P1}$$

where P1 and P2 are the respective powers received by a plain dipole and the aerial in question.

Impedance represents the coupling value for the downlead and is usually 50-80 ohms. A downlead of this impedance should be used with the aerial. N.B.—It is not dependent upon the length, but on the conductor sizes and spacings as well as the insulation material.

The Front to Back ratio is the ratio of maximum to minimum response of the aerial in different directions, and is a measure of its ability to discriminate against unwanted signals or interference coming from directions

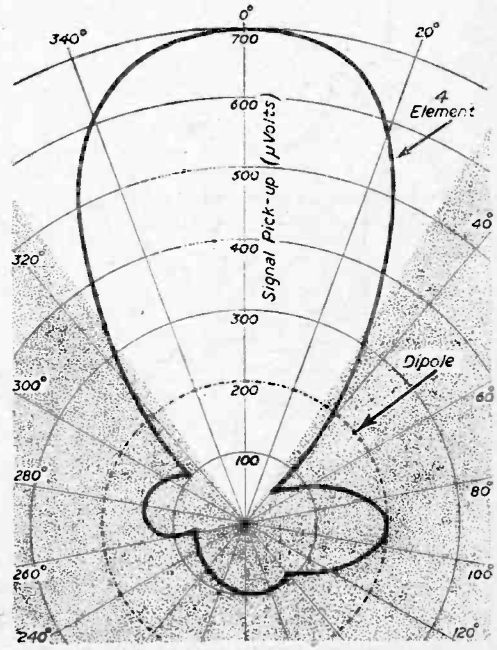


Fig. 6.—Polar diagram of vision reception only showing corresponding dipole reading.

other than that of the transmitter. Contrary to popular opinion, a wire-mesh screen does not improve results unless it is very large and covers at least 50 per cent. of the aerial.

"Yagi" Arrays

All aerials having "parasitic" elements and only one dipole are termed "Yagi" arrays, and Figs. 2 and 3 are examples. It is known that this arrangement gives the highest gain with a minimum of space and engineering.

A serious drawback with highly-directional Yagi arrays (three- or four-element aerials) is the presence of a metal supporting mast, guy-wires, etc., and the length of this must be cut so as to be non-resonant at the operating frequency. In Fig. 3(m) and (n) the mast is out of the field of the separate aerials, so that unexpected directional properties are not encountered. Used in the wrong place, a metal mast can reduce the forward gain by as much as 3 dbs.

Materials

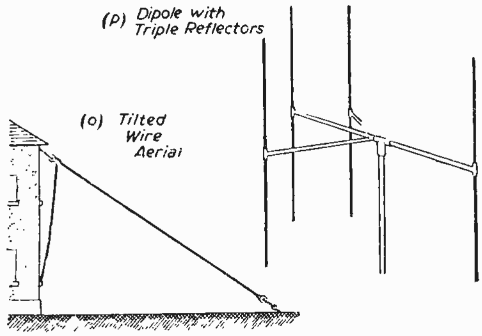
Light alloys are generally used in the construction of television aerials—mostly in view of their light weight and corrosion-free properties. Disadvantages are their high cost and tendency to whip compared with steel.

Insulation is usually Bakelite where low-impedance points are involved (dipole centres, downlead connection boxes, etc.), or Polyethylene (a waxy substance also used in downleads) for high-impedance points such as the extremities of dipoles, where values of 2,000-5,000 ohms occur.

With closely-spaced arrays, a slight variation in spacing —such as that caused by wind flexing the elements—may cause considerable changes in signal strength, and the result is a certain amount of picture flutter. As closely-spaced aerials have other disadvantages—poor gain and overall bandwidth—the best way out of the trouble seems to be a widely-spaced array.

"Humming" or whistling caused by vibration of light-weight tubes in the wind has been overcome by filling the tubes comprising the aerial with sawdust, rope, or even lengths of wire. This noise appeared mostly down straight chimney flues and was a considerable nuisance to the set-owner and his neighbours.

In "fringe" areas, great heights are often necessary, and the use of guy-wires to firmly anchor the installation becomes essential. Usually, in weak areas, the signal-strength varies directly with the aerial height, and towers may be used where the base can be firmly anchored, preferably in concrete.



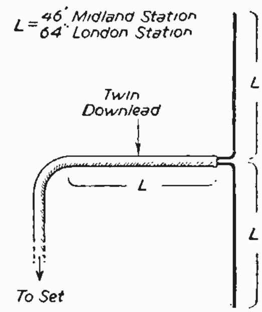


Fig. 4 (above).—The tilted wire, and a dipole with triple reflectors, and Fig. 5 (right).—A simple 'improvised' aerial made by extending the conductors of the downlead.

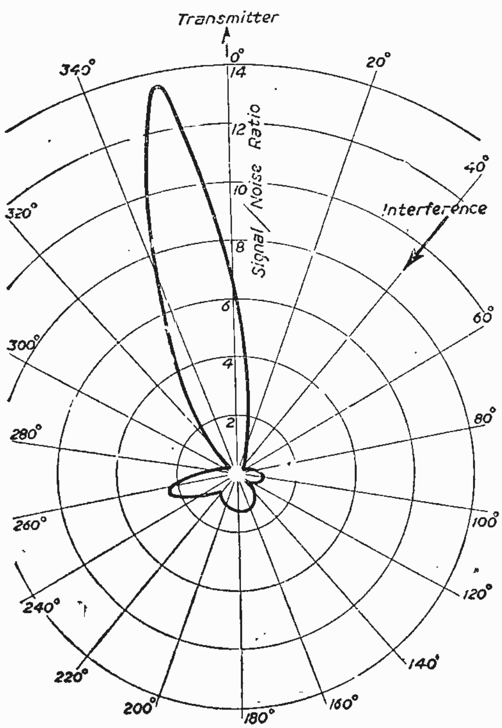


Fig. 7.—Polar diagram for signal/noise ratio for Fig. 6, with equal interference source at 40 degrees.

Polar Diagrams

Before fitting any high-gain television aerial, the relative polar diagram should be studied. This is the horizontal pattern plotted in signal-strength against the bearing in degrees, usually obtained by swinging the aerial against a fixed transmitter and plotting the received signal. The technique involved is somewhat complicated and will not be described here.

Fig. 6 shows a typical polar diagram of a wide-spaced four-element Yagi array, the shaded portion indicating directions in which the signal is less than 50 per cent. of maximum, i.e., more than 6 dbs. down. The "beam" of the aerial is thus the unshaded portion, termed its acceptance angle, and the more narrow this angle, the greater will the aerial discriminate against interference from other directions.

It will be noticed that the area enclosed by the diagram is almost equal to that enclosed by a dipole in the same place; the effect of the reflector and directors is to increase the power of the dipole in one direction only, leaving the total power integrated over space the same as before.

In Fig. 6, then, the curve may be regarded as fixed to the aerial; rotating the aerial rotates the curve but leaves the background of 0 deg., 20 deg., 40 deg., etc., unmoved. Assuming that the transmitter lies along the 0 deg. line, then rotating the aerial (and the curve) so that its maximum point lies on the 0 deg. position means that the received signal is 700 millivolts. This is read off the scale in Fig. 6 where the curve crosses the 0 deg. line. The reception from any other direction is equal to the voltage read off on the scale where the curve crosses that particular angle of direction, assuming one is looking down upon the aerial from above.

Suppose, then, that interference (of equal field strength to that of the signal) from a garage, for example, comes in from the 40 deg. direction. The curve crosses the 40 deg. angle on a circle of 110 millivolts. Signal to noise ratio is thus $\frac{700}{110} = 6.4$, with the aerial pointing towards the transmitter.

Rotating the aerial 10 deg. round means that although

TABLE I

	Impedance	Forward Gain
(a)	70 ohms	0 db.
(b)	50 ohms	4 db.
(c)	70 ohms	—3 db.
(d)	60 ohms	6 db.
(e)	20 ohms (x 3.5 with stub)	7-8 db.
(f)	70 ohms	8 db.
(g)	50-100 ohms	7-8 db.
(h)	35 ohms (x 2 with stub)	8 db.
(k)	70 ohms	10-11 db.
(m)	50-100 ohms	10-11 db.
(n)	50-100 ohms	13-14 db.
(o)	50 ohms	10 db.
(p)	30 ohms	5 db.

the 0 deg. line now cuts the curve at 680 millivolts, i.e., only 680 millivolts of signal is picked up, the 40 deg. line cuts the curve at only 80 millivolts which now equals the strength of the received interference.

The signal to noise ratio for this new position of the aerial is thus $\frac{680}{50} = 13.5$, an increase of nearly twice the original.

This is shown in Fig. 7 where signal to noise ratio is plotted against aerial direction for an interference source at 40 deg.

So far, only the response to one particular frequency has been considered, and Fig. 8 shows the radiation patterns for sound and vision on one particular aerial (in this case a three-element type), and the presence of large lobe for the sound is because the aerial resonates at the vision frequency.

For the two polar diagrams to be alike the aerial would have to tune to a point somewhere between the two frequencies, and special measures have to be taken for an aerial to operate with high-gain over a wide band. The use of 405 lines and single-sideband transmission helps considerably in achieving satisfactory high-gain television aerials in this country. An aerial of this kind may be likened to several coupled-tuned circuits; the degree of coupling represents the spacing between elements and the tuning of each circuit corresponding to the lengths.

It will be seen from Fig. 6 that minima exist on the 50 deg. and 310 deg. lines, and that the front/side ratios $= \frac{700}{50} = 14$ and $\frac{700}{100} = 7$, respectively.

If the noise lies in these directions, then operation of the aerial in its 0 deg. position secures maximum signal/noise ratio. However, if it arrives from the 40 deg. line,

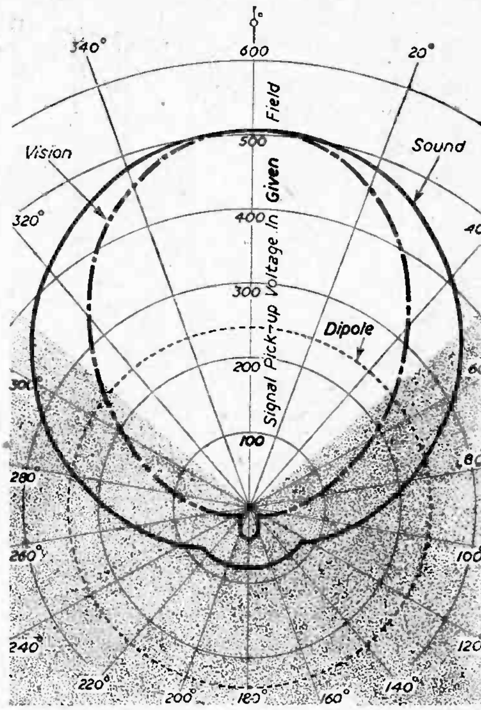


Fig. 8.—Polar diagram for sound and vision on a 3-element array.

then reference to Fig. 7 gives 350 deg. as the optimum position, and on Fig. 6 gives 680 millivolts for 350 deg., which is only 0.4 dbs. below 700 millivolts; 350 deg. is therefore the optimum direction for the aerial. Similar calculations may be made for other noise positions.

Making a Mains Transformer

Practical Design and Constructional Details

By R. F. SCARISBRICK

TELEVISION enthusiasts building their own receivers find, when they come to purchase a suitable mains transformer, that the commercially-made article is an expensive item usually running into several pounds. Apart from this, the standard ranges available often do not include one exactly suitable for their requirements. The only alternatives are to have one specially wound to specification, usually at extra cost, or to use two transformers giving the required combination of windings.

There is, however, no reason why the constructor should not tackle the job of making his own. It is not suggested that the construction of a mains transformer is a simple matter or one to be undertaken in an haphazard manner, but providing the few simple rules of design and construction are carefully observed, a home-constructed transformer should compare favourably with the commercially-made article. The cost will certainly be lower, and the constructor achieves a pride in the outcome of his work.

This article explains these elementary rules in a manner easily understood, enabling the reader to design and construct an efficient transformer to suit his particular requirements. The directions given are equally applicable to the re-winding of an existing transformer. Later in the article a worked-out example of design for a transformer of standard type is given, suitable for an average receiver employing the popular VCR97 tube. This also serves to assist the reader in understanding the principles explained.

Design Considerations

The first step is to determine the size of the magnetic core required. As most constructors know, transformer cores are built up of laminations, which are thin pieces of special iron about .015in. thick. These are assembled in staggered formation to provide a complete magnetic field for the transformer windings. Laminations are obtainable in various stock sizes and shapes, and a suitable size must be chosen according to the output rating (or wattage) of the transformer and the dimensions of the windings. Fig. 1 depicts the two most common types of lamination used in modern radio transformers, and either type is suitable for our purpose.

