HEIGHT INDICATOR FOR AIRCRAFT

The Practical Radio & Television Journal

Thursday, February 2nd, 1939.

Motor Car Interference
Three miniature valves for "Deaf Aid" or "Pocket Size" Amplifiers

All with 2 volt, 0.06 amp. filaments

**TYPE S12**
A screen grid tetrode with anode top cap, suitable for either choke or resistance coupling.
- Typical working conditions.
  - With 36 volts H.T.:
    - Anode resistance, 250,000 ohms.
    - Screen resistance, 1 megohm.
    - Anode current, 0.1 mA. approx.
    - Stage gain (audio-frequency), 26 times.

**TYPE H12**
A high "m" triode for first or second stage, suitable for choke or resistance coupling.
- Typical working conditions.
  - With 36 volts H.T.:
    - Anode resistance, 25,000 ohms.
    - Anode current, 0.04 mA. approx.
    - Stage gain, 15 times.

**TYPE L12**
An output triode giving adequate power for a telephone earpiece in cases where the H.T. voltage and current are restricted.
- Typical working conditions.
  - With 36 volts H.T.:
    - Anode current, 1.8 mA. approx.
    - Grid bias, −3 volts.
    - Power Output, 8.0 milliwatts approx.

Write for Descriptive Leaflets with Characteristic Curves and Recommended Circuit Diagrams.
EDITORIAL

Television

Accelerating Rate of Progress

THE combined efforts of the Government-appointed Committee, the B.B.C. and manufacturers have succeeded in establishing here a television service which is the envy of all other countries. It is a service of which we may very justly be proud; but public response has been slow and when we consider the excellence of the pictures, the reliability of the sets and the continually improving programmes put out by the B.B.C., there seems to be something wrong if the public does not respond and take advantage of it.

In a recent Address which he gave before the Royal Society of Arts, Mr. Kirke, of the B.B.C. Research Department, said that the television service was being seriously handicapped because the public was not responding by buying a sufficient number of sets. He emphasised the difficulties which lay in the way of justifying an extension of the service to other areas, which would involve great expenditure, until a really complete and transmissions can be justified, but to pave the way for the further extension of television to other parts of the country.

National Service

The Wireless Register

IN this issue we publish again the National Wireless Register Form which first appeared last week. The Wireless World has inaugurated this National Wireless Register in conjunction with the Wireless Telegraphy Board in order that the Authorities may be able to assess the potential resources in trained or partially trained wireless personnel in the country.

As we have already explained, filling up the form does not involve any liability, but will provide a means of classifying those experienced in wireless, so that in the event of an emergency which would require that everyone should put himself at the service of the country, the right job could be found for every person with wireless qualifications; either continuing in his present occupation or in some other where the utmost use could be made of his capabilities.

Those who are in reserved occupations would not, of course, be required to volunteer for other work, but it would still be valuable that they should be included in the Register for the sake of completeness, and because no matter what occupation of value you may at present be in there is always the possibility that you can render still more valuable service in another capacity.

It is hoped then that every reader will make it his business to complete and post this form as early as possible.

Wireless Altimeter

"ECHO SOUNDED" FOR AIRCRAFT

The wireless altimeter for aeroplanes has been something of a will-o'-the-wisp. Though presenting the attractive theoretical possibility of measuring the plane's height above the ground, rather than the sea level, it has encountered major difficulties in a rather long experimental life. One such difficulty was that the simplest of the radio altimeters has the unfortunate property of repeating the same indication for a number of altitudes at regular intervals, making possible an error somewhat like that of confusing a.m. and p.m. when reading a clock. Such uncertainty may be serious. Another outstanding shortcoming was that with the commoner schemes the readings of altitude were only as accurate as the frequency constancy of the transmitter which sent the radio signal employed in making the measurements. Since the ultra-high-frequency transmitter is installed in the plane, and aircraft conditions are severe, this is no minor problem. Both difficulties have been avoided very neatly in the new Western Electric Model 1 altimeter recently described before the American Institute of the Aeronautical Sciences by Lloyd Espenschied and R. C. Newhouse, of the Bell Telephone Laboratories (New York City).

The Model 1 altimeter begins with the familiar basis of an ultra-high-frequency transmitter carried by the plane and transmitting to a receiver in the same plane as suggested by the block diagram of Fig. 1. The UHF oscillator at the left feeds the small half-wave dipole transmitting antenna via a short concentric feeder line. The transmitting antenna radiates in most directions, hence the dipole "receiving antenna" at the other end of the wing of the plane receives both a "direct signal" and a signal which has gone down to earth and rebounded to the plane ("reflected signal" in the diagram). Both paths are shown in Fig. 1. Since the two paths are not of the same length, the two signals do not arrive at the same time. To be of practical use a radio altimeter must be able to measure this time-difference automatically, translate it into terms of plane height, and indicate this result promptly. The Model 1 altimeter differs from others principally in the manner of making this measurement and indicating the result. The transmitter does not operate at a fixed frequency, but is "wobbled" rapidly in a regular manner. The frequency modulation is in a saw-tooth pattern as shown by the solid line in Fig. 2 marked "direct signal." When such a frequency-modulated signal is received it is impossible for the frequency variation of the direct signal to be in step with the variations of frequency of the reflected signal, because of the difference in travel time. The delay of the modulation pattern is much like the analogous process effected by the first detector of a superheterodyne.

Describing the functioning of the device, the Western Electric Company states "a city usually causes rapid fluctuations of the order of 50 feet..."
Wireless Altimeter —

Farmland causes fluctuations of lower frequency and amplitude. An isolated high object such as a skyscraper or a chimney is indicated only by a slight meter kick as the aeroplane passes over it, which may not be noticed by the observer. The gas storage tank near the Chicago airport is an excellent thing upon which to demonstrate the altimeter performance. It is very useful as a position indicator when approaching an airport on a course which crosses an obstruction of appreciable height and size, since the moment of passage over the obstruction is clearly indicated.

Fig. 2 is largely self-explanatory, except as to the symbols employed. "h" is the height of the plane, "C" the speed of propagation, and "Δf" the peak value of the frequency variation or modulation. The proportionality between time-difference and frequency-difference is due to the use of a modulation curve made up of straight-line sections. The difference-frequency is not actually constant for a fixed altitude, but drops to zero momentarily at each point where the dashed and solid curves cross. This is shown by the lower pattern which is the form of the detector output. The flat tops of this curve predominate and represent the frequency to which the indicating meter responds. The height of the tops changes with the plane's height, but their length depends upon the frequency of the modulation.

It is very desirable to provide two ranges for an altimeter, one for normal use and one for landing or other close approaches to the earth. The Model I altimeter provides snap-switch selection of ranges of 0-1,000 and 0-5,000 feet. It is interesting to note that multiple ranges can be obtained in several ways with a circuit of this sort, since it is possible to cause a selector switch to operate on the meter itself, or on the frequency modulating device. The latter is possible because the difference-frequency is proportional to both the number of frequency-modulation cycles per second and to the amplitude (I) of these cycles. This is true because these two factors multiplied together represent the rate-of-change of the transmitter frequency, which when multiplied by the time difference (2hC) becomes equal to the detector output frequency fD. It is,

The various units of the altimeter equipment. A, receiver; B, transmitter dipole (length is about 41ln.); C, power supply unit, including HT generator; D, UHF oscillator; E, indicating meter, calibrated in hundreds and thousands of feet; F, range switch (hundreds to thousands of feet); G, junction box; H, receiving dipole. Total weight of equipment is 70 lbs.
Wireless Altimeter—therefore, necessary that the modulation be very constant. This problem partially replaces the one of oscillator constancy. Frequency variations of the oscillator, unless they are rapid and of considerable amplitude, do not have the serious consequences which would appear in a system attempting to establish standing waves between the plane and earth on the basis of a single frequency.

“Door-knob” Valve

The transmitter is shown partially disassembled in the first photograph. It employs one of the special double-ended Western Electric triodes previously described in The Wireless World. These “door-knob” tubes have the plate and grid support rods carried straight through the bulb so that the tube may be inserted in the centre of a Lecher wire tuning system whose ends are short-circuited (for RF). This arrangement minimises radiation losses from the rods forming the tuned system and approximately halves the RF current flowing into each lead-in wire of the tube. Since the wavelength is below 1 meter this effects a considerable gain in efficiency. The adjustable tuning bridges and the upper tuned rod are visible in the photograph, as is the tube at the centre of the housing.

The second photograph shows the essential component parts of a Model 1 equipment. The front row consists of the sending and receiving dipoles and the indicating meter with its range-selecting switch. The dipoles are less than a foot long. They are carried on short lengths of tubing which with the enclosed concentric rod act as impedance-matching devices and in turn connect to the feeders (not shown) from sender and receiver. The indicating meter is a normal DC meter working in conjunction with a frequency-measuring circuit. In the rear row from left to right are the receiver, the power supply and control box, the transmitter, and a junction box, all connected by such lengths of shielded multiple-conductor cable as may fit the particular installation. Definite information is lacking, but the frequency employed and the appearance of the receiver both make it fairly certain that the coupling devices are concentric tuned lines with trombone adjustment at the front panel.

PROBLEM CORNER—5
Test Your Powers of Deduction

HENRY FARRAD, another sample of whose correspondence is given below, has a reputation for correctly diagnosing his friends’ radio troubles. Readers are invited to work this one out for themselves before turning to p. 112.

99, Blomfontein Parade,
Surbiton.

Dear Henry,

Since you last heard from me, too, have been confined to my room—sciatica, it seems. A most unfortunate time, for I wanted to give the garden a good digging before the winter is too far advanced, and now I have had to pay a fool of a man to do it for me.

Another regrettable occurrence is that just when I wanted the wireless most it has let me down. Not altogether, you understand, but it is definitely not as good as it was, and there seems to be more hum than usual. Another thing—when your aunt was connecting up the extension loud speaker for me she says she got quite a shock from it. I am quite certain that has never happened before. Can you understand it, my boy?

Your affectionate
Uncle Adrian.

What was wrong with “the wireless,” and why?

Amateur Transmitting Station G5CD

At Hendon, London, N.W.4

This station, owned and operated by Mr. D. N. Corfield, carries out experimental transmissions on 1.7, 3.5, 28 and 56 Mc/s wavebands.
Motor Car Interference

Part I.—HOW IGNITION SYSTEMS AFFECT TELEVISION RECEPTION

It is fortunate that those types of electrical interference which are so prevalent on medium and long waves have, in most cases, negligible effects on the ultra-short wavelengths earmarked for television and other important services. It is unfortunate, however, that the reverse can occur and that certain forms of electrical interference, while producing negligible effects on medium and long waves, can bring utter confusion into the ultra-short wavebands by virtue of the effects they produce.

Of the few forms of interference which may mar either or both vision and sound channels of our television broadcasts one may tabulate:

1. Ignition systems of internal combustion engines.
2. High-frequency medical apparatus.
3. Oscillation from certain badly designed broadcast receivers.

The interference due to the ignition systems of motor vehicles of private and commercial type is by far the worst offender in this respect, not only on account of the effects of the interference upon both the vision and sound channels, but because of its widespread influence; it will accordingly be the only form to be discussed in this article.

The interference is primarily due to the high-voltage circuit of the ignition system which provides a spark across the sparking plug gap. At each spark a train of highly damped oscillatory currents will flow through the high-tension wiring system, and from it will radiate electro-magnetic fields. The reason why these currents are oscillatory is due to the fact that the distributed constants of the ignition wiring system comprise inherent inductances and capacities, and these are set into oscillation by the momentary voltage pulse applied to the circuit by the spark coil, or magneto.