Before choosing the laminations we must determine the permissible minimum size of the core, which is the wider limb (A) which passes through the centre of the windings. The cross-sectional area of this core (i.e., the width A × total thickness of the stack of laminations) is determined by two considerations—the frequency of the supply mains and the total wattage of the transformer. For 50-cycle mains this area is calculated from the following formula :

$$A = \frac{\sqrt{\text{Total wattage output}}}{5.6}$$

For mains of a higher or lower frequency the iron area should be decreased or increased respectively, in inverse proportion to the frequency. The core area thus obtained must be increased by 10 per cent. to allow for the thickness of insulation which will be found on one side of each lamination. In using the above formula the " total wattage output " means, of course, the sum total of the wattages of the required secondary windings.

The next step is to ascertain the correct number of " turns per volt," which, when calculated, will be used to determine the number of turns on the primary and secondary windings. For this we have to use another formula :

$$\text{Turns per volt} = \frac{100,000,000}{4.44 \times F \times \phi}$$ in which the factor ϕ is the required total magnetic flux of the core, calculated by multiplying the cross-sectional area A by the magnetic flux density. For ordinary radio and television transformers this flux density may be taken as 60,000 (lines per square inch).

We have now calculated the minimum cross-sectional core area which we can use and the number of " turns per volt " required, but before we can choose a suitable size of lamination it is necessary to determine the amount of space required for the bobbin and windings. This, in turn, involves selecting the correct gauge of wire and calculating the number of turns for each winding.

Calculation of Windings

Commence with the primary winding. The wattage of this will be the same as the total wattage of the secondaries, which has already been calculated. The voltage of the supply mains being known, the full load primary current can be obtained by Ohms Law. From the wire table (columns 1 and 2) select the correct gauge of wire. The number of primary turns is found, of course, by multiplying primary voltage by the " turns per volt " figure. If it is intended to provide mains voltage tappings on the primary, the turns for the sections between tappings are ascertained in the same manner. The cross-sectional area which the primary turns will occupy can be calculated by reference to column 4 of the table. Each of the secondary winding areas can be obtained in the same manner, as the desired voltage and current of each is known. For E.H.T. windings, although a 5 mA rating is ample, it is not advisable to use a gauge finer than 40 S.W.G., or frequent breaks are liable to occur in winding. The number of turns calculated for the secondary windings must be increased by 5 per cent. to allow for voltage drop under load.

By adding the total winding areas together we now know the total space occupied by the wire, but no allowance has yet been made for the thickness of insulation between each layer and each winding, or for the space occupied by the bobbin. Allowance must also be made for the " space factor " of the windings, which, if not taken into account, will cause trouble later on. The figures given for winding areas in column 4 of the table indicate the number of turns which can be accommodated provided the adjacent turns and layers are tightly and quite evenly wound. In practice it is almost impossible to achieve this no matter how carefully the work is done, as the turns per layer always work out fewer than were expected, and there is an unavoidable tendency for the layers to develop a slight bulge on the flat sides of each turn.

Another point is that when winding it is advisable to leave a margin at each end of the layers, otherwise the end turns may slip down the edges of the layer, with consequent risk of insulation breakdown. The constructor winding his first transformer would be well advised to leave a margin of 3/16in. minimum at each end of the layers. Further space must be allowed for the screen between primary and secondaries, and for the final outer covering of the windings.

S.W.G. WIRE TABLE

Wire size, S.W.G. (1)	Current (amps.) at 2,000 amps./sq. in. (2)	Advised wire covering (3)	Turns per sq. in. (4)	Yds. per lb. (5)
14	10.0	D.C.C.	139	17.16
15	8.1	"	172	21.23
16	6.4	"	213	26.86
17	5.0	"	272	35.00
18	3.6	"	376	47.66
19	2.5	Enamel	560	48.66
20	2.0	"	680	85.0
21	1.6	"	865	107.6
22	1.23	"	1,110	140.6
23	0.91	"	1,510	191.6
24	0.76	"	1,775	228.3
25	0.63	"	2,120	257.3
26	0.51	"	2,560	340.0
27	0.43	"	3,120	410.0
28	0.35	"	3,760	503.0
29	0.29	"	4,390	596.6
30	0.24	"	5,380	716.6
31	0.211	"	6,060	820.0
32	0.183	"	6,890	943.3
33	0.157	"	7,900	1100
34	0.133	"	9,610	1300
35	0.111	"	11,250	1556
36	0.091	"	13,450	1903
37	0.072	"	16,400	2380
38	0.056	"	20,400	3056
39	0.031	"	36,864	4066
40	0.020	"	43,390	4766

To allow for all these factors, the total of the cross-sectional winding areas as ascertained from column 4 of the table should be increased by 100 per cent. This sounds a large margin, but will prove to be none too much in practice. If the transformer is to include an E.H.T. winding the area should be increased by 150 per cent. as the high peak voltages call for a greater margin of safety in the insulation.

At last, then, we are in a position to choose suitable laminations. The centre limb (A) should be as near to square section as possible, rather than rectangular, as this reduces the amount of wire required to enclose a given magnetic flux, and makes for a better-proportioned bobbin for winding. The width of the outer limbs (B) is not critical, but should be about half of the centre limb. Suitable standard laminations are obtainable from many good radio suppliers or, in case of difficulty, from manufacturers, such as Messrs. Joseph Sankey & Sons, Ltd., Bilston, Staffs; Messrs. G. L. Scott & Co., Ltd., Shotton, Chester; or Richard Thomas & Baldwins, Ltd., Cookley Works, Brierley Hill, Staffs.

If it is intended to purchase a ready-made bobbin for the windings, obtain details of the stock sizes available before ordering the laminations to ensure that the bobbin can be suitably matched to the laminations chosen. Bobbins of paxolin or similar laminated plastic material are the most suitable and are obtainable from several sources, among which are Messrs. H. Clarke & Co. (Manchester), Ltd., Atlas Works, Patricroft, Manchester, and Messrs. Armand Taylor & Co., Ltd., Marsh Road, Pitsea, Essex. Although it is possible for the constructor to make his own bobbin from sheet paxolin, it is difficult to make a strong job of it, and the writer advises purchasing one ready made.

The correct gauges of wire have already been chosen for the windings, but it is necessary to know what quantity of each to purchase. Copper wire is expensive and it is wasteful to buy too much. On the other hand, it is annoying to run out of wire part-way through the job, and it is desirable to avoid joints. By measuring the "average" length of one turn at the centre of the approximate position of the winding, the total length of wire required can be assessed fairly accurately. Reference to column 5 of the wire table enables the necessary quantity to be calculated. Allow a few ounces to spare.

Method of Winding

It is usual to wind the primary on first, followed by the H.T. secondary and, lastly, the heater windings. The E.H.T. winding, if any, should be between the primary and H.T. secondary. Heavy duty heater windings should be left until last.

The bobbin should be supported on a wooden jig (Fig. 4) consisting of a core with end cheeks to support the flanges, otherwise there is a slight tendency for the latter to bulge as the winding progresses. Winding of the lighter gauge wires can be done on a lathe at slow speed or by a hand drill held in a vice, but it will be found necessary to put on the heater windings by hand.

The ends of the windings are covered with short

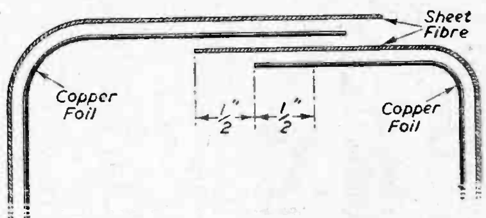


Fig. 2.—Method of insulating the screen.

lengths of good quality sleeving and brought out through holes drilled through the end flanges and cheeks. Providing the holes are not too neat a fit for the sleeving it is a simple matter to remove the cheeks when the windings are completed. Apart from the first hole, the remainder cannot be drilled until the exact positions are known, as and when each winding is finished. Be sure that the leads are not brought out in a position which will cause them to foul the laminations when

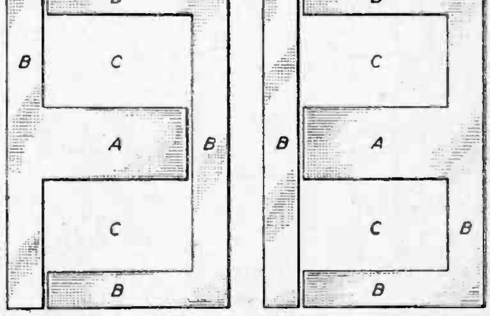


Fig. 1.—Two popular types of laminations.

assembled. If it is intended to mount terminal strips on the transformer clamping brackets, arrange as far as possible for the ends to emerge in positions convenient for connection.

Completely fill the first layer of the primary winding, leaving no margins. Take care to wind as evenly as possible, keeping a fair tension on the wire, and avoid letting turns overlap. Don't rush the job. Irregular winding on one layer makes it more difficult to put the next layer on evenly, and the irregularity becomes worse with successive layers. Feed the wire with finger and thumb, keeping an even tension and smoothing out any kinks as the wire goes on. After completing each layer, give it a quick coat of insulating varnish and before it dries cover with one layer of strong thin paper. Apply a further coat of varnish over the paper. Continue the winding to the required number of turns and temporarily secure the last few turns with adhesive tape. Drill a hole for the sleeving as close to the last layer as possible and bring out the end of the winding. Leave plenty to spare for connection and wind the loose end of the wire round the sleeving, which will retain the tension and prevent the ends impeding the winding operation. Unless different-coloured sleeving is used for each winding, identifying tags should be attached to the leads. Apply a coat of varnish and cover with two thicknesses of strong paper and one thickness of thin sheet fibre, secured with adhesive compound.

The next step is to fit the primary screen, which consists of a layer of thin copper foil. over the sheet fibre, with ½in. overlap at the ends. Cut the foil ¼in. narrower than the bobbin width to provide a ⅛in. margin

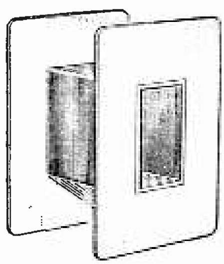


Fig. 3.—A typical transformer bobbin.

at each side. Cover the screen with a further layer of sheet fibre, and 1in. of this must be inserted between the overlapping ends of the foil to prevent electrical contact. This is important, otherwise the screen would be in effect a complete closed circuit of low resistance and would ruin the transformer. Fig. 2 shows clearly the method of fitting the screen. Solder a thin flexible lead to one edge of the copper, insulate it with sleeving

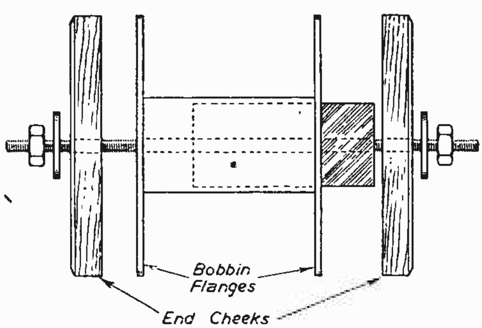


Fig. 4.—Assembly of the winding jig.

and bring it out through a hole in the flange. Take care to fit the screen and sheet fibre as tightly and neatly as possible, securing the overlapping ends with adhesive compound. Before proceeding with the next winding apply more varnish and two layers of stout paper, with a further coat of varnish.

The E.H.T. Winding

Particular care and patience are necessary with the E.H.T. winding in view of the fine wire used and the need for perfect insulation. With this winding it is not

CALCULATION OF WINDING AREAS, WIRE GAUGES, AND TURNS REQUIRED.

Windings	Current (amps.)	S.W.G.	At 3 T.P.V. Total turns	C/S. area (sq. in.)
Primary 250v. (120.8W.)	.48	26	750	.29
H.T. 350-0-350v. ..	.15	33	2,200 (C.T.)	.28
E.H.T.2,500v.	.005	40	7,875	.18
E.H.T. rect. 4v. ..	1.00	22	12½	.10
Tube heater 4v. C.T. ..	1.00	22	12½	
H.T. rect. 4v.	2.50	19	12½	
Valve heaters 6.3v. ..	6.00	16	20	
		Total actual wire area		.85

possible to lay the turns accurately side by side, but it should be done as evenly as possible, working smoothly across the winding area. Apply varnish liberally, particularly to the edges of the layers, to prevent any possibility of turns slipping. and cover each layer with *three* thicknesses of strong thin paper, well dried beforehand. Good insulation is absolutely essential, as the potential difference between adjacent layers of this winding is very high.

Watch carefully for kinks occurring, as, if undetected, they will fracture the enamel insulation. If a break occurs make a carefully soldered joint, coat with varnish and enclose it in a small fold of insulating tape before proceeding. When the winding is completed, insulate the last layer as at the commencement with two layers of paper well varnished and a layer of fibre sheet. As the wire of this winding is very fragile, the leads brought through the flange for connection should consist of a few strands of flex soldered to the ends of the winding. Keep the E.H.T. leads well spaced from each other and from the other leads of the transformer.

H.T. and Heater Windings

The H.T. winding presents no particular difficulty, as with patience the turns can be wound evenly and closely without overlap. At the centre-tap twist a long loop in the wire and bring it out through the sleeving. Interleave and varnish each layer as with the previous windings, using two thicknesses of thin paper between each layer. Cover the winding, as before, with sheet fibre, closely fitted.

As the heater windings consist of comparatively few turns it is permissible to put two separate windings on one layer if the gauges of wire used are similar. Separate the windings by at least ½in. and carefully insulate with sleeving where the end leads cross the turns of the winding. Use a separate layer for E.H.T. rectifier and C.R.T. heater windings, keeping them widely spaced, with the ends of each winding brought out through opposite flanges to avoid cross-over. After varnishing insert a layer of fibre insulation. The main heater winding, being of much thicker wire, should be left until last and wound as a separate layer. A useful tip to secure

(*Concluded on page* 376)

AS the receiver employs staggered tuning to provide the required bandwidth, it is now necessary to adjust various coils on either side of 45 Mc/s The core of L4 should therefore be unscrewed 1½ turns, and that of L2 1 turn. The core of L3 should be given about half a turn out, and all sound coils (L6, L7 and L8) adjusted for maximum sound output with the coil of L1 unscrewed only a fraction. If the picture is now brightened, and contrast correspondingly reduced, it should be well detailed, although perhaps not at its best. To obtain maximum detail, use should be made of the test card C which is broadcast every morning (except Sunday) between 10 a.m. and 11 a.m. An endeavour should be made to obtain each of the central ruled squares clearly, without any white line following the right-hand large white line. All the white ruled squares on the background should be truly square and of equal size (adjusted at the time base), and the correct setting of contrast and brilliancy will permit each of the central blocks to stand out clearly from black up to white.

With a Signal Generator

The most satisfactory method of lining up calls for a good meter in addition to the generator. The anode circuit of the video amplifier should be opened and a meter shunted by a .001 μF condenser inserted. A range of about 20/30 mA is called for. An alternative is to use a meter with a full scale of 1 milliamp connected in series with cathode of the diode rectifier. Finally, the tube itself may be used, making all adjustments to obtain maximum black and white horizontal bars—keeping the input and brilliancy down to maintain the black and white bars of equal width. Peaking frequencies for the coils are as follows:

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	L1—45.25 Mc/s		
	L2—48 ,,		L6—41.5 Mc/s
Vision	L3—46 ,,	Sound	L7—41.5 ,,
	L4—49 ,,		L8—41.5 ,,
	L5—45 ,,		

Sutton Coldfield

The above frequencies are, of course, for the London transmitter, and for the Birmingham frequency alternative coils are required. In addition to the circuit as already shown, one or two extra coils will be needed. Outside the "swamp" area only one extra coil is needed and this is inserted in the cathode circuit of V4 as shown in Fig. 1, its exact position being on the side runner of the chassis as shown in Fig. 2. Note that it is inserted between the bias and feed-back resistor. At closer distances, or where sound break-through is experienced on vision, a further similar coil should be inserted in the cathode circuit of V3.

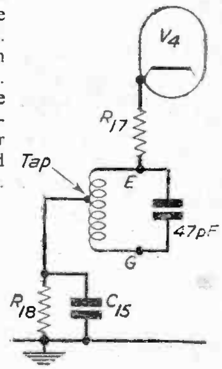
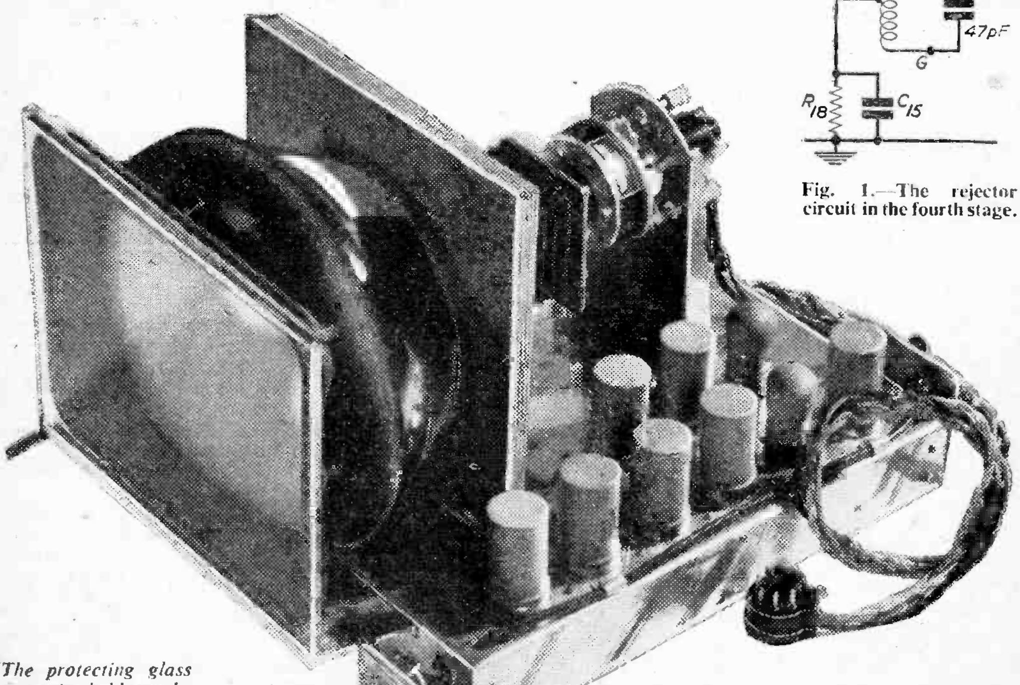


Fig. 1.—The rejector circuit in the fourth stage.



The protecting glass front is held on by any desired method—metal clamps, springs, etc.

Fig. 3.—This view of the receiver shows the vision and sound stages, and the clean appearance of the chassis.

...ng the ...ON RECEIVER–5

...etails and Lining-up

The 33Ω resistor may not be needed. The Sutton Coldfield frequencies are as follows :

	L1—59 Mc/s		L6—58.25 Mc/s
	L2—61.75 ,,		L7—58.25 ,,
	L3—60 ,,	Sound	L8—58.25 ,,
Vision	L4—61.75 ,,		L9—58.25 ,,
	L5—59 ,,		(Rejector)

It will be noted that the two ends of the coil are marked E and G, and experiments may be carried out by changing round the relative positions of all three connections to the coil to obtain the desired separation according to reception conditions in the various localities. Probably the best results will be obtained with R18 and C15 joined to the tapping point, and R17 to end E.

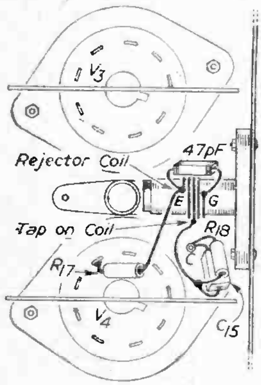


Fig. 2.—Practical arrangement of the rejector circuit.

A small point may be mentioned here in connection with L6—the sound input coil. As shown in the theoretical diagram in the July issue, this has no core. In some localities this will be found quite in order, but in some cases a slight modification may be made to this particular coil. Firstly, the core may be inserted and the coil peaked to provide the maximum sound output. In other localities it may be found that the sound output is not sufficient. An improvement may be effected by connecting a 47 pF silver-mica condenser across the coil—that is, from grid to chassis. This condenser is, of course, in addition to the iron-core.

Queries

There have been one or two queries raised concerning parts of the complete installation, and these have concerned only minor points which have not been clear to individual readers.

One major query concerns the use of a 12in. tube. The scanning power of the receiver as designed will permit of a 12in. tube being used without any modification. An alternative mounting device will be needed, of course, and the tube is slightly longer. Brilliancy should be sufficient, but if it is found that a slightly greater brilliance is needed this may be accomplished by increasing the H.T. supply to the E.H.T. unit. Resistance R44 will thus have to be modified. If it is simply reduced in value the H.T. applied to the E.H.T. unit will rise, but unfortunately this point also feeds the EL33 output valve which is rated for a maximum of 250 volts and it will not tolerate too great an overload. Therefore, two separate resistors will have to be used, one to reduce the main H.T. line to 250 for the output valve and the other to give a full 300 to the E.H.T. unit. Care must be taken not to overload this unit in view of the risk of insulation breakdown, and under all normal conditions the 7.5 Kv. provided is adequate for all but aluminised tubes.

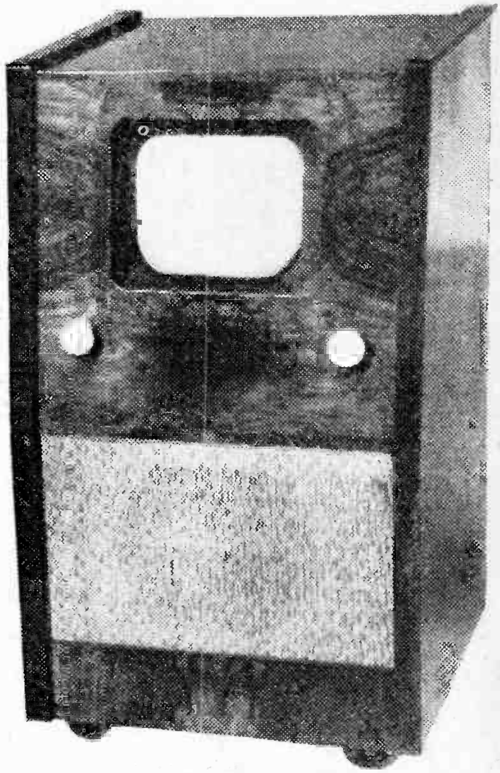


Fig. 4.—A cabinet like this is available from Messrs. Tallon and Sons for £10, packed flat for transportation.

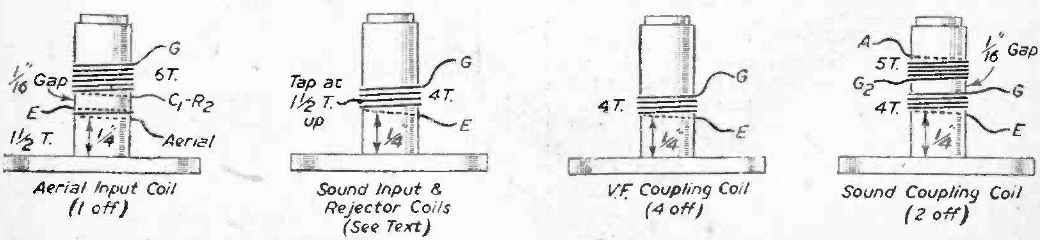


Fig. 5.—Details of the coils for the Sutton Coldfield transmission.

NATURE'S PHOTOCELL

The Eye and its Response to Television Images

THE human eye has often been compared in structure to a camera. It certainly has the essentials of a photographic camera. It possesses its lens, its diaphragm or stop by means of which it exerts control on the amount of light entering it. There is the sensitive screen—the retina—which is analogous to the plate or film of the camera. Altogether, one might say that the eye comprises a neat and an expertly-made ultra-miniature camera designed to work with the utmost precision.

But here the analogy comes to an end. Unlike the eye, the camera cannot give us direct colour images.

Fig. 1.—The eye in its natural setting. Note the cornea (the white part of the eye), the iris (the circular coloured portion) and the central pupil which is directly in front of the all-important lens of the eye.

It does not alter its focus automatically or control the amount of light which it receives by a similar automatic mechanism. Most particularly, the camera cannot deal with moving images. In such circumstances, all it produces is a blur. And here, of course, it will be remembered that a cinema film does not embody motion itself. All it consists of is a chain of still pictures of successive phases of motion taken at regular short intervals.

But the eye has the remarkable power of recording motion directly, and, for this reason, it functions in the human or animal body not merely as a focusing camera but also as a sort of chemical photocell.

We only see the front portions of our eyes, the portion which is called the *cornea.* The complete eye, however, is like a round ball in shape, having at its rear a cable of fine nerves (the "optic nerve") which proceed directly to the brain. In the centre of the *cornea*—the front or visible part of the eye—there is the characteristically-coloured portion which is termed the *iris*, and right in the centre of this there is the dark spot known as the *pupil.* The pupil is not really dark. It is, in fact, a window which opens on to the lens of the eye, which latter is held in position by equal masses of fine muscular tissue at each side and by means of which it can be altered in surface convexity, thus enabling the eye to focus near or distant images. The iris tissue is able to expand and to contract, this acting as a diaphragm in front of the lens and permitting more or less light to pass through the lens.

Notice the eyes of your cat: how, in weak light, the iris or eye-diaphragm opens out to its fullest extent, and how, in sunlight, it closes down to a narrow slit. Our eyes do the same, but they do not close down to slits.

Inside the eyeball itself is a clear liquid substance—the *aqueous humour.* This exerts an outwards pressure on the interior of the eyeball. It serves not only to transmit the light passed by the eye-lens, but also to keep the eyeball rigid and the eye-lens taut and firm.