The British Electrical and Allied Industries Research Association have conducted a series of investigations into the sparking mechanism of ignition systems with a view to finding out the nature of the oscillatory currents produced thereby. Their studies include some excellent high-speed oscillography. These oscillograms show that the current through the sparking plug, at the time of discharge, consists of a series of decaying oscillations whose fundamental frequency is of the order of 35 megacycles per second. These oscillations rapidly decay to a negligible magnitude in a time not generally greater than 24 microseconds, depending rather upon the general disposition of the high-voltage circuit and the length of lead employed. A typical pulse of this oscillatory current would look something like that depicted in Fig. 1.

A very surprising and original finding was that the peak amplitude of this current pulse at or around its starting time was of the order of 100 amperes, depending to some extent upon the gap length of the sparking plug. It is interesting to note that the instantaneous peak amplitude of the current in the transmitting aerial at Alexandra Palace never attains anything near so great a value! It is indeed fortunate that the radiating efficiency of the high-voltage wiring in a vehicle is less than that of the Palace aerial!

It is a simple matter to provide a suitable measuring equipment to verify that the interfering fields from ignition systems are mainly vertically polarised. The response of a horizontal doublet to this form of interference is some ten times less than when the same doublet is vertically disposed. It is wondered whether the Radio Corporation of America have adopted horizontal polarisation for their experimental television service for the same reason.

It is difficult to measure or express the field strength of ignition interference because of the transient nature of the disturbance.

Effect on Television Reception

If one sets up a television receiver and drives a motor vehicle close to the aerial it will be observed that the picture will be covered by longitudinal flashes of light, exhibiting the general appearance of a driving snowstorm in which the snow is moving horizontally. Now, as the car is driven away from the aerial it will be noted that the flashes of light will diminish in size rather than in brightness until they ultimately become mere specks and appear to become merged into the picture. The most important point to realise here is that the spot never appears to become grey or dim, but rather to decrease in size and ultimately vanish. Now, although the shape of the initial pulse of ignition current is known, it cannot truthfully be said that we know much about the shape of the pulse after it has passed as an electromagnetic wave through the ether, and as a current through the aerial feeder, the tuned circuits and detector of the receiver. All we know from experiment is that the
Motor Car Interference—length rather than the brightness of the actual spot appears to decrease as the intensity of the field is made to decrease (for example, by driving the car to a remote point).

Now, having a knowledge of the original pulse shape and its effect upon the picture, particularly as the magnitude of interference is decreased, a logical determination of what modifications to the pulse shape are effected during its transmission may be established.

As a start, let us suppose that the original oscillatory impulse as depicted in Fig. 1 is undisturbed in its general shape in the process of being transmitted through the ether and the complicated network comprising the television receiver until it arrives at the terminals of the detector. After detection (rectification) it is clear that the pulse will become uni-directional, and will appear as shown in Fig. 2(a), which is, of course, an outline of one side of the envelope of Fig. 1. This is the pulse of voltage which would be applied to the controlling electrode of the cathode-ray tube. Now, supposing at the instant of time T the amplitude $v$ of the voltage applied to the controlling electrode of the cathode-ray tube is of sufficient intensity to produce full-vision white intensity on the screen, then the amplitude over the time from the origination of the pulse up to time T would have the same effect. It is quite clear, therefore, that an intensity corresponding to full-vision white will occur over a time of duration $OT$.

Now let us take the vehicle to a more distant point so that the magnitude of the impulse when it arrives at the aerial system of the receiver is much smaller, as depicted in Fig. 2(b). It is clear now that the time between initiation and the instant $T_{1}$ over which the pulse is of sufficient amplitude to give full-vision white, has been reduced by quite a considerable amount; for example, at a distance of a few feet the impulse may be of such magnitude that it has the effect of maintaining full-vision white amplitude at the cathode-ray tube for a period of 25 microseconds, whereas when taken 30 or 40 yards away the effective time over which this full-vision white is maintained may be less than 1 microsecond.

The electron beam which is scanning the surface of the screen at a fixed velocity travels from one side of the screen to the other in approximately 100 microseconds. On the receiver side in width a pulse producing full-vision white for 25 microseconds will, by a little calculation, produce a spot between one-eighth and one-fifth of an inch long, the spot due to a pulse occupying an effective time of $\frac{1}{4}$ microsecond for the full-vision white period would be reduced in length to approximately one-twentieth of an inch, and so on for a very much shorter period.

This theory fits in with the observed facts very nicely, and it can therefore be assumed, with some degree of certainty, that the envelope shape of the initial pulse is not modified to any vast extent by the circuit network through which the disturbance has to travel before it ultimately reaches the controlling electrode of the cathode-ray tube.

When Interference Disappears

The foregoing may also explain in some measure the reason why the brightness of the spot does not seem to change to a very great extent, although its dimensions do; for we can visualise the limiting time interval becoming so short that the length of the interfering spot becomes comparable, or small, in relation to the diameter of the spot due to the electron beam, thus producing the effect of the interference becoming submerged into the picture mosaic.

While the theory is undoubtedly speculative, it does appear that the annoyance factor of television interference from the viewpoint of its effect on the picture must be expressed in terms of the size of the spot rather than by its brightness, for a number of large dull spots would be far more objectionable than the same number of minute bright spots.

From the foregoing it is evident that any instrument which is to measure the peak intensity of the interfering field will be very different from that intended to measure what might be regarded as the annoyance factor, and due consideration must be given as to which type of measurement will be preferable.

It is evident, from an inspection of the interfering pattern obtained on pictures in known field strengths exceeding 20 millivolts per metre, that at a distance of 30 to 40 feet from the side of a main road the peak intensity of the interfering field, from the ignition systems, must be of a similar order to those of the incoming signals themselves, that is, to the peak amplitude at full-vision white modulation.

Apparatus is not as yet available whereby the exact instantaneous peak amplitude of the ignition interference can be measured, but it is safe to predict that very high figures would be obtained, because the indications in practice so obviously point to this.

So far as the interference with the sound reproduction is concerned, this is another matter, since the principles involved are so very much different in that the ear is now involved instead of the eye.

If we assume, as we did in the case of vision, that the actual envelope shape of the pulse is relatively unaffected by the aerial and receiver network, then the loud speaker will receive pulses of current of similar shape to that shown in Fig. 2. Now these pulses occur rhythmically in the firing order of the engine; at an engine speed corresponding to 30 miles per hour for average vehicles, the number of sparking impulses per second is of the order of 30, but the pulse itself lasts for a very much shorter period than the actual time between each pulse. So for those of the pulse current in the voice coil of the loud speaker will be to cause the diaphragm to be set into oscillation at its own natural frequency, and the time over which it tends to oscillate will be determined largely by the amount of mechanical damping. The result is a rhythmic clicking sound, very much like that produced by a distant machine gun. In either the measurement or the expression of the interfering effects of ignition systems with television reception, it must be made clear whether reference is being made to the vision or sound channel.

Independent of the method used for the measurement of the interfering field intensity, it will be interesting to see how this intensity changes with the distance from the source. If an initial measurement is taken at a distance of about 10 yards from the bonnet of the vehicle it will be observed that the intensity has fallen to approximately one-thirtieth at a distance of about 130 yards. At about 60 yards the interference will have fallen to approximately one-tenth of its original value.\(^1\)

It must not be forgotten that these measurements must be taken under conditions where no stray effects can be introduced. It is well known, for example, that the interference can be picked up by telephone and telegraph wires and carried some distance and re-radiated on to the receiving aerial, but this is hardly a fair test. It is also possible for reflections to occur, so that as one recedes from the source of interference the actual field intensity exhibits a succession of maxima and minima. Here again the presence of some conducting obstacle or obstacles is indicated.

Having given quite a lot of consideration to the cause, and nature of the effects, of ignition interference, it is now necessary to deal at some length with the means whereby the effects may be eliminated so as not to affect the performance of a television receiving system. Part II of this article will attempt to cover that important aspect of the subject.

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1 ERA Report M/747, Short Wave Interference from Ignition Systems.
Part V.—Constructing and Adjusting the Power Amplifier

As the exciter unit is designed to operate on two wavelengths, viz., 21 and 42 metres, the same provision must be made in the power amplifier. We can use either switching or plug-in coils for band changing, but the latter are in general the more satisfactory. RF currents of some magnitude circulate in these circuits and a very little resistance in the wrong place can lead to quite a serious loss in power.

Idle coils may also prove troublesome, for if with the stray capacities they resonate to the working frequency, losses will take place through absorption. By properly designing the amplifier the neutralising will hold with any set of coils likely to be used. We can now draw the complete circuit of the amplifying stage which takes the form of Fig. 11.

If a metal chassis is used the grid circuit tuning condenser, C1, should be mounted on an insulated bracket, as the moving vanes are not actually connected to the earth line. If this is inconvenient they could be made "earthly" by shifting C2 and connecting it between R3 and the moving vanes of C1.

There would probably be no noticeable difference in the performance by making this change though it is a good policy to complete all tuned circuits in transmitters in the most direct way and avoid including non-essential components that may have an appreciable RF resistance at the frequency of operation.

For the grid circuit the coil L1 can be wound on a standard four-pin former and the extra pair of pins utilised for the small coupling coil connections.

Another method of coupling that has been found very satisfactory in practice is to make up a two-turn coil from stiff wire, and of larger diameter than the coil former, and mount it so that it encircles L1 and is coupled to the lower or earthy end of the grid coil. The illustrations show how this can be arranged.

Grid Bias Arrangements

As the valve is operated as a Class ‘C’ amplifier, grid bias has to be obtained from a battery, or at least from a source of constant voltage, but it is also an advantage to include a resistance as well, R3 in Fig. 11. This has a compensating effect, as the extra grid bias obtained with the resistance will depend on the RF input. If the excitation increases, so will the grid bias and vice versa.

The circuit shows the inclusion of a screen between the grid and anode circuits of the valve. It has been included to prevent, or at least minimise, direct coupling between L1 and L3. Any coupling between these two coils not only makes neutralisation more difficult but when the stage is stabilised it only remains
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so at or near to one particular frequency. By eliminating the unwanted coupling the valve can be neutralised at say, 42 metres, and it will also be correctly neutralised when the 21-metre coils are plugged in, or coils for any other wavelength for that matter. The alternative would be to screen individually the coils, but this is neither desirable nor practical; first because screening cans of very large size would be required, and secondly, it hinders the charging of the coils.

The salient features of the anode circuit have already been discussed, and now we are only left with the coils for L3 position. Two coils are needed, one for 42 metres and the other for 21 metres, and they have been wound on the Eddystone glazed Frequentinite formers. These formers measure 2½ in. in diameter and they are grooved for winding 7½ turns to the inch. As the coil is centre-tapped it is most convenient if we have an even number of turns, as an odd number would entail bringing the tapping down from the top and there are no holes on the top of the former through which wires can be passed.

For the 42-metre coil, 20 turns of No. 14 enam. wire are employed, while for the 21-metre coil 8 turns of the same gauge wire are required. Though there are holes in the lower part of the former, at every alternate groove it is well nigh impossible to thread the thick wire through them and bring it out again and down to the plugs on the sub-base. At least, the writer found it to be so.

It is suggested that about one inch of wire be passed through and turned over to anchor the ends of the coil. The connecting wires are then soldered to the last turn at each end just before it enters the former.

The only other part of the circuit that needs comment is the resistance R2 and C4 and C5. R2 takes the place of the usual centre tap on the filament winding while C4 and C5 are RF by-pass condensers. This combination provides the shortest possible return path for both anode and grid circuits and also confines the RF to the wiring in the unit and keeps it out of the filament leads. A resistance of about 30 ohms is suitable for 42 and the actually used was a Caud Lyons H.D. 30 Hum-Dinger.

In order to keep check on the operation of the transmitter we shall require to know the anode current of the valve and occasionally the grid current. An anode current meter should be regarded as an essential part of the set and it is connected in the HT positive line at the point marked A. In the illustration of the unit the two terminals for connection of this meter are the pair on the right-hand side of the chassis, while the two on the left are those marked B in the grid circuit.