Regarding the Retina

Right at the back of the eye comes the all-important retina, which, on dissection, takes the form of a very fine network of nerve fibres, and from which formation it derives its name, the Latin *rete* meaning "a net." The retina is the essential recording surface of the eye. It is not flat like a photographic plate or film. Rather, it follows the rear curve of the eyeball. There is hardly a more delicate structure in the human body than that of the retina. It is not a continuous sensitive film. On the contrary, it comprises a surface which is made up of innumerable nerve-endings. There are between five and six million of them all told, each having its tiny nerve fibre connecting it to the main optic nerve-bundle.

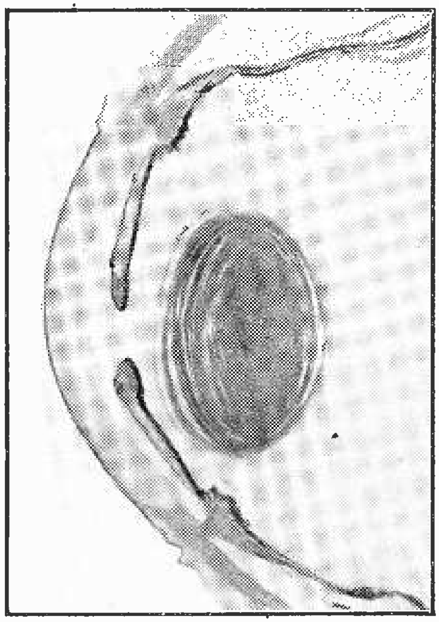


Fig. 2.—A section through the front of the eye. It depicts clearly the outer surface or "white" of the eye, the contractile coloured portion or "iris," and the "pupil" or gap through which the rays of light are enabled to pass to the lens which, in this specimen, is seen as an oval-shaped body. Owing to the necessity of dehydrating the specimen, the lens structure has undergone a shrinkage, giving it the appearance of a fibrous mass.

Some of these nerve-endings are more or less cylindrical in formation. Others are cone-shaped. They comprise the famous " rods and cones " which are detailed in so many textbooks. Each nerve-ending acts as an individual light-cell. Over the entire surface of nerve-endings flows a somewhat mysterious dye, called *rhodopsin* or " visual purple." The visual purple is highly sensitive to light undergoing a sort of bleaching or chemical change on light-exposure, a change which may be complete or partial according to the intensity of the light. This change influences the light-cells of the retina. In sympathy with the changes in the visual purple they send up impulses to the visual centre of the brain, which impulses we experience as the sensation of light.

Just how it is done is still one of the major mysteries of physiology. Nevertheless, it is important to realise the similarity between these tiny nerve-impulses and the electrical pulsations which proceed from the sensitive surface of the television camera.

Visual Persistence

We also realise, after reflection, that our vision must be a " grained " one, because it is made up of the five or six million separate nerve-impulses which are sent up to the brain from the retina of each eye. We can understand, also, why the eye can record motion in a direct way, because, as an object moves, its focused image passes successively over a chain of retinal nerve-endings or light cells, each of which transmit their record of the object to the brain. True, it is that the eye is not extraordinarily clever at recording motion, because after a retinal nerve-cell has been " used " or stimulated, there is a very slight time-lag before the nerve cell is able to recover itself and to become ready for further stimulation.

Fig. 3.—A close-up view of a section of the back of the eye, showing the ribbon-like retina. In manipulating the specimen, the retinal ribbon has become detached from the back of the eye.

This is the mechanism which gives rise to the well-known " persistence of vision," which, in effect, means that the eye, having had an image impressed on it, takes about 1/10th second to get rid of that image. Certainly, it is a defect in the working of the eye, but for us humans it is a happy defect, for it makes all sorts of visual effects possible.

Without visual persistence, for example, there could be no cinema projection. All we would witness, in such an instance, would be a rapid succession of slightly different still pictures. In the same way, screen television would be impossible, for, in this case, we would not even witness a series of rapidly-changing still pictures, but merely an ultra-rapid succession of minute *portions* of pictures.

The Rods and the Cones

Returning, however, to the retinal " rods and cones." These are both light-cells, but they do not appear to have the same functions. They are certainly not evenly distributed in the retina of the eye. The centre of the retina consists almost entirely of cones, but as we go from the centre to the sides of the retina the proportion of rods gradually increases, until at the retinal boundaries the proportion of rods is very much greater than that of cones.

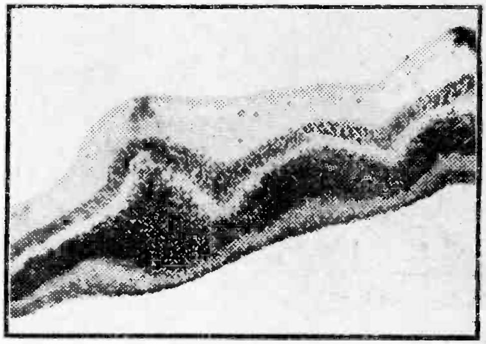


Fig. 4.—The surface of the retina seen at high magnification. The individual light-cell elements (the rods and the cones) are clearly visible as black dots. Each of these acts as a separate photocell, converting light energy into nerve impulses which are passed to the brain.

The true significance of this unequal distribution is not yet fully understood. It would seem, however, that the rods are more able to deal with low intensities of light, the cones being used only for normal light-intensities. Under normal and strong illumination we are able to discern minute detail. In poor lighting, however, things are different. The eye cannot pick up much detail, because not only are the rods more widely spaced in the retina than are the cones, but they are situated more towards the retinal boundaries.

That is why, when we want to pick up as much detail as possible of a poorly-illuminated object, we bring it into the centre of our vision. In this case, however, the eye attempts the impossible, for at the centre of the retina there are mainly the cones, and these are only able to deal with normal and strong light-intensities. The result is, of course, an annoying lack of detail, which no amount of eye effort can improve.

Colour Sensitivity

The eye, like the photographic emulsion, is far less sensitive to some colours than it is to others. It is most sensitive to a certain blue-green spectrum band. As the colour of an object becomes redder and redder, the eye decreases in sensitivity to it. That is one of the reasons why the reddish- and orange-coloured images produced by the early neon-illuminated television receivers were so unsatisfactory in point of detail. They strained the eye, just because the eye wanted detail, and because that detail lay outside its range of sensitivity.

Another curious feature of the human eye in relation to television reception is that the actual size of a picture is related to the ability of the eye to see it in good detail and clarity. A picture or a scene is obviously made up of lights and shades. Between the whitest white and the blackest black, the eye, in good daylight, can distinguish about 50,000 different tones, this gradual merging of light into shade being termed the "gradation" of the picture. An average photograph possesses a gradation range of more than 100 tones, whilst, in a

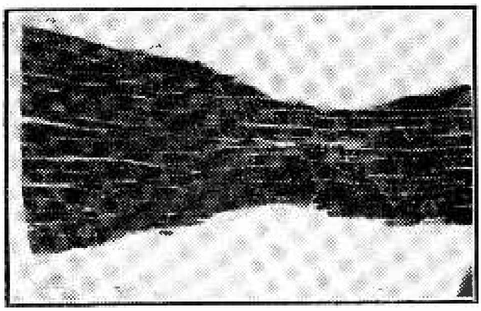


Fig. 5.—Here is a highly-magnified section of the optic nerve. It consists of closely-compacted bundles of minute nerve fibres whose function it is to transmit the impulses from the rods and cones of the retina to the visual centre of the brain.

projected cinema film, this range is reduced to about 60 or even less.

Now, the facility with which the eye can discern differences of lights and shades is decreased as the size of the image screen is decreased. Such is most particularly the case under conditions of low light-intensity. Hence, for clarity and detail and all-round satisfactory viewing, it is always beneficial to have the television screen as large as possible.

Curiously, too, whenever there is motion in a televised picture, the detail is improved. Even slight motion in a picture will benefit the detail of an image very considerably. Or, at least, we might say that such is the *apparent* effect of motion in a televised image. There are viewers who would explain this fact by assertion that motion gives additional interest and vitality to the picture so that the eye (or, rather, its terminal receiving centre, the *brain*) automatically donates to the received image familiar detail which is not actually there. On the contrary, there are observers who assert that the presence of detail brings about a very slight coincidence of the successive phases of the televised picture, so that the " grain " of the picture is much reduced, thus enabling detail to be perceived in sharper outline.

Viewing Conditions

The apparent brightness of a televised picture is obviously determined by the circumstances in which it is viewed. In full sunshine you would see little or nothing of a televised picture. In complete darkness, the image would appear at maximum brilliancy. There is, you see, the question of contrast between the light-intensity of the televised image and that of its surrounding conditions. Although, in subdued illumination, a modern televised picture has very satisfactory brilliance and clarity, its apparent illumination would be much reduced in full daylight. This is because the iris or diaphragm of the eye contracts in strong daylight in order to permit just the right intensity of light to pass to the retina. But, in this contracted condition, sufficient light from a televised image cannot actually get past the contracted iris to enable the eye to discern it adequately. A televised image, like any other projected picture, must always be viewed under subdued lighting conditions for it to be discerned adequately. Nevertheless, it is clear that the varying conditions of this " extrinsic " illumination do not in any way affect the actual brilliance or light-intensity of the televised image itself. It is only the reaction of the eye to the surrounding illumination which gives rise to the illusion of *apparent* brilliance of the image.

Contrast Essential

Contrast makes for good television images. This is simply because the greater the difference between black and white, the more readily the eye picks out the boundaries or outlines of these differences. A black cat lying asleep on a black rug would be a difficult object to discern on a television screen. So also might be a white cat on a white rug. But a black cat on a white rug or a white cat on a black rug would show up in sharp outline on a television screen. There is good " contrast," as we say, between the cat and the rug in these latter instances, and contrast makes for clarity in a televised image. Provided that you have a fair amount of contrast in your picture, provided, also, that you do not sacrifice any of the high lights or the bright parts of the picture, the eye will not usually object to any lack of detail in the darker portions. But detail in the high lights must be present, otherwise the eye will interpret the picture as being flat and lifeless, no matter how much detail may be discernible in the darker areas.

It is all, of course, a matter for the rods and cones in the retina of the eye. You will remember that the cones take the major part in our viewing mechanism. As long as they are functioning well we do not complain much of our visual acuity. But if we leave everything or, at least, the greater portion of our retinal activity to the rods (the low-intensity illumination light-cells) then our vision becomes confused and we begin to complain.

"Permali"

WE recently attended a preview of " Strength Where You Need It," the latest industrial film to be made by Mr. E. Cook, of the Big Six Film Unit. The film, which lasted 30 minutes, showed how " Permali " is made and the important part it played in many industries. The film was sponsored by the New Insulation Co., the makers of " Permali," which combines both mechanical and electrical strength. It is used extensively by many well-known electrical companies as well as the National Coal Board, British Railways, the textile industry and the British Broadcasting Company.

" Permali " frameworks support and clamp the inductance coils at the Droitwich transmitting station, as well as the dipole aerial system used by the B.B.C. for sending outside television broadcasts to the main transmitter, because the material does not distort the delicately adjusted radiating characteristics of the aerial.

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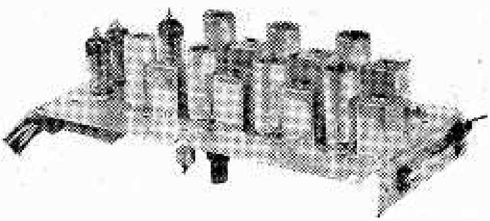

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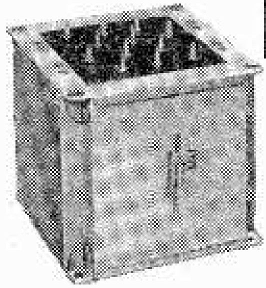

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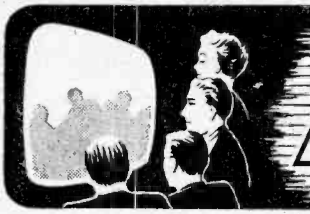


TELENEWS

Amateur TV Broadcasts

AFTER repeated requests the P.M.G. has at last authorised the use of special bands for the sole use of amateur television broadcast experiments. Provisionally the bands allocated are 2,300 to 2,450, 5,650 to 5,850 and 10,000 to 10,500 Mc/s. Full conditions of the appropriate licence have not yet been worked out, but we understand that two or three amateurs have already built experimental equipment which has been operated very successfully on closed circuit, and in one instance a public demonstration has been given at which personalities of the B.B.C. were present and commented very favourably upon the results obtained.

Broadcast Receiving Licences

THE following statement shows the approximate number of licences issued during the year ended October 31st, 1950:

Region	*Number*
London Postal ..	2,335,000
Home Counties ..	1,642,000
Midland	1,732,000
North-eastern ..	1,893,000
North-western ..	1,597,000
South-western ..	1,061,000
Welsh and Border Counties ..	728,000
Total England and Wales	10,988,000
Scotland	1,123,000
Northern Ireland ..	206,000
Grand Total ..	12,317,000

The above total includes 511,150 television licences.

Brimar Open New Factories

IN an effort to increase output to meet the steadily growing demand for Brimar radio receiving valves and Cathode-ray tubes, the Receiving Valve Division of Standard Telephones and Cables, Footscray, is opening a number of feeder plants in Kent, mainly in country districts.

This move has been made necessary by shortage of suitable female labour in the Footscray area, and the purpose of these feeder plants in the main is to take advantage of relatively small groups of suitable labour in various country districts in Kent. The exception is at Rochester where a fairly large area of a former aircraft engine factory at Rochester Airport has been acquired, for which it is hoped to obtain suitable labour from the Medway towns.

Pulse Techniques

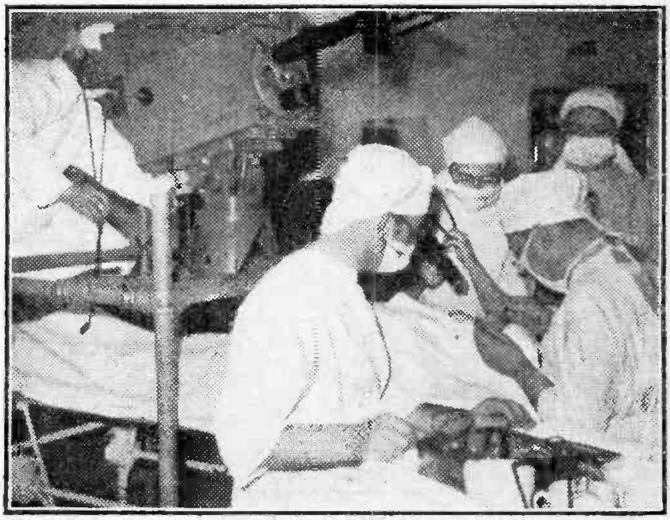
INCLUDED in the lectures now being given at the Technical College, Southall, Middlesex, are details concerned with electro-acoustics and pulse technique. Applications for enrolment should be made immediately to the secretary at the above address, and the fee for each course is £1.

Norwich Reception Poor

"TELEVISION in Norwich is not yet a practical proposition," explained one of the lecturers at a meeting of Norwich Engineering Society at the Stuart Hall recently. Two members of the staff of Pye, Ltd., of Cambridge (Mr. C. R. Thompson and Mr. J. H. Fletcher), spoke on television and displayed

The Editor will be pleased to consider articles of a practical nature suitable for publication in "Practical Television." Such articles should be written on one side of the paper only, and should contain the name and address of the sender. Whilst the Editor does not hold himself responsible for manuscripts, every effort will be made to return them if a stamped and addressed envelope is enclosed. All correspondence intended for the Editor should be addressed to: The Editor, "Practical Television," George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.

Owing to the rapid progress in the design of wireless apparatus and to our efforts to keep our readers in touch with the latest developments, we give no warranty that apparatus described in our columns is not the subject of letters patent.



A television camera mounted on a special scaffolding and with white-gowned operator looks on as an eye operation is performed at Moorfields Eye Hospital, London. In a nearby room, delegates of the 16th International Congress of Ophthalmology, were watching the work of the surgeons on a picture monitor with 15-inch screen.

slides showing some of the latest equipment the firm is producing.

British Transport Helps TV

TO reduce interference with television reception, all petrol motor vehicles owned by British Transport regularly operating within the range of the television stations at Alexandra Palace and Sutton Coldfield are to be fitted with suppressors.

This announcement is made in the current number of "British Transport Staff News." It is stated that the suppressors cost only a few pence each.

British Road Services and the Tilling Bus Group will soon begin fitting 16,000 (sixteen thousand) vehicles operating in the television areas. British Railways and London Transport have already suppressed their petrol motor vehicles.

Radio and Television Servicing Certificate Examinations

THE results issued by the Radio Trades Examination Board and the City and Guilds of London Institute show that 264 candidates entered for the Radio Servicing Certificate Examination held last May. Of these, 137 were successful (including 15 who were referred in 1949) and 45 were referred in the practical examination.

The first Television Servicing Certificate Examination, held last May, was restricted to the London area and 30 entries were accepted. Of these, 16 candidates were successful and 12 were referred in the practical. The remaining two candidates were unsuccessful.

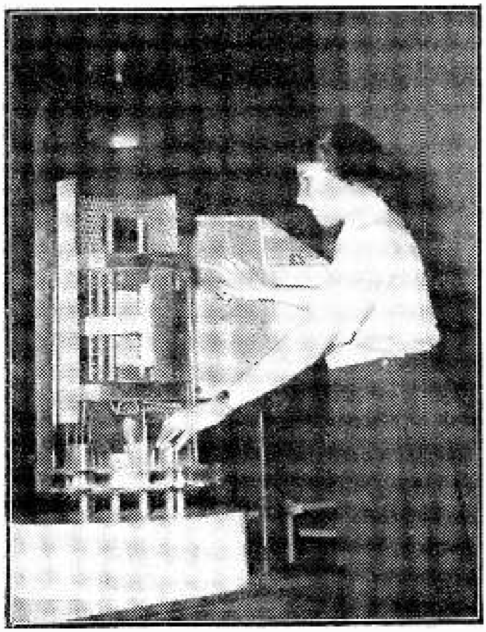
The closing dates for the May, 1951, examinations are:

Television Servicing Certificate Examination, January 15th, 1951. Radio Servicing Certificate Examination, February 1st, 1951.

Forms of application may be obtained from the Radio Trades Examination Board, 9, Bedford Square, London, W.C.1.

Electronics Exhibition

THE Institution of Electronics, Midlands Branch, will be holding their Second Annual Exhibition of Industrial Electronics in the Midlands, in the City of Birmingham, from January 1st to 6th, 1951, both dates inclusive. Tuesday, January 2nd, 1951, has been set aside for a private trades preview. Free admission tickets for the preview are obtainable on request from the Chairman, Institution of Electronics, "The Orchard," Beech Road, Bournville, Birmingham, 30. Details of the exhibition and space available, if any, will be sent to bona fide inquirers.



A student from Chorley Wood College for Girls with little or no sight, examining a giant scale model of a television valve at the special Exhibition for the Blind referred to in our last issue.

Another Interference Drive

FROM mid-November all the new and used cars and petrol-engined commercial vehicles delivered by City Motors and its branches, Great Western Motors, Reading, and Layton's Garage, Bicester, will be supplied and fitted with an ignition suppressor free, thus anticipating compulsion or concerted action from the industry.

This supplements the company's current offer to fit without charge suppressors bought by "good neighbourly" motorists at its branches. To identify cars so fitted they will be delivered with a special label on the windscreen.

Aerial Kills Two

A VIEWER with his son and daughter were erecting a television aerial on a 29½ft. metal mast recently at Lake Success, when the mast fell against the overhead high-tension wires carrying 13,000 volts. Father and son were killed instantly and the girl was saved by the efforts of a policeman who pulled her away from the fallen live wires with the aid of some newspapers to act as insulators.

Australian Television System

THE Australians have now, after considering all existing systems, decided upon the standard they will adopt. It will be a 625 line interlaced 2 to 1 system with a frame or picture frequency of 50, but not locked to the mains. Aspect ratio is to be 4 to 3, scanning left to right horizontally and top to bottom vertically; negative amplitude picture modulation (black level 75 per cent. of the carrier); sound frequency-modulated; signal horizontally polarized; channel 7.5 Mc/s wide; vestigial sideband transmission; station to be located in the 181.5 to 204 Mc/s band and to use peak power of 5 kW on vision and 2.5 kW on sound.

Opposition

TELEVISION is receiving opposition from a group of school teachers who are claiming that children are arriving at school tired and cannot pay attention to their lessons. They claim that the children stay up late in order to see the plays, and also on this account neglect their homework. (See Leading Article.)

Television Thieves

A SUBURB of London recently received much publicity as a result of an epidemic of thefts of television receivers from private homes, whilst the owners were out. It was stated that the thieves marked out the houses carrying television aerials and watched until the house was left empty. Only television receivers were taken. As a result many viewers are having their aerials removed and are using indoor types.

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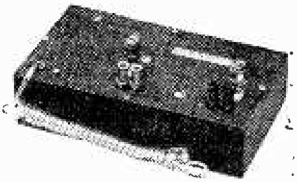

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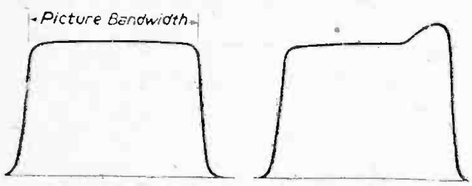
Servicing Television Receivers—8

How to Locate Faults and Cure them in Commercial and Home-made Equipment

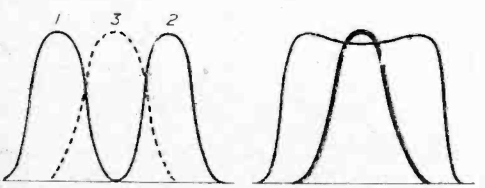
By W. J. DELANEY (G2FMY)

NORMAL servicing does not include the re-alignment of tuning circuits, but the service engineer should know just what part the tuning circuits play in the modern television receiver. A set may be working perfectly in all stages (that is, from an electronic point of view), but the picture may be very poor—simply because the tuned circuits are incorrectly adjusted. In a normal broadcast receiver, a bad adjustment of a tuning coil may lead only to a reduction or build-up in signal strength, unless seriously off-tune, whereas the slightest off-tune adjustment in a vision receiver coil may result in an extremely poor picture—in many cases giving the impression that some "electrical" fault exists in one or more stages.

To guard against variations in tuning circuits various devices are adopted by different manufacturers. In practically all commercial receivers an adjustable iron-core is fitted to the coils and vibration from the speaker could cause these cores to turn gradually unless some means of fixing were employed. Unfortunately, as a re-adjustment may be called for due to some form of "ageing," any fixing must be of a type which can be eased. One common idea is to use a short length of rubber string sandwiched between the core and the former, but this may perish if the receiver is of a type where the internal temperature of the receiver rises. It does, however, last under normal conditions for a considerable time, and a thin rubber band may be cut in half and used as a substitute for the proper material. Hard wax, polystyrene cement and similar materials are often dropped into the coil at the factory after the initial setting-up, and these should not vary throughout the life of the receiver. If, however, a viewer has tampered with a receiver and upset adjustments, and then called in the service engineer he must have some idea of the function of the special coil arrangements used, and how to adjust them.



Figs. 1 & 2.—Ideal response curve of a vision receiver, and the type of curve most generally adopted.



Figs. 3 & 4.—A 'square' response is obtained by several single tuned circuits staggered about the main frequency, or by a 'peaking' circuit and band-pass circuits.

Overall Response

On the vision side there are usually a number of circuits, stagger-tuned to cover the necessary 2.5 to 3 Mc/s band-width. These circuits may be arranged in several ways—either as I.F. transformers, or as a series of single or double circuits tuned to cover double or single side-band frequencies. Owing to the close proximity of the sound channel the vision circuits must be so tuned that they fall off rapidly on the side of the sound signal, and at the other end they must also fall off (preferably equally rapidly) to avoid undue "noise" and, perhaps, the leakage of an adjacent channel signal. The theoretical ideal curve of a vision receiver should be as shown in Fig. 1—a "flat response" over the full vision channel. Such an ideal is almost impossible to attain in practice and some compromise is necessary.

Tuned circuits may consist of band-pass pairs which give a double-humped curve as shown by the light curve in Fig. 4, or a single coil damped by a shunt resistor as a rule to give a broader single curve of the type shown by the individual curves of Fig. 3. These two illustrations show how, by a combination of circuits using these coils, the desired bandwidth with the "flat" top may be obtained. Several circuits tuned to different frequencies will overlap as shown in Fig. 3, whilst a single coil "peaked" to fill in the gap in a band-pass coil will provide the same final result as shown in Fig. 4. Any number of circuits may, of course, be combined to provide an elaborated form of these two illustrations, and the final curve may be equally disposed about the vision frequency (in the case of the London transmitter) to provide double side-band reception, or specially disposed about the vision frequency to provide single side-band reception. There is, however, one important point to be taken into account before considering the correct form of the curve for single side-band working, and that is the compensation for high-frequency losses which many manufacturers introduce. This compensation takes the form of the inclusion of special resonant chokes arranged usually in the video stage to give a rising effect at the H.F. end, producing a final curve of the type shown in Fig. 2. This effect is also obtainable by special biasing

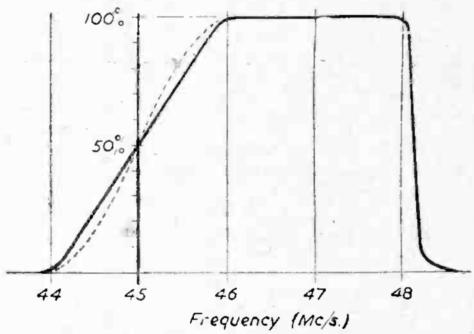


Fig. 5.—For maximum detail the vision response curve for single side-band reception should be as shown here.

arrangements of the video amplifier and it is therefore necessary to study the circuit diagram of the receiver carefully before attempting to line up a receiver. As is well known, undue emphasis at the H.F. end will result in outlining of the various parts of the picture, "black after white," and similar effects which will spoil a picture. Where transformer-type coils are employed, it will probably be found that each half can be adjusted properly only by damping the other half, and here the maker's instructions should be carefully followed, as a wrong

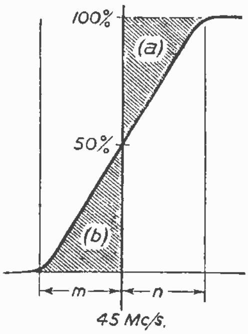


Fig. 6.—The critical part of the curve shown in Fig. 5 is indicated here. The sections *m* and *n* should be equal, as also should be areas (a) and (b).

adjustment can make such a difference to the final picture.