With 70 watts input the anode current will be about 30 mA under normal conditions of operation, but bearing in mind future requirements a meter capable of recording up to 75 mA at least should be obtained.

Multi-Purpose Meter

For grid current measurements a milliammeter reading up to 20 mA will suffice as the average value of current in this circuit is of the order of 10 mA only. If it is desired to make one meter serve for all purposes, at least at the outset, then a multi-range instrument should be acquired, as a grid-circuit meter will be necessary when neutralising the amplifier.

We now come to the important question of the valve for the amplifier. Mention has already been made of the Mullard TZ08/20, and this is a very good example of an inexpensive power triode for amateur wavelengths. Its filament requires 6 volts at 1.1 amps and the valve capacities are not unduly high. This firm have just introduced a new transmitting valve of the same power rating but with appreciably smaller valve capacities and having the anode lead brought out to a plug connection on the top of the bulb. It is suitable for use down to five metres and it is known as the TZ08/20.

The unit was built for this new valve to come to hand and if a TZ08/20 had been available at the time we would have fitted a chassis valveholder instead of the baseboard one shown, as this enables a shorter anode lead to be used and the grid lead will come up from below the chassis its length will be only about ¾ in. longer than the existing one, but the anode lead will be shortened by about ½ in. This will make no difference to the operation on 42 or 21 metres. The shorter anode lead will be an advantage if the unit is used as a straight amplifier on 10 metres, by interposing a frequency doubling stage between it and the exciter.

The initial adjustments for neutralising will, however, be the same whichever valve is used. The TZ08/20 has a 7.8-volt filament and requires 1.7 amps.

Before HT is applied to the power amplifier it must be neutralised, which is done with the filament hot and an RF voltage applied to the grid circuit.

This adjustment can be made on either 42 or 21 metres; we will for explanatory purposes decide on 42 metres. First set the neutralising condenser C3 to about one-tenth of its full capacity, plug the 42-metre coils in exciter and amplifier units and apply a negative bias of -48 volts to the grid of the power amplifier. A milliammeter should be connected to the terminals B. Join the coupling coils on the units together by a length of twisted, or better still, a piece of low-impedance feeder cable (70-80 ohms).

With the exciter oscillating, tune the grid circuit of the amplifier to resonance, which will be indicated by the highest reading on the grid-circuit milliammeter. It should read about 15 mA.

If the link-circuit coils are coupled too tightly more grid current will be driveable than desirable will flow, and it is quite possible for the coupling to be so tight that it stops the exciter valve from oscillating.

Now couple the absorption wavemeter, previously tuned to the working wavelength and in which a small flash lamp has been fitted, to the anode coil of the PA and tune this circuit to resonance. The lamp should glow and the needle of the grid circuit meter will kick violently. Now increase the capacity of the neutralising condenser C3, using a tool with a long insulated handle, until the lamp ceases to glow, at the same time making any necessary corrections to the grid and anode circuit condensers C1 and C0. As any change in C3 will affect the tuning of these two circuits, especially the grid circuit.

The final adjustments of C3 should be made without the wavemeter and by
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noting the effect on the grid current. A setting for this condenser must be found that on swinging C6 slowly through resonance no flutter is seen on the grid current meter.

Fig. 12.—Method of coupling the PA anode circuit to a dummy aerial, using a low-impedance link (twisted flex).

There will be a gradual fall in grid current as C6 is rotated towards minimum capacity, but if the stage is incorrectly neutralised the needle will flicker as C6 passes through the resonant position.

Having neutralised the amplifier a reduced value of HT, say 250 volts, can be applied to its anode. Now when L3 C6 is tuned to resonance the anode current, measured by a meter inserted at A, will fall to a very low value, about 5 to 6 mA only, but any movement of C6 each way will cause a rapid rise in current.

This fall in current at resonance is characteristic of Class "C" amplification. One would not usually run a transmitting valve without power being drawn from the anode circuit as valves can be quickly damaged by so doing, but in the present transmitter those valves mentioned will safely withstand this treatment as they are not damaged by so doing, but in the present transmitter those valves mentioned will safely withstand this treatment as they are not damaged by so doing.

Anode dissipation is the difference between the power applied to the anode and the power taken out by the load. Thus if we apply 10 watts to the anode and draw 5 watts of RF for the aerial, the anode dissipation is 5 watts. Now both the TZ08/20 and the TZ08 have an anode dissipation rating of 20 watts and one of the advantages of the beginner choosing a larger valve than the immediate requirement demand is that it is not likely to be damaged while initial adjustments are being carried out and experience gained in handling the transmitter.

The next step is to make up a simple dummy aerial in which the power from the transmitter can be absorbed while making the final adjustments as it would be contrary to one's licence to do this on a radiating aerial. It need be nothing more elaborate than an absorption wave-meter fitted with a six-watt car lamp.

A single turn of wire wound round the centre of L3 and joined by a low-impedance link to another single-turn coupling coil on the dummy aerial, as shown in Fig. 12, serves quite well for this testing circuit.

The full HT of 350 volts can now be applied to the amplifier valve and leaving L3 C6 tuned as previously described for minimum anode current the dummy aerial is tuned to resonance, when the lamp will light quite brightly.

If the adjustments have been made correctly the anode current of the amplifier will rise when power is taken from the anode circuit. At the same time there will be a fall in grid current.

If the coupling between L5 and L6 is varied there will be a corresponding increase or decrease, according to the nature of the change in coupling, in the brightness of the lamp, an increase being accompanied by a rise in anode current and a decrease by a fall.

The point to remember is that C6 is always tuned for lowest anode current while the coupling between the aerial, or dummy aerial, and the PA tank circuit is adjusted for highest anode current. The grid circuit is always tuned for maximum grid current.

The correct operating conditions with 10 watts input and with 350 volts HT is with the dummy aerial coupling adjusted so that the amplifier draws 29 mA. It can be made any value up to about 50 mA by adjusting the coupling. The grid current will be of the order of 8 to 9 mA.

If all the circuits of the transmitter are properly in tune then the lamp in the dummy aerial will be almost at full brilliance, indicating that an RF output of about six watts is being obtained.

This experiment repeated with the 21-metre coil will show that the RF output is approximately the same on both waves.

There will be no need to re-neutralise after changing the coils as this process needs carrying out only on one wave-length for it holds good on all others. Of course, if the valve is changed then the amplifier will have to be reneutralised. Of the two valves mentioned the TZ08/20 is slightly more efficient on the higher frequencies and if it is proposed to transmit on 10 and 5 metres later it will prove a good investment. Incidentally, the transmitter as described can be arranged to give a moderately good RF output on ten metres by operating the amplifier as a frequency doubler, but we will defer a discussion on this matter to a later date, as there are several matters of more importance, such as the design of the power supply unit and the method of keying the transmitter, also the possibilities of applying modulation for telephony transmission, to be dealt with before we need consider its use on the ultra-high frequencies.
A Case for Legislation

I AM not, as many of you know, one who places much faith in proverbs—or wisecracks, as the younger generation term them—but the one which states that it is an ill wind that blows nobody any good has certainly proved true of late in my own case. I dare say that there are quite a number of you who sometimes have an idle moment after studying the sporting pages in your daily paper and endeavour to fill it by turning to less important sections of the journal dealing with the daily doings of dictators and divorcées, and probably you may have noticed that a month or so ago a large part of the Thames Valley was plunged into darkness for several hours owing to what the B.B.C. would euphemistically call a technical hitch.

At the time it occurred I was engaged in endeavouring to trace the source of certain very aggravating interference to television which a friend who lives in that area was experiencing. Naturally, I was exceedingly annoyed when the lights went out, as, of course, the television set went off also, and I complained bitterly of my wasted journey, as there was no longer any television to be interfered with. I had, as a matter of fact, spent many fruitless evenings in endeavouring to trace interference, which affected both the vision and the sound side of the Alexandra Palace transmission, but was not apparent on the ordinary broadcasting wavelengths. I had patiently scoured the neighbourhood with my interference tracking outfit and had succeeded in tracing it, as I believed, to the residence of a rather acidulous spinster living next door, who was, however, not very helpful and had taken umbrage at my enquiry as to whether she had recently installed an electric beauty-treatment apparatus.

When the power suddenly failed, my friend brought an up-to-date battery set into service to beguile the time, and endeavoured to tune in America on the 13-metre waveband. I was distinctly surprised to hear obvious signs of man-made static of a type which appeared familiar, and, hastily switching on my portable interference-tracking gear, I discovered that on the television wavelength the trouble was as bad as ever, even though the mains were off. I at once realised that this was a very important discovery and that the black-out was a blessing in disguise. The fact that the power was off did not, of course, affect the interference-conducting properties of the mains in any way, but it did mean that all the host of mains-operated devices were ruled out as sources of interference.

Distinctly puzzled, I went into the street with my gear and once more traced the trouble to the house of the acidulous spinster, and, feeling thoroughly aroused, I determined to solve the mystery once and for all, even at the cost of being arrested on the time-honoured charge of conduct whereby a breach of the peace might have been occasioned. When she responded to my knock I noticed the same peculiar phenomenon that I had observed before, namely, that during the actual time she was with me the interference ceased. I therefore determined to discover what she did after slamming the door in my face.

With this end in view, I peered through a chink in the blind of the front room and beheld her sitting by the light of a guttering candle doing nothing more depraved than stroking one of a large number of cats with which she was surrounded. I was completely nonplussed until the interference suddenly and temporarily cleared up as she paused to put down one cat and take up another, and in an instant the truth flashed upon me, and I recollected my old schoolboy experiments of rubbing catskin to produce static charges. Although I have discovered the cause of the trouble, I am no nearer to eliminating it. The obvious cure would be to earth all the cats permanently, a task which I would gladly undertake.

One for Henry Farrad

It has always been one of the guiding principles of my life to give even the devil his due, and consequently when I received a letter the other day from a friend up North, in which he somewhat bitterly anathematised the manufacturer of a certain anti-static aerial, which he declared to be a dud, I at once constituted myself as counsel for the defence, and informed him that it was much more likely that it was the maker of the set who was deserving of censure.

In a subsequent letter my friend said that the set was new and completely up to date and was, therefore, beyond reproach, a piece of utterly illogical reasoning to which I fear far too many people are prone nowadays. I did not attempt to shuffle out of the difficulty by telling the sufferer that he must expect any interference that was present to show up more on a new set than on an old one because of the far greater sensitivity of the former. This case was one of many, and many so-called technical advisers frequently use in order to cover up their inability to diagnose the trouble accurately.

It is quite true that the more sensitive the set the more interference it will pick up and, therefore, a modern receiver might be expected to be more noisy than an old one. The obvious solution would, on the face of it, seem to be to employ a suppressor in the mains lead and a good anti-static aerial, and this is another instance of where many so-called technicians come unstuck, for with many modern sets such a remedy will have very little effect at all.

The truth is that it is, after all, the set that is the cause of the trouble, but not because of its great sensitivity as the technically ill-informed would have us think, but because so many set-makers neglect the elementary precaution of screening the wire which connects the aerial terminal to the first tuning circuit in the set. With a modern superhet, these few inches of wire are all that are required to pick up nearly all the interference that is going and completely nullify the efforts of the anti-static aerial, the makers of which wrongly get blamed for a delinquency of the set manufacturer.

This was, as I expected, the cause of the trouble in this case. My friend had hitherto been using one of the earliest all-mains sets made in which the makers had very wisely gone to a lot of trouble to screen the lead I have referred to and, indeed, every other lead in the receiver (Philips Type 2511, Vintage 1928). This set had been displaced by a modern one in which complete screening of the internal connecting leads had been neglected (no names, no libel actions) with the results that I have indicated. I have left my friend to argue it out with the set makers who, I feel sure, will not be at a loss for an excuse.
**B.B.C. FOREIGN SERVICE**

**Revised Schedules and Staff Reorganisation**

At the request of many European listeners, all B.B.C. Regional programmes except those for Scotland, Wales, and Northern Ireland, are broadcasting news in French and German from 6 till 6.45 p.m. on Sundays, and from 7 till 7.45 p.m. on weekdays. These transmissions, as well as a bulletin in Italian, which will immediately follow them, will also be broadcast from Daventry GSA.

The Government will take over the B.B.C. Foreign Language Service and Foreign Language News Service, previously under separate Editors, have been brought to the newly enlarged Overseas News Section under an Overseas News Editor. Mr. A. E. Barker, former Editor of the Foreign Language News Service, has been appointed to this post.

The Arabie and Spanish-Portuguese services, also included in the new section, remain under the same Editors as hitherto.

**TELEVISION CAMPAIGN LAUNCHED**

**Hopes for a Nation-wide Service**

Mr. F. W. Ogilvie, Director-General of the B.B.C., who, with Mr. C. O. Stanley, Chairman of the Television Development Sub-Committee of the R.M.A., was televised last Thursday morning when they launched the campaign to popularise television in London and the Home Counties. Speaking principally to the industry, he said: "Television cannot help going forward, but the pace at which it is to go forward will depend upon the close and friendly co-operation between you, who make and market television sets, and ourselves at the B.B.C."

A Nation-wide Service

Whilst recalling that we are only at the beginning of television as a nation-wide service, Mr. Ogilvie gave the assurance that there would be no change that we make to affect sets for some years to come.

Mr. Stanley, who spoke immediately following the D.G., said that we begin a high radio to make everybody television conscious; to show that the effort and money expended on launching this service has not been wasted, but on the contrary has laid the foundation for a great new public service of entertainment. Television must continue to progress. Its service area must be extended. It must become a national service."

Referring to the present prices of television sets he said, "I can assure you and the public there will be no further reductions."

**Transatlantic Sales Contest**

It has been stated in the American periodical Business Week that 1939 will be a television year in the U.S.A. and that more sets will be sold in New York than in London. Mr. Stanley read a cablegram which was sent from the Television Development Sub-Committee accepting the challenge for a friendly transatlantic sales contest between London v. New York.

In an earlier speech Mr. Stanley stated that British television receiver sales were approaching the million-pound mark.

**U.S. GOVERNMENT STATION**

**Plan for Latin American Transmissions**

A Bill calling for an appropriation of $750,000 for the construction of a Federal Broadcasting station in Washington, with provision for a further $200,000 per annum for maintenance, was brought to the United States Congress by a Representative a few days ago. It is proposed that the Navy Department should operate the station, which would be primarily concerned with counteracting the propaganda broadcasts for Latin America transmitted by totalitarian States.

The Paris edition of the New York Herald Tribune calls attention to reports which state that the transmitter at 90,000 watts was to make over the 20-kw short-wave station at San Francisco at the close of the World's Fair in that city.

**C.B.S. EXPERIMENTS**

High-frequency broadcasts in America

Eight high-frequency stations located in widely separated sections of the United States will be available to the Columbia Broadcasting System following the inauguration this week of W6XDA, and the opening in April of its already famous television transmitter.

With the advent of television in America, receivers will be put on the market capable of picking up high-fidelity programmes from such stations as these.

**B.B.C. STAFF AND NATIONAL SERVICE**

Who is an executive on the B.B.C. staff? Everyone at Broadcasting House is asking this question following the inauguration of B.B.C. executive and administrative staff in the National Service Schedule of reserved occupations. In the strict interpretation of the term there are only four "executives" in the Corporation—one to each of the four Divisions, namely, Programmes Administration, Public Relations and Engineering. It is considered, however, that "executive" is a generic term for the purposes of the Schedule, and in practice will include the majority of officials on the staff over the age of 25.

**BROADCASTING IN WAR**

Confiscated Wireless Sets in Barcelona

The importance of wireless in time of war was illustrated practically in Barcelona during the days immediately preceding the entry of Nationalist troops into the city. By order of the Government, all wireless receivers had been confiscated for a period, in consequence of General Franco's propaganda transmissions.

Before the city fell, General Franco made a broadcast in which he gave assurance that he would not bomb or shell the city. His words were not generally heard. If they had been they would, as observed in The Times, have disposed of the one menace of which the inhabitants lived in greatest terror—an attempt such as was made in March to bomb Barcelona into submission.

**P.A. AT THE WORLD'S FAIR**

Three-Thousand-Watt Output

Sixty powerful high-fidelity loud speakers, delivering an output of three thousand watts, are being installed for the extensive PA system at the World's Fair, Treasure Island, in San Francisco Bay. The system, which was designed by the R.C.A., provides for picking up programmes at any one of twelve points in the grounds, and for the handing of six different programmes simultaneously. This sound system, which provides loud speakers in thirty-six parts of the grounds, is only half of the installation; for an immense broadcasting control centre is being incorporated in the State of California Broadcast and Auditorium Building.

Adjacent to the control centre is a large broadcasting studio, seating 3,200, and several smaller studios. From what is called a
News of the Week—radio promenade; the programmes presented in three of the studios will be visible to visitors through sound-proof windows and audible through concealed loud speakers.

EDUCATIONAL BROADCASTS

The Position in India

WIRELESS as a means of education is rapidly gaining ground in popularity throughout the world. The organisers of broadcasting in India have not been slow in realising this and, as has already been announced, transmissions for schools are regularly being radiated from Delhi, Bombay, Calcutta and Madras.

It is, however, little use broadcasting programmes for schools that are not equipped with receivers. With a view to raising money for equipping schools, the A.I.R. Calcutta station recently held a concert at the New Empire Theatre under the title "Radio on View" for which the stage was fitted out to represent a studio. The proceeds of the concert, after deducting expenses, has been added to the School Broadcast Fund.

The Government of Bengal is soon to constitute an Advisory Committee for All-India Radio. It will be composed of the Controller of Broadcasting (president), the station director and four or five non-officials. The Committee will meet quarterly and lay down broad lines of policy, on the programme side.

As part of the plan for the expansion of their rural broadcast department, the Madras Government also propose to afford radio engineers the facilities of a fully equipped laboratory in order to carry on research with a view to the production of cheap receiving sets.

RADIO IN THE CANADIAN ROCKIES.—Sunshine Valley, one of the best skiing districts in the Rocky Mountains, is now linked directly with the town of Yarmouth, 16 miles away, by using two-way short-wave wireless installations. Unaffected by storms, snowslides and other enemies of line telephone systems, the short-wave stations CZ2Z at Sunshine Lodge, shown here, and CZ2Y at the Mount Royal Hotel, Banff, which are operated by members of the hotel staffs provide intercommunication across miles of difficult trail.

STUDIO ON SPRINGS

Hollywood's Room Within a Room

STUDIO "G" in the Hollywood headquarters of the National Broadcasting Company is actually a room within a room. Specially designed to accommodate the 1,800-pound organ which has just been installed there and to keep the sound from carrying beyond the walls (such as is the unfortunate case with the B.B.C.'s Concert Hall at Broadcasting House), the studio is hung on springs. It is literally a box suspended within a room; even the air ducts are joined with flexible joints. The walls are designed to give the amount of resonance desired for perfect reproduction of the organ tone, being partially treated with a sound-absorbing material and partially finished in smooth texture for sound reflection.

INDIAN ADVISORY COMMITTEE

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IN THE STUDIO

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FROM ALL QUARTERS

Amateurs in Czechoslovakia

About two hundred amateur wireless operators in Czechoslovakia, who were licensed between October 16th, 1938, have been granted permission to recommence their transmissions. The authorities, however, are not prepared to issue new licences.

News from China

Mr. H. E. Scott, of Hayes Kent, reports good reception of the Chinese short-wave station NGOY (?GRY), working on 9.5 Mc/second, last Sunday, January 26th. Announcements were made in English and French, and transmissions are made between 6 and 10 p.m. G.M.T. each evening, with news in English at 9 o'clock.

Newfoundland and Broadcasting

The broadcasting possibilities opened up by the new radio-telephone service which links Newfoundland to the outside world through the Canadian Marconi beam station at Yarmouth, Quebec, are considered important, since Canadian and United States advertisers have been sending recorded programmes for transmission by the Newfoundland broadcasting stations. It may now be possible to transmit direct programmes by means of the new radio link.

THE MOST POPULAR NEWS BULLETIN

The Listener Research staff at Broadcasting House have discovered that the 6 o'clock news bulletin has the biggest audience. The 10 and 7 o'clock bulletins follow in that order.

Following correspondence received from listeners, the B.B.C. is considering the transfer of the 10 p.m. Regional News to the National wavelength at 9 p.m., the former being especially popular owing to the inclusion of topical talks.

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B.B.C. Television Programme Relayed by N.B.C.

Listening to the National and Empire programmes as well as listeners to the National Broadcasting company heard the television tour of the Post Office International Telephone Exchange at Friday House, London, last Sunday. Leslie Mitchell who conducted the tour spoke by radio telephone with R.M.S. Aquanaut in the Atlantic. Mr. Gerald Cock at Alexandra Palace conversed with Professor Royal, Vice-President of the N.B.C., who was located by the Post Office "chaser" near the studios of the N.B.C., New York.

Peak Listening Hours

Among the many coloured charts which adorn the walls of the Listener Research Section of the B.B.C. is a graph showing the potential audience to the B.B.C. programmes. Between 6 and 6.30 p.m., this is estimated at 83 per cent., at 7 93 per cent., whilst at 8 o'clock it has reached 99 per cent., which level is maintained until 10 o'clock, when it begins to drop—steeply, however, on Saturdays than on other weekdays.

Out of Action

The Norwegian commercial radio station, Yorkshire Radio, in South-East Greenland, was recently practically destroyed by a violent blizzard which tore off the roof and blew in the walls. No member of the staff was seriously hurt and they were able to salvage the most valuable of the equipment.

Station at Yarmouth

A TRANSMITTING-INFRA-Station, PR9, has been opened by Section Lieutenant Wingrave, of the Royal Canadian Wireless Auxiliary Reserve, for the purpose of maintaining a voluntary service with the Cross Sands and Hasbrouk lightships.

Landing in Fog

In conjunction with the Lornenz radio direction beam, PR9, is to be installed at Ruigway Airport, Manchester, the Air Ministry is to lay down a powerfully illuminated glass-covered "log line" 1,400 yards long running across the aerodrome flush with the ground.

Television Receiver Tax

The French Senate recently approved of a 100-franc tax to be levied on television receivers. Fortunately for the industry, the Chamber of Deputies rejected the tax as being premature.

Denmark Halves Licence Fee

To increase the number of listeners the Danish Broadcasting Council has reduced the annual radio licence fee from ten crowns to five. The concession holds good until March 31st next.

Interference Permanently Waived

The Vilno (Poland) Hairdressers' Union has instructed its members to fit all interference devices to all electrical equipment.
Receiving Conditions in the Arctic

By I. M. Hunter

A brief summary of radio results obtained by the Wordie Expedition

Although used primarily to study cosmic radiation, the balloon transmitters and ground receiving stations, described in our issue of December 29th, 1938, also produced some interesting data on long-distance short-wave conditions.

In the summer of 1937 Mr. J. M. Wordie, of Cambridge, led a scientific expedition to West Greenland. One of the objects of this expedition was to examine the variation with altitude of the cosmic radiation near the geomagnetic pole, and for this purpose automatic radio transmitting apparatus was sent to great heights (20 km.) by means of free balloons. The present writer had been partly responsible for the development of this apparatus, and accompanied the expedition to help with the experiments. It was also found possible to use the radio apparatus to investigate some of the electrical properties of the lower regions of the stratosphere, and this note is intended to give some account of the results obtained.