The Ideal Curve

For proper picture detail there is an ideal curve which one should endeavour to obtain, but, as already pointed out, some manufacturers introduce special peaking devices which may prevent this being obtained. The home-made receiver should, however, be adjusted to give this curve when no outlining, smearing or similar defects should be present. Fig. 5 illustrates the ideal curve in respect of the London transmitter, from which it will be noted that there is the required "flat top" with the steep falling away at each end. The upper fall is not too critical, but as already mentioned, it is desirable to attempt to obtain this steep fall away to remove unwanted "noise" and adjacent signals. The slope at the L.F. end, is, however, a very critical one and attention should be paid to the following points. In Fig. 6 the relative portion has been drawn separately from which it will be noted that the half-way mark between minimum and maximum response falls exactly at the video carrier frequency. The slope should be of such a character that the area above is equal to the area below as shown by the two shaded sections (a) and (b). In a practical receiver it will not, of course, be possible to obtain a perfectly straight slope and the actual curve will be somewhat similar to that shown by the broken line in Fig. 5. The variation from straight should balance on both sides of the carrier frequency so that the two areas are more or less equal. The actual slope, or steepness of the slope is not of great importance, provided that the two sections *m* and *n* are equal, and these may be .5, 1, or even 1.5 Mc/s. If the slope is too steep, that is where *m* and *n* are equal to only .5 Mc/s, any slight movement of the slope from right to left (due to valve ageing, etc.) will result in a large movement from the 50 per cent. point on the carrier frequency, and therefore such a setting might require checking at frequent intervals. On the other hand a more gradual slope such as would be obtained if the divisions *m* and *n* represented 1.5 or more Mc/s would mean that quite a large variation could take place to right or left without the overall effect being so noticeable, and in practice it is found that the best compromise is to make *m* and *n* equal to 1 Mc/s as shown in Fig. 5.

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THE Admiralty announce that their range of hermetically-sealed transformers and chokes are the first type to qualify as fully Inter-Service Type-Approved Standards. The design comprises "C" core assemblies accommodated in deep-drawn steel cases, and owing to the many technical improvements which have been incorporated the new transformers and chokes are as much as 40 per cent. smaller and give up to 50 per cent. reduction in external magnetic field compared with their counterparts using orthodox laminations.

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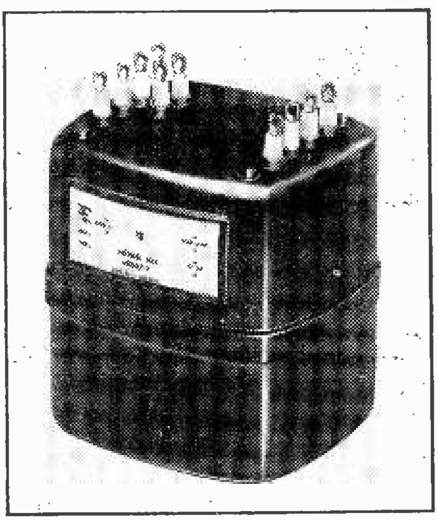
Although the design of this range is Admiralty property, it may be used freely for commercial purposes by any manufacturer who so desires. Where firms do not wish to tool the range for themselves, they can obtain supplies of cases, internal fittings, etc., through commercial sources. More than 12 firms have already taken advantage of this arrangement, and as their production increases so a greater flow of these standardised transformers and chokes will reach the home and export markets.



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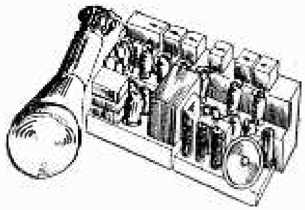

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Improving Video L.F. Response

Obtaining Better Picture Quality in Simple Receivers

By D. CAVE

MANY readers who are building their own television receivers using ex-Government equipment will be making use of the circuit shown in Fig. 1, to feed the signal to the grid of the cathode-ray tube. V1 is the video amplifier valve, which is resistance-capacity coupled via condenser K to V2 the D.C. restorer valve, and V3 the phase-splitter valve.

The author suggested in an article in the second issue of PRACTICAL TELEVISION how the high-frequency response of this circuit might be improved; and it is the purpose of this article to indicate how the low-frequency response of this circuit may be improved.

If we examine the coupling section of the Fig. 1, circuit (shown in Fig. 2), we can see that the low-frequency input voltage grid to chassis of V3 is less than the low-frequency output voltage at the anode of V1 due to the presence of the reactance of the coupling condenser K. The fraction of the video output so appearing is given by the expression—

$$\frac{R_2}{\sqrt{Xk^2 + R2_2{}^2}}$$

Where Xk = reactance of K.

Now R2 is usually about 1 megohm and K is about .1 μF.; so that at all frequencies above about 100 c.p.s. the reactance of K can be ignored in comparison with the resistance of R2. But when we consider frequencies below 100 c.p.s., the reactance of K rises and causes the voltage across R2 to fall. In addition the presence of K causes a phase shift which becomes greater as the reactance of K rises; i.e., at lower and lower frequencies. Now the very low frequencies are concerned in the reproduction of large black and white masses; so that phase shift and poor low-frequency response may cause loss of sharpness at the edges and blurring of detail in the masses.

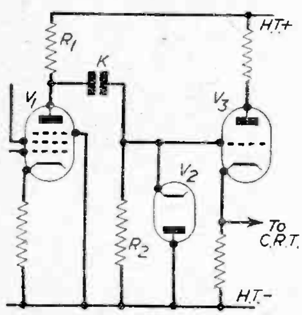


Fig. 1.—Condenser K affects the response of V3 compared with V1.

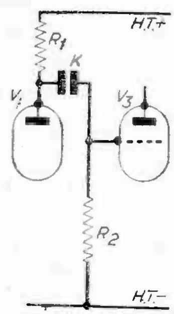


Fig. 2.—The coupling components of the circuit in Fig. 1.

The difficulty might be overcome to a certain extent by making R2 small and K large; but there is a limit to this, set by the need for good D.C. restoration; the danger of grid blocking with a large value for K; and the possible loss of high-frequency response due to the self capacity to chassis of a physically large condenser.

Probably the best way of overcoming the difficulty is to arrange for the output of the video amplifier to rise as the frequency falls; and in such a manner as to compensate the coupling loss. A method of doing this is illustrated in Fig. 3, where a condenser C has been inserted in series with the anode load R1. It will be obvious that the valve will no longer function as an amplifier since the H.T. supply to the anode has been cut; but asssume for the moment that the valve continues to function; then its gain will be gm. Z, where gm is the mutual conductance of the valve, and Z is the impedance of its anode load consisting of the condenser C and the resistance R1. Now the impedance of this circuit will rise as the frequency falls owing to the increasing reactance of C. This, of course, is what we need to compensate for the fall of low-frequency output due to K.

A Formula

The increase in output obtained when using the condenser C in series with the resistance R1 as the anode load of V1 instead of the resistance R1 alone is given by the ratio of the impedance Z to the resistance R1; i.e., by the expression:—

$$\frac{\sqrt{Xc^2 + R_1{}^2}}{R_1}$$

Where Xc = reactance of C.

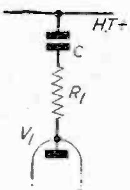


Fig. 3.—Condenser C in series with the anode load will result in a rising characteristic.

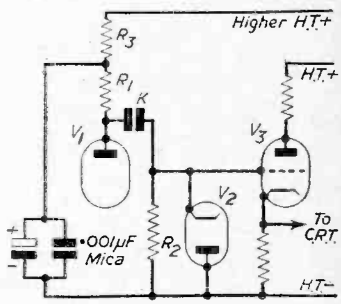


Fig. 4.—The final circuit recommended by the author.

In order that the input between phase-splitter grid and chassis shall not fall off at low frequencies, we require that the increase of gain at the video anode due to the presence of the condenser C shall balance the fall off due to the condenser K. Therefore, the product of the two algebraic expressions given must be equal to unity.

$$\frac{R_2}{\sqrt{Xk^2 + R_2{}^2}} \times \frac{\sqrt{Xc^2 + R_2{}^2}}{R_1} = 1$$

Whence $R_2{}^2(Xc^2 + R_1{}^2) = R_1{}^2(Xk^2 + R_2{}^2)$

i.e., $R_2{}^2Xc^2 + R_2{}^2R_1{}^2 = R_1{}^2Xk^2 + R_1{}^2R_2{}^2$, i.e., $R_2{}^2 Xc^2 = R_1{}^2Xk^2$.

Whence $R_2Xc = R_1Xk$.

Now Xc and Xk are the reactances of C and K, respectively, so that $Xc = \frac{1}{2\pi fC}$ and $Xk = \frac{1}{2\pi fK}$

When $R_2K = R_1C$.

That is to say, the time constants of the two circuits should be equal and the capacity of $C = \frac{R_2K}{R_1} \mu F$

Assuming R2 = 1 megohm and K = .1 μF, and R1 = 5,000 ohms; then C would be 20 μF. This is rather large, so if K is made .05 μF. and R2 about 750,000 ohms then C becomes 8 μF. approximately.

D.C. Path

In order to make the circuit work we must supply H.T. to the anode of V1, and this may be done by connecting a resistance across the condenser C. This resistance must have a large value compared with the reactance of C, otherwise it will impair the correct functioning of the circuit. Generally speaking this resistance should be at least 10 to 20 times the reactance of C at the lowest frequency at which we wish the circuit to work correctly.

Precautions

The complete circuit is shown in Fig. 4, where it will be seen that the arrangement is fundamentally the familiar "decoupling circuit." When trying this circuit there are one or two practical points to observe. In the first place R3 should be at least 15,000 ohms which will lead to a serious loss of H.T., to the anode of V1; so that the H.T. end of R3 should be connected to a point of higher potential sufficient to allow for the voltage drop. R3 should be 2 watts or more depending on the valve anode current. Secondly, owing to the poor power factor of electrolytic condensers at high frequencies it is advisable to shunt it with a .001 μF mica condenser as shown in Fig. 4.

Making a Mains Transformer

(*Continued from page* 359)

the ends of the heater windings in position is to slip a loop of strong twine on the end of the first turn and wind the succeeding turns over both ends of the twine. The last turn of the winding can then be tied down by the loose ends, thus firmly securing the whole winding.

Protection

It remains only to give the windings a few final coats of varnish to exclude moisture, and an outer covering of suitable material such as thin leather-cloth. When removing the end flanges, be careful not to drag the lengths of sleeving. Ease them gently out of the wooden cheeks one at a time.

Checking

Before assembling the core in the bobbin, check the windings for continuity. Also test the insulation between windings, preferably with a high-voltage insulation tester if one is available. The windings must not be connected to the supply mains, of course, before the core laminations have been fitted. The laminations are assembled by inserting the centre core sections at each end alternately, with the insulated surfaces all facing in the same direction. Pack the core aperture as tightly as possible, using a small piece of paxolin or metal as a final wedge to prevent vibration of the laminations. Suitable mounting clamps and terminal strips are obtainable from advertisers in this journal, but the handyman will have no difficulty in making his own.

Standard Transformer Specification

As an example illustrating the foregoing design principles, the following is a worked specification for an average television transformer.

Specification

Input: 210-230-250v. 50 cycles.

Output:	Wattage
350-0-350v. at 150 mA	52.5
2,500v. at 5 mA	12.5
4v. 1a. (E.H.T. rectifier)	4.0
4v. 1a. C.T. (tube heater)	4.0
4v. 2.5a. (H.T. rectifier)	10.0
6.3v. 6a. (valve heaters)	37.8
	120.8

Calculation of core cross-section:

$$A = \frac{\sqrt{\text{Total wattage (120.8)}}}{5.6} = 2 \text{ sq. in.}$$

Allowing 10 per cent. for lamination insulation, this gives 2.2 sq. in.

Thus a suitable stack of laminations would have a centre core 1½in. wide x 1½in. thick, with outer limbs ¾in. wide.