A fuller account of the development and use of the apparatus has already appeared in this journal, but a short description may be advisable here. The apparatus consisted of a number of Geiger-Müller counters whose output was arranged to modulate a radio transmitter operating on 40 megacycles, the output of these counters consisting of a single pulse of electric current corresponding to the passage of each cosmic ray. Modulation was effected by first paralysing the RF oscillator with negative bias, and arranging that the impulses fed to the grid were of such a direction as to reduce the bias, and to cause a momentary burst of oscillation. The whole assembly, counter and transmitter, was placed in a gondola which could be raised to considerable heights by means of balloons; and since two balloons were employed the apparatus would descend to earth after one of them had burst owing to reduction in atmospheric pressure.

There was further in the apparatus a switch mechanism designed periodically to suppress the cosmic ray impulses and to make the oscillator "squeak" with an audio-frequency of approximately three cycles per second. This switch came into operation whenever it was desired to transmit the value of atmospheric pressure. The measurement was effected by tuning the oscillator with a variable condenser whose capacity was governed by the pressure.

The signals, which were received on a commercial ultra-short-wave receiver, consisted therefore of pulses of radio-frequency oscillation occurring either at a frequency of three per second or at a frequency determined by the number of cosmic rays. The amplitude was, however, approximately constant for any one flight. It was found possible to estimate the change in intensity of received signals during a flight, and to plot the relation between field strength of the signals and altitude of the balloon.

Some description is necessary of the scale of field strength. The volume control of the receiver was calibrated with a scale from 0 to 15, 0 being the minimum

Observation of signal strength from three typical balloon ascents.


FLIGHT No. 3. August 8th, 1937, at Thule (Latitude 77° N, Longitude 72° W. Height from Bosch Meteorograph). Maximum horizontal distance, 15 km. Working value of volume control on coincidence.

Receiving Conditions in the Arctic—

setting; and in the case of flights Nos. 1 and 2 the volume control setting for signals to disappear is recorded. In the case of flight No. 3, no squeezing was employed, and therefore recording of the volume control setting during reception of cosmic ray impulses was made. These readings are by no means so arbitrary as might appear, since the output of the receiver was examined on an oscillograph and had to be kept constant for suitable operation of the recording counter.

It will be seen that there are a number of temporary fluctuations confined chiefly to the beginning of the flights. Some of these fluctuations may be traced to the balloons being nearly overhead, the aerial hanging vertically; others, possibly, to buffeting of the apparatus, causing changes in the transmission frequency. The time of fade-out of flight No. 1 agrees almost exactly with the time at which low-tension supply was expected to fail, this occurring very early in this flight, as immediately before launching one of the filament batteries was seen to be faulty and was therefore abandoned, thus throwing a double load on the remaining one. The severe fall in signal strength during flight No. 2, when the balloon was between 2 and 7 kilometres in height, has, however, no adequate explanation; particularly as signal strength during the remainder of this flight was remarkably steady.

Effect of Low-level Layers

Apart from these fluctuations it will be seen that signal strength fell off gradually, unmarked by any sudden or permanent discontinuities. Decay of this nature was to be expected, and was due more to increasing distance between balloon and receiver than to any other cause, though no doubt there was some slight fading off in the power transmitted. Most remarkable is the absence of absorption due to the newly discovered low altitude layers, for in no case is there any suggestion of their effect on signal strength. It seems that the absorption is too slight to be detectable, their density being not sufficient to absorb to an appreciable degree waves of the frequency employed, though further experiment with specially designed apparatus might be expected to yield more conclusive results.

When the major part of the balloon work was completed, general listening was carried out on two commercial receivers, one of which was designed to operate off batteries and the other off an alternating supply. The latter had to be converted to battery operation on account of severe interference from the ship’s dynamo. Even so, this was the most sensitive receiver, though somewhat deficient in audio-frequency amplification. Results are as follows:

(1) Throughout the period of listening (July 19th to August 29th, 1937) there was almost exactly with the time at which low-tension supply was expected to fail, this occurring very early in this flight, as immediately before launching one of the filament batteries was seen to be faulty and was therefore abandoned, thus throwing a double load on the remaining one. The severe fall in signal strength during flight No. 2, when the balloon was between 2 and 7 kilometres in height, has, however, no adequate explanation; particularly as signal strength during the remainder of this flight was remarkably steady.

(2) Periods of bad reception took place from July 29th to 31st; August 15th to 16th; August 18th to 19th; and on August 24th; September 11th and September 21st. Of these periods, Nos. 1 and 2 were very severe and affected the local Greenland stations. That on September 21st was a short period complete fade-out. The beginning of this was missed, but it was estimated that it began between 23.45 GMT on September 20th and 00.00 GMT on September 21st. The fade-out continued at 01.15 GMT on September 21st. Recovery was complete in two hours.

(3) Auroras were observed on September 13th; September 14th; September 20th; September 22nd; September 23rd; and September 24th. That on September 20th was very dim, whereas that on the 26th was bright. On all these occasions reception was normal to good. The aurora were not heard either directly or on the wireless, though any slight defect would have been masked by the sound of electrical noise from the ship’s dynamo.

(4) Atmospheric disturbances were negligible; only two records of such interference occurring during the period of listening. Other work of the expedition showed that the atmosphere was extremely still up to great heights, and in some cases balloons, having ascended to a height of 28 kilometres, descended to within two kilometres of the send-off station. Though there may be correlation between these facts it is also likely that the absence of atmospheric disturbance may be connected with the great distance from the Equator.

(5) The best reception from Japan and China coincided with bad periods of reception from Europe. No reception was obtained from Australia even during these periods.

Further observations upon sections (4) and (5) have been made by the Danish Government wireless operators. These results agree with the observations made by the expedition: full results, however, are in possession of the Danish Government.

Television Programmes


An hour’s special film transmission, intended for demonstration purposes, will be given on 12 days in each week. The National or Regional programme will be radiated on 41.5 Mc/s from approximately 9.35 to 9 p.m. each day.

THURSDAY, FEBRUARY 2nd.


FEBRUARY 2nd, 1939.
The Cathode Ray Microscope

OUR TECHNIQUE INVADES THE WORLD OF OPTICS

By "CATHODE RAY"

NOW that television is a going concern one is beginning to get used to optical terms encroaching on our preserve. A few years ago the idea of focusing by adjusting potentiometers would have seemed very odd both to the photographer and the radio man. But when one actually sees the same result on a screen as the photographer does when he moves his lenses to and fro, there is obviously some close connection between the two. That being so, there should now be nothing very strange in the idea of an electrical microscope.

The ordinary optical microscope has gone about as far as it can, and that is not very far. Sam Weller had doubts even about his "pair of patent double million magnifying glass" or "lifeless water," and, no doubt, would have provoked similar rude remarks about tautology or redundancy. But "light" is now generally understood to cover electromagnetic radiation not only within the band of wavelengths that is visible but also the invisible radiation of longer wavelengths (infra-red) as far as the boundary of the band described as "heat," and of shorter wavelength (ultra-violet) as far as the next known band. You may have noticed that I said "visible light". Some time ago it would have sounded like saying "wet water" or "lifeless death," and, no doubt, would have provoked similar rude remarks about tautology or redundancy. But "light" is now generally understood to cover electromagnetic radiation not only within the band of wavelengths that is visible but also the invisible radiation of longer wavelength (infra-red) as far as the boundary of the band described as "heat," and of shorter wavelength (ultra-violet) as far as the next known band. You may have noticed that I said "visible light". Some time ago it would have sounded like saying "wet water" or "lifeless death," and, no doubt, would have provoked similar rude remarks about tautology or redundancy.

The technique of generating and controlling rays of electrons and rendering them visible on a screen is all ready to hand, but there is one rather awkward difference between electrons and light. There is no difficulty in finding a substance—glass—through which light can easily pass when the thickness is amply great enough not only to bear the tiny weight of the objects to be examined but also to stand handling. But to allow an electron beam to pass, the "slide" must be of a nature called the ultra-microscope for detecting specks much smaller than the wavelength of light, in much the same way as specks of dust invisible to the naked eye can be seen in a beam of sunlight, but it is unable to disclose shape or form.

Greater Resolving Power

The development of cathode-ray tubes, particularly the specialised sorts used in television cameras, has shown that in many ways a ray of electrons can be manipulated like a beam of light, using either electrostatic deflecting plates or magnetic coils in place of lenses. The important difference is that the "wavelength" is thousands of times smaller and the theoretical resolving power therefore thousands of times greater, opening up new possibilities for examining the minute nesses of Nature.

Explanatory sketch showing an electron microscope in simplified form. On the right is an electron-optical diagram to illustrate its operation.
The Cathode Ray Microscope— even less than gossamer thickness, otherwise it would not only stop the beam but be destroyed by it. Another thing that makes the electron microscope awkward for amateur microscopists is that the object has to be put inside the cathode ray tube, which means having handy all the apparatus for pumping the tube to a high vacuum. Still another limitation is that objects cannot be examined by the reflected beam as with light.

In spite of these drawbacks the electron microscope is very valuable for revealing particles that are quite invisible under the most powerful light microscope, and for showing the distinctive forms of microbes or powders that are otherwise only seen as undefinable specks. A magnification of 100,000 has already been claimed.

Illustration showing bacteria magnified 4,200 times by the electron microscope and subsequently enlarged up to 10,000 times.

The photograph shows the Siemens electron microscope. It is a modified form of a television cathode-ray tube. A much higher anode voltage is used—something like 100,000. The beam is first made to converge on the object, which is supported on an incredibly thin film of collodion. Collodion is the stuff dissolved in ether that will have to be solved at a moderate magnification half-way down for adjustment purposes; another stage of magnification yields the final image at the foot. Apart from the obvious uses for the electron microscope, one wonders if it will not be the means for extending our knowledge of the nature of matter and electricity. In a more simple form it has been helpful in studying emitting surfaces—cathodes, in other words. In the early days valves depended on plain tungsten filaments run at bright white heat. Then came the 'thoriated' dull-emitter filament. Now the oxide-coated cathode, run at a still lower temperature. The way in which emission takes place from these surfaces is of great interest to the valve and cathode-ray tube designer. By suitable adjustment of the electrode voltages it is possible to get an enlarged image of the cathode on a screen. If you have played about with the focusing of a torch or headlight you may have hit on an adjustment that projects an enlarged image of the lamp filament on the wall. An exactly analogous process gives this cathode image. I have watched a cathode being over-run and then rejuvenated, using this method.

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The diagram shows in greatly simplified form a British electron microscope described by Martin, Whelpton and Parnum, and alongside is the electron-optical diagram. The electron beam is produced from a cold cathode in a low-vacuum tube at the top, and the hole in the anode is so small that it is possible to maintain a high vacuum in the main body of the apparatus. To help solve the problem of getting the desired object in the path of the beam it is placed on a revolving plate so that it can first be examined and adjusted by an optical microscope and then rotated into the electron beam. An image on a fluorescent screen (or photographic plate) is given at a moderate magnification half-way down for adjustment purposes; another stage of magnification yields the final image at the foot. Apart from the obvious uses for the electron microscope, one wonders if it will not be the means for extending our knowledge of the nature of matter and electricity. In a more simple form it has been helpful in studying emitting surfaces—cathodes, in other words. In the early days valves depended on plain tungsten filaments run at bright white heat. Then came the 'thoriated' dull-emitter filament. Now the oxide-coated cathode, run at a still lower temperature. The way in which emission takes place from these surfaces is of great interest to the valve and cathode-ray tube designer. By suitable adjustment of the electrode voltages it is possible to get an enlarged image of the cathode on a screen. If you have played about with the focusing of a torch or headlight you may have hit on an adjustment that projects an enlarged image of the lamp filament on the wall. An exactly analogous process gives this cathode image. I have watched a cathode being over-run and then rejuvenated, using this method.

The bright parts of the picture are not necessarily the parts of the cathode that are hottest, they are those that are emitting most electrons. A spot of emissive coating, which might be seen as a dark patch on the cathode viewed direct, would appear on the screen as a patch of bright light on a dark ground.

The European Wavelength Conference

PROPOSED MEDIUM- AND LONG-WAVE ALTERATIONS

DELEGATES from some thirty countries will meet at Montreux, Switzerland, on March 1st to decide on the new wavelength plan for broadcasting stations in the European zone. The delegates will have plenipotentiary powers from their Governments, and the new wave plan, which will become operative on October 1st this year, will be binding after ratification by the countries whose delegates were signatories.

Before dealing with the problems which will have to be solved at Montreux, it is well to recall that at the time of the first official European wavelength conference, in 1933, seven countries represented were not signatories, and therefore did not adhere to the convention. These countries, Holland, Finland, Hungary, Sweden, Poland, Luxembourg and Lithuania, have therefore continued broadcasting on unofficial wavelengths, with resultant chaos.

The foundations for the European wavelength conference have been well laid at the International Telecommunications Conference at Cairo in February, the frequency bands to be used by European broadcasting stations were decided upon, and the International Broadcasting Union was requested to prepare a new plan.

The project for a plan, which was prepared in Brussels and of which we gave details in our November 24th issue, may still undergo many changes in detail, but its general principles will, it is expected, remain unaltered.

It is, of course, quite impossible to accommodate with a 9-kc/s separation in the available space the 200 or so European stations with a power of more than 1 kw. "European," in this case, includes stations in Algeria, Morocco (French and Spanish), Tunis, Egypt, Algiers, Palestine, Syria and Turkey. At Cairo, space for a further six channels in the long-wave band, bringing the total to 116, was made possible by lowering the bottom end of the band to below 200 metres, i.e., to 1,500 kc/s. There are 14 channels on the long-wave band, allowing for proper separation, although at present over 20 stations are accommodated.

Non-signatories to Lucerne, i.e., Holland, Luxembourg and Lithuania, are to be removed from the long-wave band, some Norwegian will share wavelengths, and Iceland and Turkey will also share a wavelength (Iceland should not interfere with Turkey's transmissions as Brasov (Radio Romania) does with Holland at the moment), thereby considerably reducing the number of stations to share the 14 channels.

The so-called "intermediate" wavelengths between the medium- and long-wave bands, which some stations are allowed to share with other services under special conditions, will contain 14 low-powered stations on 9 channels.
The European Wavelength Conference—

The question of exclusive wavelengths in the medium band has become increasingly difficult during the past few years until it is now almost as bad as the long-wave situation. The old maxim, laid down many years ago, that in all international discussions of a technical nature, national requirements only are to be considered, has long been dead in spirit, and every nation thinks in terms of its foreign listeners. Exclusive wavelengths, therefore, become an all-important subject. It is proposed that of the available 116 medium-wave channels 54 should be exclusive, whilst on the long-wave band, 73 should be exclusive.

The following are some of the allocations proposed in the new arrangement of exclusive wavelengths:

- Germany
- Russia
- France
- Italy
- Sweden
- Poland, Yugoslavia, Hungary
- Great Britain
- Italy
- Spain
- Norway
- France
- Belgium
- Poland 6
- Belgium
- Poland
- Great Britain
- Italy
- France 3
- Germany 2
- France
- Italy
- France
- Italy
- Sweden
- Portugal

Of the thirty countries which have broadcasting stations in the European zone, nine will have an exclusive wavelength. According to the proposed plan, Rumania will lose four exclusive wavelengths, France three, Germany two and Britain one, whilst Italy gains two.

The bulk of the shared wavelengths, which are of considerably less importance from an international point of view, are suggested to be distributed as follows:

- France 11
- Germany 11, Russia 11
- Italy 10
- Spain 10
- Norway 9
- Great Britain 8
- Poland 6
- Belgium 4

France has an individual problem: the private stations. No indication was given by the French Delegation at Brussels for the suggested new wavelengths of the private stations, and she will, moreover, lose three of her exclusive medium wavelengths.

Delegates to Montreux will also consider international conventions regarding the power of transmitters, and it is probable that permission will be granted for 500-kW long-wave stations and generally to permit medium-wave stations to go up to 120 kW.

Letters to the Editor

The Editor does not necessarily endorse the opinions of his correspondents

Ignition Interference

In your Editorial note on the voluntary suppression of interference you did not mention one point that I regard as important. I refer to the size of the suppressors needed and their method of attachment to sparking plugs and distributor; the presence of these components may cause considerable annoyance when the removal of a plug becomes necessary. This operation must sometimes be effected on the road-side, perhaps in all weathers, and it always in an inconveniently arranged and well-lighted garage.

I do a fair amount of work on my car, and so am all in favour of simplicity and accessibility under the bonnet. For the last few years things have been getting worse and worse in that respect, and one does not want to increase the difficulties by adding awkward wireless gadgets.

Furley

J. M. SELLOWS.

Television Transmissions

Your recent Editorial criticism of overambitious television programme items brings up another matter—that of technical shortcomings in the transmissions.

As an example of a minor form of technical irritation, one invariably finds that at least one of the six camera channels in use suffers from inherent parasitic oscillation, giving a fine heterodyne pattern over the picture each time that particular camera is faded in (the oscillation mentioned in Mr. P. Scales' recent letter was probably transmitted by the B.B.C.).

Again, the camera used for an O.B. of a football match has invariably an inconveniently placed spot of extremely high or low sensitivity, adding to the irritation with the result that one has to sort out two balls in order to follow the play. It is hard to explain away such a happenstance to a non-technical observer, who, incidentally, may be a prospective purchaser of a television set.

N. Wombly, Middlesex.

Non-removable Valves

As one who has long admired "Cathode Ray's" ability to hit the nail on the head with scientific precision, I was astonished to read his views on the valve as the basis for an article based entirely on misconceptions.

It is apparent that "Cathode Ray" has forgotten the difficulties of servicing the modern superhet when he makes the astonishing assumption that given sound mechanical design valves can be left to "lie low and say nothing"—except what is written in the programmes.

Briefly the following are the reasons why valves are, and must remain, easily removable from the chassis:

1. The more complicated types are liable to intermittent faults of a nature requiring rapid interchange with known "good" valves to identify them. These intermittent faults may be of the rapidly fluctuating type, or may not become apparent until after some hours of use. Particularly when sets are serviced in situ, changing valves can often be the only hope of rapid and efficient service. Further, these defects are not necessarily caused by faulty mechanical structure, but are frequently due to changing gas content in the valve and faults in the cathode surface.

2. With the coming of four-and five-wave bond sets, frequency-changers present many problems, failing to oscillate in localised regions of the lower wave-bands, and frequency drift among them.

3. Most important of all, modern servicing is effected by analysis of the various currents through the valve circuits, the method adopted being the removal of the valve and the substitution by a plug and cable to the meter and oscilloscope, thus it is the testing and servicing not only of the valve, but of the entire instrument. It will be a sorry day for servicemen when valves are riveted to the chassis because, to get an immediate answer, testing must be tackled before analysis can be effected.

And so, although I will still turn to "Cathode Ray" each week, I can only hope that he has included in his New Year resolutions one to remember the poor service engineer.

C. GORDON.

Short-range Fading

The assumption by Mr. P. H. Earl, that the fading of London National at short distances is due to its synchronisation with the North, is untenable for the following reasons:

1. The fading takes place just the same when the Northern transmitter is just out of action.

2. The magnitude of the fading is greater than that of the Northern carrier.

3. Exactly the same type of fading is observable from the Regional transmitter at somewhat longer "short" distances—forty miles or so.

The effect is purely night fading.

It is interesting to note that in this same issue of The Wireless World Sir Noel Ashbridge is reported to covet the 600-metre shipping band for broadcasting, as being ideally suited for the purpose.

There is one very good reason for this. It is free from troublesome night fading up to a distance of approximately 80 miles from the transmitter.


THREE NEW COSSOR RECEIVERS

The Model 31 battery receiver recently released is a four-valve superhet with triple-heated frequency change, high gain pentode IF amplifier, double diode triode secondary detector and high slope "economy" pentode or tetrode output valve. Three wave-ranges cover 1631-31.5, 100-500 and 812-1850 metres and the semi-circular dial carries forty-three station names. The specification includes automatic grid bias, and the price is £7 guineas excluding batteries. A de luxe version of this receiver (Model 32) is available at 8 guineas without batteries.

Cossor Model 31 all-wave 4-valve battery receiver.

The principal difference from the Model 31 is in the loudspeaker, which employs a special magnet with a flux density of 10,500 lines per sq. cm. The Model 31 for AC mains at 7 guineas makes use of a similar circuit, but the output valve in this case is a triode. The specification of similar design to that of the battery models and measures 110 x 59.5 x 201.
Scott "Phantom"

A COMPREHENSIVE CIRCUIT SPECIFICATION IN AN EXCEPTIONALLY WELL FINISHED CHASSIS

As pioneers of the "custom built" receiver in America, Scott Laboratories have a unique experience of the design of multi-valve circuits and of their presentation in attractive chromium-finished chassis.

Since 1930, when a Scott receiver was first demonstrated over here, these sets have been available in this country through a number of agencies. Now a factory and service department have been established in London, and the latest designs are built up in this country in close technical collaboration with E. H. Scott Radio Laboratories, Inc., of Chicago.

The latest model, while retaining all the qualities of range, selectivity and power output which have been associated with this make, has a number of up-to-date refinements which enable it to more than hold its own in a class of receiving equipment which it was largely responsible for bringing into being.

Including the two power rectifiers and the tuning indicator, there are sixteen valves in the circuit. The aerial input transformer has been designed to work with an anti-interference aerial system, but may be used with the conventional elevated single wire. To reduce the effects of electrostatic pick-up in the down leads the primary windings for the short- and medium-wave ranges are screened from their secondaries by a gapped metal shield.

The RF stage makes use of a variable-mu pentode of high mutual conductance. It is tuned-anode coupled to the heptode mixer valve. The separate oscillator is an electron-coupled triode and injects into the third grid of the heptode.

Special attention has been given to the question of frequency stability, and a combination of air dielectric and negative temperature coefficient trimmers is used. It is claimed that the frequency is constant within 1 k/c at any part of the scale over the usual range of room or receiver temperatures.

Three IF stages amplify the resulting intermediate frequency of 470 kc/s and three degrees of selectivity are provided by mistuning the second and third coupling transformers. The input transformer is fixed and serves to fill in the middle of the response curve when in the broad or double-humped setting. In the position of maximum selectivity the circuits are...

aligned at 470 kc/s with the fixed series condensers shorted in the second IF transformer and in circuit in the third. For minimum selectivity and the widest audio frequency response (8,500 c/s) these conditions are reversed, so that the second transformer is tuned above, and the third below, 470 kc/s.

The total trimming capacity in the IF circuits is large, so that the alignment is not seriously affected by changing valves. High circuit efficiency is ensured by the use of stranded wire in the coils and large-diameter (3½ inch) screening cans. Decoupling is provided for each circuit and a high overall gain is achieved with stability. The overall gain is not appreciably disturbed by changes in selectivity, as the standing bias in the two IF valves is automatically adjusted by contacts in the selectivity switch assembly.

An exceptionally wide range of control is provided by the dual AVC system. The normal control for the IF valve is derived from the second detector stage, and the RF amplifier is controlled by an auxiliary AVC amplifier and rectifier taking its voltage from the anode of the mixer valve. This gives exceptionally good control on weak signals.

The rectifiers, output valves and smoothing equipment are mounted in a separate chassis, which, like the main chassis, is finished throughout in polished chromium.