Calculation of turns per volt:

Factor ϕ = core cross-section 2.25 × 60,000 = 135,000

$$\text{Turns per volt} = \frac{100,000,000}{4.44 \times 50 \times 135,000} = 3.3 \text{ T.P.V.}$$

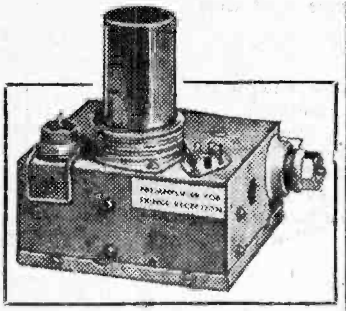
With a very slight permissible temperature rise under full load, this figure may be reduced to three turns per volt.

Allowing 150 per cent. for insulation, etc., the laminations which should be chosen should have an aperture (C) of, say, 2.25 sq. in. on each side of the core limb (A).

Book Received

"*An All-Purpose Tool*," by G. W. Arthur-Brand. 48 pages. Price 2s. 6d. Obtainable from Wolf Electric Tools Ltd., Pioneer Works, Hanger Lane, W.5.

THIS book has been specially written for the user or potential user of the Wolf Cub electric drill and its equipment. This home constructor kit, which is manufactured by Wolf Electric Tools Ltd., comprises a drill stand, saw, lathe, grinding and polishing kit, bench clamp, etc., and in each case the motive power is supplied by the Wolf Cub electric drill. It is ideal for the small workshop, and the author relates the various experiments he has carried out with the outfit. He deals with each assembly separately, starting with the drill itself and working up to the circular saw bench. If you follow the simple instructions given in the book you will have no difficulty in obtaining satisfaction from the equipment, and many important points will be brought to your notice which in the ordinary way may have escaped your attention. Excellent photographic illustrations by Mr. Stuart Seager considerably simplify the task of the author.



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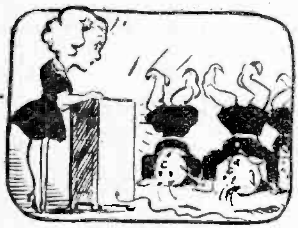

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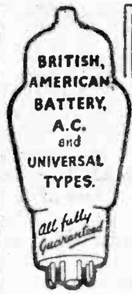

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TELEVISION PICK-UPS AND REFLECTIONS

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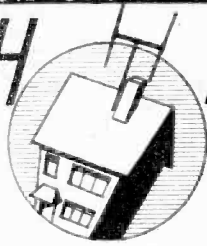


By Iconos

LARGE SCREEN

DURING 1949, considerable progress was made in perfecting large screen theatre television reproduction. Excellent demonstrations were given of British systems, and further improvements have been made during 1950, including the provision of higher standards of definition than 405 lines. But the demonstrations have been followed by—silence ! There have been no signs in this country that a regular public service will be established or that any of the large cinema circuits will install it at their theatres. Demonstrations will continue, no doubt, notably at the Festival of Britain next year, but the commercial exploitation of large screen TV lags behind its technical development.

BIG STUDIOS

BIG studios are in the news in America as well as in England. Not long after the acquisition of the Lime Grove film studios had been announced by the B.B.C., the American Broadcasting Company purchased the Vitagraph studio plant in Hollywood. The site is a large one, covering twenty-three acres, and contains the usual film studio buildings, workshops, stages, property rooms and power plant. Much of the acreage is taken up with an open air " lot," complete with permanent street sets, " ranches," façades of " public buildings " and the like. The actual studio stages are less in number but greater in size than those of the B.B.C.'s Lime Grove studios. One of them is claimed to be the world's largest television sound stage.

BIG SCREEN TV IN U.S.A.

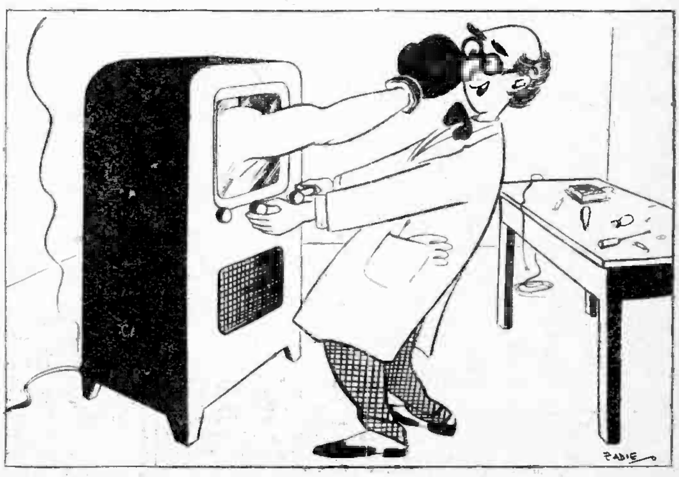
IN America, the R.C.A. Company have sold large screen direct-projection TV equipment to a few theatre owners, and the Baseball World Series was shown to paying audiences in the Fox Theatre, Brooklyn, the Pilgrim Theatre, Boston, and the West Side Theatre, Scranton. This series of baseball games was also shown on a large screen at Paramount's State-Lake Theatre in Chicago, by means of a film TV recording made a few minutes before in a laboratory across the street. Incidentally, the Paramount intermediate-film method now includes a new high-speed drier which reduces the time between photography and projection to 20 seconds ! But the intricate equipment has to be situated in the theatre projecting room to take advantage of this speedy processing. The large Fabian's Fox Theatre in Brooklyn installed an R.C.A. Direct Projection equipment for showing the Walcott-Charles heavyweight championship fight to an overflow crowd of spectators almost 1,000 miles from the scene of the fight.

As a result of these initial public shows, Twentieth Century-Fox have worked out plans for equipping 24 theatres in a 400-square-mile area around Los Angeles, including studio originating facilities and micro-wave radio link.

PICTURE FRAMING

BEFORE the moving-coil loud speaker came into general use, all varieties of sound quality, from a waffy "mellow" tone to a shrieky reediness was acceptable. One became accustomed to the particular kind of distortion on one's own set —in fact, drugged to it—and the sound on other people's sets seemed awful. That was in the days of " horse-drawn radio " ! But something of the same kind is happening with television reception, particularly on sets which have been in operation for a year or so. Height, width and centring may slowly, but surely, alter as the valves or other components deteriorate. Maladjustment of controls has its effect, of course, but the deterioration is so slow that it is not noticed by the set owner. In any case, deterioration which results in overscanning the receiving tube is much less noticeable, whether the error is in width or height. Apart from the distortions which make the actors look fatter or thinner than they really are, the composition of the picture and important information is seriously affected. This trouble has caused commercial sponsors of TV in the U.S.A. to have serious headaches. One sponsor, advertising an item for \$2.95 was startled to see on a viewer's screen the figures " .95 " only. This resulted in a flood of inquiries from viewers with badly adjusted sets who wished

PROFESSOR BOFFIN



" Eureka ! Third-dimensional TV."

to purchase the $2.95 article for the greatly reduced price of ninety-five cents! The result of a few catastrophies of this kind has led many TV companies in the U.S.A. to insert a "dead border area" of coloured gelatine in the television camera viewfinders. Any information or object which is seen through this gelatine is liable to be "lost" on badly adjusted sets. Everything of importance is now concentrated in the rectangle within this narrow neutral border.

TV "INLAY"

GREAT progress has been made with the B.B.C's TV travelling matte system, mentioned in these columns recently. It has been found possible to "inlay" sections of a live performance upon a small photographic background. For example, one TV camera is focused upon a still photograph of the front of a building, the doorway and a window of which are masked off with black paper cut to shape. A second camera is trained upon a studio "setting" with a doorway and window frame only, in front of black velvet, so disposed that they coincide in a picture mixer with the blacked-out sections of the still photograph picked up by No 1 camera. An actor enters the doorway, walks across to the window and looks out. In the composite result, the picture gives a result equivalent to that which would previously have required the construction of a large and expensive setting.

Further variations enable one picture to "wipe" over another in the manner frequently seen on cinema film trailers. Other trick process TV developments will enable actors in the foreground, playing a scene in front of black velvet, to be superimposed upon a background of film or secondary TV scene. The background could be, for instance, a seascape, the audience of a theatre or aerial views. These developments are still experimental, but it will not be long before the television studio scenes will be played upon a much broader canvas. In this field, I think, the B.B.C. is forging ahead of all other TV organisations in the world.

THE TELEFILM

IMPROVEMENT in the definition of telefilm retransmissions continues. Considering the difficulties with light on the original transmission, the telefilm of the arrival of Queen Juliana at Victoria Station was extremely good. The effect of the flash-bulbs of Press photographers was somewhat startling. It seems that when a Press man fired off his flash-light by the side of the TV camera—but out of sight of the viewers—quite a long-period flash resulted, lasting almost a second. Considering that the actual flash of one of these bulbs only lasts a few microseconds, one can only assume that the sudden intense flash close at hand momentarily paralyses the "works" of the TV camera. The remedy might be to fit outside TV cameras with extended lens hoods a device which could also advantageously be applied to studio cameras.

FRUSTRATION

THE lay Press have been carrying out quite a campaign against the B.B.C. television programmes, spurred on by angry letters from their readers. And a few important members of the staff, both on the programme and engineering sides, have resigned, telling their friends that they could no longer endure the sense of frustration they were experiencing in "trying to get a move on." This is very much the same thing that occurred in the early days of broadcasting at Savoy Hill, particularly when the B.B.C. ceased to be an ordinary "Company" and attained the dignity of a "Corporation." At that time engineers left by the score and found more remunerative—and more precarious—posts in the film industry. I have always felt that the B.B.C. was growing into a huge slow-moving colossus of the ether. This is bound to happen with the concentration of all directorial power in one place—Broadcasting House. Television is getting more than its share of exploitation by minorities, resulting in an unduly high proportion of "Third Programme" items. Until there is an alternative service, the planners should remember that the chief function of television is to entertain. This is the cause of dissatisfaction. The only item which really gets universal praise is the newsreel. I am sure that if the Alexandra Palace programme staff were given a freer hand to please their customers, they would have less Picasso and more "punch."

News Flashes

Public Interest in Large Screen TV

OVER 42,000 people passed through the projection television demonstration room on the Philips stand at the recent Radio Exhibition. This figure represents nearly one-third of the total attendance at the exhibition itself, demonstrating clearly the public interest in the bigger television picture.

Television in Canada

IN addition to supplying much of the fixed equipment for the forthcoming Canadian Television service, the English Marconi Company have also been asked to supply two O.B. vehicles fully equipped.

Colour in U.S.A.

AFTER long consideration the authorities have passed the Columbia system for public use. As a result of this announcement many firms have taken out writs and instituted legal proceedings, as they do not consider the system the best under present conditions.

Suppressed Motor Vehicles

IT is announced from the Nuffield Organisation that in future all the vehicles coming from their factories will be fitted with TV suppressors.

Free Big Screen Show

PARIS is to have its first big screen television at a cinema on the main boulevards—admission free.

The programme, including stage- and film-stars, will be picked up direct from the Eiffel Tower transmitter and enlarged on to the ordinary cinema screen.

The occasion: the 55th anniversary of the showing of the first film in Paris.

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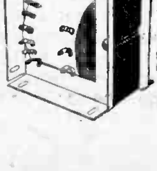

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TRADE TOPICS

Spencer-West Pre-amplifier

AMPLIFIER Type AC/3 has been designed to secure minimal valve and circuit noise. Two triode valves are employed, the first of these operates as a neutralised stage and has its anode connected to the cathode of the second triode. In this manner an excellent gain is secured and valve noise is lower than for any other circuit arrangement. The unit is completely self-contained, with its own power supply unit and mains-borne anti-interference filters. Provision is made for the connection of balanced or unbalanced feeders. No gain control is fitted and is not recommended, as the employment of such an arrangement negatives to an appreciable extent the low "noise" characteristics of the unit. Gain control should be effected with the normal receiver contrast control, thereby permitting the Pre-amplifier to make its full contribution of gain at its low noise level. Moreover, any interference existing in the receiver proper is substantially reduced in this way. The Pre-amplifier is available for London or Sutton Coldfield frequencies. Delivery is ex-stock and the price is 10 gns. complete.

Spencer-West, Quay Works, Gt. Yarmouth.

Mullard Console—Price Reduction

ON November 1st, 1950, the price of the Mullard 9in. Console Television Receiver Model MTS684 was reduced from 58 gns. (£49 14s. 7d. plus £11 3s. 5d. Purchase Tax), to 50 gns. (£42 17s. 5d. plus £9 12s. 7d. Purchase Tax). **Mullard, Ltd., London, W.C.2.**

The Q5R9 Circular Aerial

THE Q5R9 circular television aerial—Provisional Patent 14192/49—is designed for indoor use in areas where the signal is relatively strong.

The gain of this aerial is about 2 db. compared to a half-wave dipole. That is to say, its performance is slightly better than an ordinary indoor dipole.

The aerial has very sharp directional properties, and herein lies its main advantage over the ordinary dipole, for it can be so orientated to give maximum signal-to-noise ratio, and for cutting out severe interference.