After rectification by one of the diodes associated with the third IF stage the signal passes through a tone-compensated volume control to the first AF amplifier, which is a pentode with a double resonant choke system in the anode circuit. Separate damping resistances are provided for each circuit, so that there is full latitude in adjusting the balance to suit transmissions of different character. The bass boost is centred at 75 cycles, which avoids hum frequencies, and the treble at 6,500 cycles, giving a sharp cut-off above 8,500 cycles and thus avoiding heterodyne whistles. Maximum bass and treble boosts up to about 15 db. above the level at 1,000 cycles are available.

A triode phase-inverting valve feeds the second AF stage proper, which consists of two more triodes in push-pull. These are coupled to the output valves through a transformer with split secondary, and both bias and negative feedback are applied separately to each valve. There is provision for connecting headphones through a double-contact jack across one half of the interstage transformer secondary.

The output valves are mounted on a separate chassis with the twin rectifiers and smoothing equipment for the power supply. The field winding of the Magnavox '55' loudspeaker is in two sections, one of which is in the negative HT lead and provides bias for the output stage.

It is gratifying to note that the designers have given careful consideration to the question of loud-speaker matching. The output transformer secondary is tapped, and when an extension loud speaker is used the ratio is increased to maintain the correct load on the output valves. The extension leads are connected to terminals on the loud speaker output transformer.

All the controls are arranged in a compact group below the horizontal tuning.
Scott "Phantom"—

scale. They are well graded and not so closely spaced as to be uncomfortable in operation. We should have welcomed poses of heterodynes between stations. Nevertheless, the quality is not lacking in brilliance and this is obtained without resonances of the type which produce sible to use this much volume before the maximum output is reached even on weak signals. This is a set which amply justifies the

some method of showing the setting of the wave-range switch and also a slightly higher ratio in the slow-motion drive for tuning on short waves, but these are minor criticisms. In all the important aspects of performance the receiver acquires itself with distinction.

High Selectivity

Expectations of an ample reserve of volume and sensitivity were fully justified, but the selectivity deserves special commen-dation. Even in the medium position of the selectivity switch the performance is better than most receivers and gives clear reception of the Deutsclilandsender with very little sideband interference. With maximum selectivity the neighbouring stations might not exist, yet the quality, thanks to the tone correcting circuits, is very little affected. On medium waves we had the unique experience (in London at a distance of 15 miles from Brookmans Park) of hearing the Poznan station announce and enjoying its programme with negligible interference from London Regional working on the adjacent channel. Few commercial receivers which we have previously tested have approached this performance.

The whole of the wave-range covered by the set is free from second-channel interference and other self-generated whistles, and the sharp cut off at 8,500 cycles dis-harshness when the volume is turned up. The continuously variable bass control is a refinement well worth having and one can greatly improve the reproduction of organ and other broadcasts by its use. The maximum output of 13.5 watts gives plenty of latitude for peaks at the average levels which can be tolerated in the home.

When the megacycle settings of the principal American and European short-wave stations had been memorised, and the knack of handling the slow motion tuning mastered, some transmissions of unusual steadiness and volume were held over long periods, thanks to the efficient AVC system and the frequency stability of the oscillator. The performance on the 13-metre band was particularly good. The signal-to-noise ratio we would put at average for this type of set, but it should be understood that we were working with the usual single-wire aerial. A new type of anti-interference aerial is being adapted to work with this receiver and will be available in the near future.

Background Noise

With the aerial disconnected there is no direct pick up in the set at any wavelength and the background is silent over about three-quarters of the wave range. In the last quarter valve hiss is apparent, but under working conditions it is rarely pos-use of so many valves and one which is very pleasant to handle. In the matter of AVC control and selectivity it is a re-

“Designing a Filament Transformer”

A CORRECTION

TWO arithmetical errors unfortunately appeared in the article describing a filament transformer in our issue of January 29th last. The resistance of the primary section should be 0.055 ohm, not 0.55 ohm, while the core volume is 3.47 cu. in., not 3.7 cu. in.

It should be noted that in an auto-transformer, and under normal operation, the current in the common portion of the wind-

ing is the difference between the computed primary and secondary current, so that a smaller gauge of wire than specified could have been used.

When a transformer is required to be reversible, compensation for voltage drop in the windings is difficult unless extra tappings are included, and it is therefore suggested that the winding be calculated on the turns per volt factor alone and that the largest size of wire that can be accommodated should be used. A total of 76 turns of No. 16 SWG enamelled copper wire with tappings at 14 and 62 turns would satisfy this requirement. Larger sizes of wire are very difficult to wind on bobbins of small di-

Large diameter screening cans make for high efficiency in the IF circuits. The tuning scale is indirectly illuminated and calibrated in wave-lengths on medium and long waves, and megacycles on the two short-wave ranges.
Frequency-Changing Problems

THE LATEST OCTODES

By E. LUKACS and J. A. SARGROVE (Tungsram Research Laboratory)

With valves of the hexode type, fluctuating mains voltage does not cause any material frequency drift. The size of the virtual cathode is but slightly affected by changes in the first accelerator grid voltage. Although an increase in the voltage of the accelerator grid does not extract more electrons from the cathode space charge, the velocity of the electrons also increases and at higher speeds, the density of the space charge diminishes. These effects will balance each other fairly accurately, and the change in the oscillator anode voltage has but a slight effect on the impedance of the triode, and consequently on the phase lag of the anode current. With triode-hexode types (and, of course, triode-heptodes) a 10 per cent. fluctuation in mains voltage causes about 2 kc/s frequency drift at a frequency of 17 Mc/s.

As against this in the older octodes VO4 and EK2, fluctuations of supply voltage cause fluctuations in the transit time of the electrons reaching the oscillator anode and produce considerable frequency drift. The efforts to eliminate the observed defects in the older octodes led to the development of type EK3. This makes use of electron-optical principles and represents a radical departure from previous frequency-changer design.

Fig. 4 shows how the four side rods of the first grid G1 divide the electron stream into four beams. Two opposite beams impinge upon the oscillator anodes G2, which are constructed to have angle-iron profile. Thus, the transit time of the electrons is as short as in a normal triode. The first accelerator electrode G3 is made of solid sheet metal, electrostatically screening the oscillator anode, and partly screening the first control grid as well. The pairs of side rods of the first grid and the aperture of the first accelerator electrode are so designed that the electrons flying towards the second control grid G4 are accelerated by it without, however, impinging upon it. Thus, a virtual cathode is formed between the first accelerator G3 and the second control grid G4, and, consequently, a part of the electron stream returns towards the accelerator. This, being made of solid sheet metal, absorbs all returning electrons and prevents their return into the neighbourhood of the first space charge. Those edges of the first accelerator aperture which face the second control grid are so formed that their electrostatic suction effect attracts even those electrons which would otherwise fly back through the aperture of the first accelerator. It is clear, therefore, that by this means, all the aforementioned defects are simultaneously eliminated.

The principal operating characteristics of the EK3 are a conversion conductance of 0.65 mA/V, with an oscillator peak voltage of 10 volts; the working slope of the triode is 4-3 mA/V.

From the above it will be seen that the EK3 is a worthy rival of the triode-hexode type of valve, since the gravest defect of octode valves, namely, frequency drift, is entirely eliminated in it. In octode types, however, space-charge coupling is still a drawback which even if neutralised can still cause some defects. On the other hand, the disadvantages of the triode-hexodes are low input impedance and variations in grid capacity.

Space charge coupling and its elimination have been dealt with in earlier articles.1 We will now only add the following observations: the neutralisation of space charge coupling by means of capacity coupling only is never a complete success because the finite transit time of the electrons results in grid current due to space charge. In order to adjust the phase error, therefore, we must connect an additional resistance in series with the coupling capacity. The time constant of this resistance-capacity system is approximately equal to the transit time of the electrons, which in type EK3 is $2 x 10^{-8}$ sec. Hence, the coupling elements introduced between the first and second control grids have values of 1,600 ohms and $3 \mu\mu$F. However, this manner of neutralisation is only perfect at a single predetermined oscillator voltage. This is due to the fact that the voltage induced by space charge coupling becomes practically constant above a certain oscillator voltage while the capacitively transferred voltage compensating it will increase continuously with the oscillator voltage. The above values give a good practical balance to an oscillator voltage of 500 volts. (The dissimilarity of this effect to that of the limitation of conversion conductance should be noted.)

The Oscillator Circuit

As these coupling elements are built into the EK3, it is not advisable to connect the oscillator tuned circuit to the first control grid for two reasons:

The resistance-capacity combination, while stopping the effect of the oscillator grid upon the signal grid actually assists the transference of signal-frequency voltage from the second control grid to the first control grid. If the oscillator tuned circuit is connected to the first control grid, a signal voltage will consequently appear on it. It must be remembered that at short waves, where the percentage difference between the input frequency and the oscillator frequency is very small, the oscillator circuit will have quite a high impedance type.

1 The Wireless World, March 17th, 1939.
Frequency-Changing Problems—
the signal frequency. This unintended signal voltage on the first grid will be additive mixed with the oscillator frequency voltage, thus creating an intermediate-frequency component in the anode current, which will either increase or decrease the normal multiplicatively produced conversion gain of the valve. This in itself would not be a serious defect except that the valves are not quite uniform with reference to this unintended function, there being a likelihood that in a batch of EK3 valves used in one and the same receiving set a difference in sensitivity of 1 to 5 may occur.

If a tuned-grid oscillator circuit is used, trouble also arises due to AVC, as the neutralising balance will not be at an optimum through changes in signal-grid bias. Thus, the signal voltage on the second control grid will influence the first grid potential and thus the frequency of the oscillator. However, if the tuned circuit is connected to the oscillator anode, both these defects are reduced to a negligible minimum.

Hexode-type Valves

In hexodes, space charge coupling also occurs, but of a somewhat different type, the injector grid repelling more or less electrons towards the first accelerator in step with the oscillator frequency. Some of these electrons pass through the first accelerator and increase the cathode space charge, producing an oscillator-frequency voltage upon the first grid by influence. It is clear, however, that the magnitude of this coupling is practically negligible, its value being of the order of 0.01 μF in comparison with 0.1 μF, for the electrostatic coupling between the first and third grid of the hexode.

The returning electron current in hexode valves causes other serious disorders which are by no means negligible. The space charge increment near the first grid increases the input capacity and this varies in inverse proportion to the signal grid bias, and will disappear completely above a certain signal grid bias value. The change in input capacity due to the action of AVC in triode-hexodes is about 2-2.5 μF. Distortion occurs through the RF input circuit becoming detuned, which can be in unfavourable cases as much as 3 to 5 per cent., a perceptible amount in high-fidelity receivers. Detuning of the input circuit is, of course, not as detrimental as detuning the oscillator circuit, since it mainly has the effect of altering the impendence offered to the signal frequency, whereas the oscillator circuit will affect all intermediate frequency circuits.

Severe changes in capacity will increase the input damping of the signal grid as well. This effect has been fully expounded in other publications where it was shown that the dephasing of the capacitive current in consequence of the electron transit time will produce a resistive current component. This damping causes a perceptible decrease in gain at wavelengths as long as 12 metres, so that on ultra-short wavelengths it is advisable to connect the signal grid to a tapping point on the input tuned circuit.

The capacity variation and damping of the signal grid, the EK3, is much less than that with the triode-hexodes, and is even better in this respect than RF amplifier pentodes.

This is due to the fact that the virtual cathode in the EK3 is mainly a function of the cathode current, so that the change in capacity under the influence of AVC amounts to only a few tenths of one μF, the input impedance at 15 metres being approximately 100,000 ohms.

From the foregoing it is clear that very fast improvements have taken place in mixer valves, and their use in receiving sets is now almost as simple as that of ordinary amplifier valves. They do not as yet function faultlessly on the ultra-short wave-band, but further improvements no doubt will bring the solution of this problem also.