The aerial works best in buildings which do not have steel frameworks, although good reception can be expected in such buildings if the aerial is installed in one of the upper storeys. The aerial is provided with a pre-set adjustment (which can be found at the top of the aerial).

It may be found in some cases that slight improvement in the picture can be obtained by adjusting this control.

The aerial is suitable for mounting underneath the table upon which the television set stands, or else it may be mounted on top of the television set, in which case a decorative base is supplied. It is also possible to incorporate a table lamp within the aerial, thus making it serve a dual purpose. It is ideally suitable for mounting in the loft.

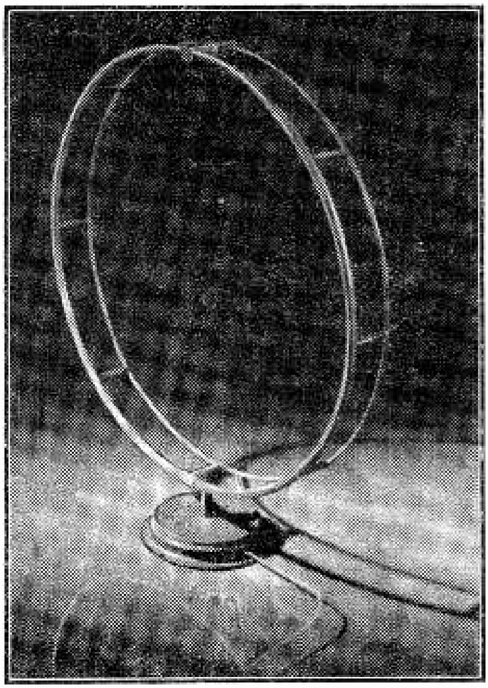
The aerial is supplied in two basic finishes, one painted; the tubes are painted either cream or aluminium, and the fittings are in black plastic. Alternatively, too, the tubes can be anodised in various colours, and the accessories coloured to match. Price 55s. London or Midland. Plastic finish 4s. extra. **Richard Maurice Equipment Co., Portsmouth Road, Cobham, Surrey.**

New Germanium Rectifier

THE General Electric Co., Ltd., announce the addition of Type GEX.45 to its range of germanium crystal rectifiers. This rectifier has been introduced to meet the needs of designers who wish for a low reverse current but do not require the exceptionally low figure given by type GEX.55. The latter has a reverse current of less than 10 μA at —10 volts and costs 30s., whereas the new type, which has a reverse current of 10-30 μA, is 16s. list price. Special net prices are quoted for quantities. Electrical characteristics of the GEX.45, apart from the reverse current mentioned above, are :—

Forward current—8 mA. approximately (at +1 volt).
Turnover voltage—greater than 60 volts.
Shunt capacitance—1 $\mu\mu$F approximately.

General Electric Co., Ltd., Magnet House, Kingsway, W.C.2.



The Q5R9 circular aerial reviewed above

Valve Replacement Guide

A NEW edition of the well-known Mullard Valve Replacement Guide has recently been issued and is available from wholesalers at 2s. 6d. net.

Where applicable, appropriate Mullard replacement valves are listed for all receivers manufactured between 1933 and 1939. For those valves for which no Mullard equivalent is available, the original valve type and make is quoted, and is printed in italics.

Receivers manufactured after 1939 are listed with their original valve complements, irrespective of make. Suitable Mullard replacements, if available, can be quite easily selected from the comprehensive Equivalents List printed on tinted sheets at the end of the book.

Mullard Electronic Products, Ltd., Century House, Shaftesbury Avenue, London, W.C.2.

Correspondence

The Editor does not necessarily agree with the opinions expressed by his correspondents. All letters must be accompanied by the name and address of the sender (not necessarily for publication).

SPOT WOBBLING

SIR,—I have been interested lately reading about a stunt known as "spot wobbling," and from the description of the idea I fail to see how it can improve television reception. It appears that some viewers or experts do not like to see the lines on the picture, and to hide these they propose to wobble the spot up and down. Surely, where fine detail is concerned (such as the features in a face at "long shot"), the movement of the spot can only result in a blurring of the features, and it seems to me that the final picture, instead of being "marred" by lines, will be completely spoilt by giving the same appearance as a badly adjusted focus. If this is not so, please tell me where I am wrong.—D. MARVIN (Wembley).

[*In practice the effect is not as you imagine. The effectiveness of the idea may be judged from the fact that the master 20in. screen receiver from which the B.B.C. records its "Telefilm," is fitted with the device and it may be switched on and off, and we understand that it is usually on when a Telefilm is made. For those who wish to experiment with the idea, constructional details of a unit are given on page 349 of this issue.*—Ed.]

BACKGROUND NOISE

SIR,—I have been very disappointed with the pictures on my home-made set for some time, due to the very heavy graining and flickering of the background. I thought perhaps this was natural to long-distance television reception until I saw a friend's set locally. This was almost free from the effect, and after some investigation I have now got my set in a similar condition. For the benefit of those who are experiencing similar effects, I would like to pass on my experience. I was using a home-made dipole aerial and a two-stage pre-amplifier to a well-known home-constructor kit. I found that my neighbour's set had three valves less than mine on the video side, and he was using a multi-array aerial. I accordingly purchased one of these aerials, and when I tried it out I had tremendous overloading. Eventually, I cut out completely the two-stage pre-amplifier, and now have the contrast control set back about one-third. The result—a clean picture without fading and much better tonal quality. Furthermore, interference is not nearly so noticeable. So a good aerial does pay sometimes.—G. ENNIS (Lowestoft).

TELEVISION INTERFERENCE

SIR,—May I be permitted to reply through your columns to the criticisms of Mr. L. C. Walters in the December issue.

First, I should like to see Mr. Walters produce some sort of proof of his statement that in no case does the beam density in a C.R.T. attain sufficient level to produce a condition where mutual repulsion between the electrons affects the focus of the beam. Direct experiment is rather difficult and special circuit design is called for, but in a particular experiment where the E.H.T. potential was absolutely fixed and the focusing field was constant, increasing the beam density invariably caused defocusing of the spot.

In his statement that it is not true to say that magnetic tube deflection does not depend on beam velocity (and hence E.H.T. potential), I can only refer Mr. Walters to some elementary work on the dynamics of a particle, or, to perhaps make it more "comprehensible" to him, suggest that he tries the simple experiment of varying his E.H.T. and see what happens to the size of his picture. If V is the final anode voltage of the tube, the width and height of the picture for a constant deflecting current is inversely proportional to $\sqrt{V}$, that is, inversely proportional to the electron velocity itself. This, of course, is common knowledge. Further, as a matter of interest, the change in picture size with change in electron velocity is not the same in the horizontal and vertical directions.

Finally, I must disagree with the remark that electron velocity is not affected by signal variations. Electrons emitted from the cathode can and do leave the grid plane at *different* velocities, and these velocity *differences* are maintained as the stream passes the final anode. As I stated correctly in my article and also mentioned above, that the amount of deflection depends on the electron velocity, then obviously a stream composed of electrons having a field of velocities will suffer a corresponding field of deflections, the tendency being for elongation of the spot in the horizontal direction. Mr. Walters' explanation of the long splash, taking a 20 μsec. interfering pulse, will produce a 2in. elongation approximately on a 9in. tube, which seems to me to be rather long.

I will conclude by saying that after several years' TV experimenting, nothing is "obvious" in this intriguing subject and the "simple" explanation is generally the wrong one.—S. A. KNIGHT (Wellingboro').

AMATEUR PLEA

SIR,—Some time ago you made a plea for an experimental programme for the amateur experimenter. I was recently kept home due to an infectious disease, and had the opportunity of seeing the morning programme, and I should like to make a further plea to the B.B.C. Why cannot the Test Card "C" be broadcast when the majority of workers are at home—say, early in the evening or at the week-ends? I was surprised to see how my set showed up faults on this card, and I would not have known it had I not had to be at home due to illness.—G. SYMONDS (N.4).

VCR140

SIR,—I should very much like to hear from any readers using a VCR140 12in. magnetic ex-Government tube, as I have one of these and should like to know if this is suitable for TV use.

I should be glad of any details concerning this tube. —J. S. BUCKLER (Somerset).

SERVICING NOTES

SIR,—I have been interested in the series of notes on Servicing which you have been running, but do not think that the author has drawn sufficient attention to the most important part of the modern television receiver. I refer to the fixed condenser, of which literally hundreds may be seen in a modern set, and the majority of them are really necessary. I have serviced a large number of receivers and in the majority of cases the trouble has been an open-circuited or partially short-circuited condenser—even mica components working at points where no D.C. is applied ! I think, therefore, stress should be laid upon the need for a condenser bridge with power factor check for those who are going in for servicing.—G. PAYNE (Streatham).

D.C. COMPONENT

SIR,—An important feature of the feed to a tube in modern TV receivers is the maintenance of the D.C. component, and I notice that a large number of modern commercial receivers, in an attempt to economise by avoiding high potential differences between heater and cathode, often include a potential divider in the video anode-circuit, a condenser being included in the top part of the feed. I wonder if the resistor across the condenser really acts as a direct-coupling, or whether the A.C. coupling does, in fact, predominate. Has any reader made a quantitative analysis of this method of feeding and if so, could he give us his findings?—G. SMEDLEY B.Sc. (Glasgow).

THE CASCODE PRE-AMPLIFIER

SIR,—I have noted Mr. Thomasson's letter in the December issue in which he provides further views on the "Cascode" circuit as applicable to television pre-amplifiers, and in addition criticises some suggestions I passed on for improving the circuit published in his original article. I had intended my letter to be helpful, and it did not occur to me that it would evoke a condemnation of some of the improvements outlined, since they appear to have such obvious advantages. It seems necessary, therefore, to deal more fully with the points raised by Mr. Thomasson concerning these improvements, so that interested would-be constructors of such units may be better able to determine what form their pre-amplifiers shall take.

There are many references in the literature to the "Cascode" circuit employed as a low-noise R.F. amplifier.

The description cited by Mr. Thomasson (*Electronics*, November, 1949) is a recent one, and the circuit arrangement published therein is almost the same as I recommended in my original letter. There is, however, a much earlier description published (L. A. Moxon, *Wireless World*, May, 1947), and it is very odd that this description should have apparently attracted so little attention, especially since it was published at such an early date. The circuit given by the author is the same as I recommended, with the exception of the method employed for completing the cathode circuit of the second valve.

Dealing now in detail with the points raised by Mr. Thomasson.

We are agreed that the first valve should be neutralised. I would mention that some experimental care in the choice of the values employed for this purpose is desirable in order to ensure that the neutralisation is held over a reasonably large percentage of the passband.

Concerning the tuning of the cathode circuit of the second valve. This is necessary to ensure that as far as possible this valve appears as a pure load to the first valve. The bandwidth of the circuit can, if desired, be increased (not reduced) when employing this additional circuit, though this is not recommended. When this circuit is correctly tuned the bandwidth as determined by this tuned circuit will be more than is necessary or desirable, by reason of the fact that the tuned circuit is shunted by the cathode impedance of the second valve, an impedance usually of the order of 150 ohms or so. Tuning of this circuit is quite uncritical and will not render any more difficult the correct adjustment of the input and neutralising coils.

The difficulty of alignment to which I referred exists with all arrangements of this nature when neutralisation of the first stage is included. This is apparent on reflection, for it will be seen that the input coil with the associated valve input capacity will have its adjustment modified by adjustment of the neutralising coil. The required procedure is first to adjust the input coil, then to neutralise, and so on through the circuit.

Concerning the use of the parallel-connected circuit, as against the series connected arrangement, the advantages of the former are surely obvious. If the H.T. voltage available is, for example, 200, then a greater efficiency is secured by providing each valve with this voltage and not by sharing it between the two valves, i.e., operating the valves at the reduced voltage of 100 or so. In passing, it can be noted that the parallel arrangement can be employed if desired without tuning the cathode of the second valve merely by fitting an R.F. choke or resistor in place of the tuning coil, so that the difficulty mentioned by Mr. Thomasson is readily surmounted. However, as I have mentioned, a tuned circuit is very simply adjusted and does confer other benefits.

The grid of the second valve should be directly earthed to R.F. (for correct operation), whichever arrangement is employed, and it is most undesirable to permit feedback to occur at this electrode as will result from the inclusion of an undecoupled grid-resistor.

In conclusion, I must mention, if I may, that it strikes me as a little odd that Mr. Thomasson should say that he is not convinced I have found the best possible circuit. I, for my part, am jolly certain that I have not reached finality. What experienced worker in this ever-changing field would be?—S. WEST (Gt. Yarmouth).

VCR139

SIR,—I saw recently an ex-Services 12in. magnetic tube on offer at about £5. As with many ex-Service tubes, the question of suitability to television purposes is always problematical.

It would be interesting to know from any readers of their experience with this C.R.T. and their opinions on persistence, colour and suitable E.H.T. voltage. In these hard times the economy offered by the use of this tube is highly attractive!—E. J. SUNMAN (Sidcup, Kent.)

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