Random Radiations

Major Armstrong's Scheme

A CONSIDERABLE amount of fuss was made by some of the lay papers over what was described as Major Armstrong's new system of wireless transmission. It now appears, though, that this wasn't the whole story; it is merely a fresh application of a very old method of transmission. What Major Armstrong has done is to develop a means of using frequency modulation rather than linear modulation to reduce interference from atmospheres and man-made static. He has long been a champion of this kind of modulation; three years ago he published a long account of his experiments with frequency-modulated transmitters, in which he made certain points very strongly. One was that radio engineers were all wrong in regarding amplitude modulation as the one and only satisfactory method for broadcasting and for telephonic communications; another, that a noticeable decrease in interference occurred when frequency-modulated transmissions were received in areas regarded as abnormally noisy for the reception of amplitude-modulated transmissions.

Transatlantic Expectations

TELEVISION is having a great run just now in both the technical and the lay papers across the ocean. Everything is nearly ready for the inauguration of the New York services at the opening of the World's Fair, and the man-in-the-street is in much the same keyed-up condition of expectancy as was his counterpart here four or five years ago. There seems to be just the same two widely different opinions amongst those in the business in America as there were with us just before the opening of the A.P. station. One school holds that present listeners in the area to be served will stampede to become viewers; the other believes that the story of television in the U.S.A. will follow much the same lines as it followed in this country. In either case the general public will be eager to attend demonstrations, but will be very slow at first to acquire receiving apparatus of their own.

Conditions Different

RASHLY venturing into the realms of prophecy I predict that neither of these views will prove to be the correct one. I've always held that what put the brakes on television here after the high-definition service had come into being and many firms were offering excellent receiving equipment at prices that weren't too stiff was the public's memory of the way in which it had been led up the television garden so frequently and with such sickening results during the preceding decade. Nothing could have been more ill-advised than the preposterous claims made for television in its early days here. Eleven years ago it was trumpeted at the public that practical television had arrived; that in a matter of weeks or, at the worst, months, it would be possible to sit in one's home and see Test matches at Lord's or even at Sydney! The Wireless World did splendid work in sorting out laboratory achievements from figments of the imagination, and the Postmaster General of the time issued a public warning to those who contemplated buying low-definition television receivers that they did so at their own risk: he couldn't see that television had yet any real entertainment value.

A Wiser Policy

IN America they have adopted what I think are sounder methods of approach. There have been no irresponsible promises of impossible things; television was not presented to the public as a matter of interest in the distant future. Further, manufacturers have realised thoroughly the need for educating the average man and woman to appreciate the standards of television. An American will not be made to make people get used to the comparatively small images of the six-by-ten viewing screen; television, in a word, is to be accepted as television and not as something that compares or competes with the movies. Whether the American public will respond is another matter; I think you will agree, though, that the situation is being soundly dealt with. For these reasons my forecast is that the American people won't be so chary as we were a few years ago about taking up television as a hobby. If the programmes are reasonably good I believe that television may get off the mark rather more quickly in the United States. I don't see, though, how there can be a boom, since the areas served for some time to come will be so small a proportion of the whole of that great country.

Hard Lines

DID you happen to see the story of the arrival in New York of the gifts sent by the Pitcairn Islanders to the lady who had done so much to put them into regular touch by wireless with the rest of the world? She is one of the best known of
American amateurs, and it was owing to her reception of a faint message that their delectable wireless gear must shortly go out of use. Helene was started in America by a ham who led to the presentation to the Island of up-to-date transmitting and receiving equipment. As a mark of their gratitude the ham presented her an offering of baskets and other specimens of their handicraft. When the ship was approaching the coast her operator got into touch with the lady and wirelessly: "We'll be in port only 24 hours; come and collect your staff as soon as we berth." The ever-vigilant Customs service intercepted the message and at once saw visions of large-scale smuggling. When the ship tied up battles of sleuths searched her from truck to keelson, whilst others captured the lady and bore her off for examination. It took a long time to straighten matters out, and when finally the Customs men were convinced that they had been looking for a mare's nest, they extracted their pound of flesh by charging her duty to the tune of 50 cents!

Spoonerisms

Strange how rarely one hears a Spoonerism on the wireless, for in the ordinary way such things are by no means rare when speakers are nervous or are letting their thoughts run ahead of their words. However, one does occasionally hear a good one, as, for instance, when the bucking broncho, introduced during a recent tour behind the scenes of a circus, became a brocking bunko. I'm sure that if I were an announcer and found myself, as announcers often do, faced with the task of reading some rather involved news item, I should be constantly pouring Spoonerisms into the microphone. Is the making of Spoonerisms, by the way, confined to those who use the English language? I don't ever remember hearing one or hearing of one from a foreign station. Nor does one seem to come across the Spoonerism as a cause for mirth in books. It's a pity. The word is still in vogue and in "all-wave" sets would make a power of difference to the growth of shortwave listening as a hobby. I don't see why it shouldn't be done, though I certainly won't if makers are determined to compete with one another to see who can produce the cheapest sets.

What We Miss

That's just one example of the good things that shortwave enthusiasts are missing because of the low price of receiving sets. To introduce band-sapping costs money, and though it would treble the attractiveness of the shortwave rath, four wavebands are going down to 11 cents if every penny has to be considered. And there are many others as well. Real tone-control is a comparatively rare thing; we have to put up with uneditorialized whistles, because the price won't run to an RF valve and proper image suppression. I needn't mention the catalogue, for you'll think of plenty of other things for yourself. Cheap sets there must be; but why the wireless industry has, intentionally or otherwise, led the public to believe that you can get everything that you want in a receiving set for ten pounds or a bit less will always be a mystery to me.

NEW H.M.V. SETS

Four new receivers have been released by the Gramophone Co., Ltd., this week, all being based on the radiophonograph with automatic record changer at 29 guineas. This is the Model 490, which employs an eight-valve superhet circuit rather than the earlier 489, which has been given close attention, and the HT consumption is 9 mA., but an economy control is fitted, by means of which the total current is reduced to 6 mA. for moderate volume levels. A three-valve TRF circuit is employed in the Model 1401 battery receiver. It includes a filter for Droitwich when the set is to be worked near that station, and there are three wavebands going down to 16.5 metres. The HT consumption is 7.5 mA., and the set, complete with batteries, sells for 15 guineas.

Club News

Croydon Radio Society

Headquarters: St. Peter's Row, Lollbury Road, South Croydon.
Meetings: Sundays at 8 p.m.
Hon. Pub. Sec.: Mr. E. T. Cumber, 14, Campden Road, South Croydon.

At the last meeting Mr. F. G. J. Davey, the inventor of the Hallicrafter diversity receiver, gave a talk on "The Theory and Practice of the Hallicrafter Diversity Receiver." During the course of the interesting features of the set were demonstrated.

South London and District Radio Transmitters' Society

Headquarters: 16, Buckland Avenue, Slough, S.W.15.
Meetings: First Wednesday in every month.
Hon. Sec.: Mr. H. D. Cullen, 14, Campden Road, South Croydon.

South London and District Radio Transmitters' Society

Headquarters: 83, High Street, Slough.
Meetings: Alternate Thursdays at 8 p.m.
Hon. Sec.: Mr. J. R. Siz, 16, Buckingham Avenue, Slough.

On January 21st, the last meeting of the South London and District Radio Transmitters' Society was held at the new headquarters of the South London and District Radio Transmitters' Society. The meeting was devoted to a demonstration of the Hallicrafter diversity receiver by Mr. H. D. Cullen. During the course of the demonstration the technical features of the set were explained.
## PRINCIPAL BROADCASTING STATIONS OF EUROPE

Arranged in Order of Frequency and Wavelength (Stations with an Aerial Power of 50 kW and above in heavy type)

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<th>Power</th>
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Recent Inventions

SECONDARY-EMISSION OSCILLATORS

A FORM of oscillation generator is known in which an electron stream is forced to travel to and fro between a pair of "target" electrodes so as to build up a large current by secondary emission. In this case an accelerating anode is usually arranged between the two targets, and tends to create a space-charge which limits the output. According to the invention, the two electron streams are forced to take separate paths, instead of vibrating along a common path, so that one does not tend to "choke" the other. As shown in the Figure, two "cold" cathodes K, K1 co-operate with a common cylindrical anode A which is biased to provide an accelerating field. An external anode (not shown) supplies a magnetic field, the lines of which run at right angles to the plane of the paper. The action is explained as follows:—

An electron leaving the cathode K is forced by the combined effect of the electric and magnetic fields to describe the circular path marked r. As the electron strikes against the cathode K1 on its return journey, secondary electrons are emitted, and necessarily travel away from the cathode in the opposite direction. The action of the magnetic field, therefore, compels them to follow the circular path marked 2. As they return to the cathode K and produce more secondary electrons, the latter are now forced to follow the circular path r, and so on. To ensure that the impact always occurs with sufficient force, an oscillating voltage is applied to both cathodes from a Lecher wire circuit L, tuned to the working frequency.

Telefunken Ges. für drahtlose Telegraphie m.b.h. Convention date (Germany) September 9th, 1936. No. 493393.

REMOTE CONTROL FOR LOUD SPEAKERS

A LOUD speaker is arranged to be supplied from a central station which may be so far distant as to be out of audible range. To allow this to be done the speaker is energised by carrier current modulated with the signal frequency. Near the transmitter and control point the carrier current is passed through a high-pass filter, from the further side of which a low-pass branch line goes back to the control.

As shown in the Figure, two electrodes so as to build up a large current by secondary emission. In this case an accelerating anode is usually arranged between the two targets, and tends to create a space-charge which limits the output. According to the invention, the two electron streams are forced to take separate paths, instead of vibrating along a common path, so that one does not tend to "choke" the other. As shown in the Figure, two "cold" cathodes K, K1 co-operate with a common cylindrical anode A which is biased to provide an accelerating field. An external anode (not shown) supplies a magnetic field, the lines of which run at right angles to the plane of the paper. The action is explained as follows:—

An electron leaving the cathode K is forced by the combined effect of the electric and magnetic fields to describe the circular path marked r. As the electron strikes against the cathode K1 on its return journey, secondary electrons are emitted, and necessarily travel away from the cathode in the opposite direction. The action of the magnetic field, therefore, compels them to follow the circular path marked 2. As they return to the cathode K and produce more secondary electrons, the latter are now forced to follow the circular path r, and so on. To ensure that the impact always occurs with sufficient force, an oscillating voltage is applied to both cathodes from a Lecher wire circuit L, tuned to the working frequency.

Telefunken Ges. für drahtlose Telegraphie m.b.h. Convention date (Germany) September 9th, 1936. No. 493393.

PRODUCING TELEVISION SIGNALS

LIGHT rays are focused on to a photo-sensitive screen mounted at one end of a cathode-ray tube, and the electric "image" so formed is scanned by an electron stream projected from the other end of the same tube.

The screen liberates electrons corresponding to the light intensity of each picture point. These are focused by a magnetic coil which automatically deflects the "picture" stream out of the path of the oncoming "scanning" stream, because the two streams are travelling in opposite directions.

The picture stream is first accelerated by one or more "suction" rings, and is then projected on to target electrodes, which amplify it by secondary emission.

Radio-Abt. D. S. Loewe. Convention date (France) February 14th, 1936. No. 491963.

SHORT-WAVE AERIALS

The drawing shows a "wide-band" aerial, suitable for receiving television signals, and less onerous C of 50 m-fds. The capacity loading creates a phase-velocity greater than that of the wave travelling freely in space. This, in combination with the tilt of the conductor, gives a pronounced directional effect, pointing away from the feeder end.

The loaded aerial is connected through a surge resistance R of 20 ohms to the centre point of an elevated wire B, which for signals on 35 megacycles is made 11 feet long, and acts as an effective "earth point," i.e., as a half-wave termination to the aerial proper. The lower end of the aerial A is connected through a matching transformer T, and the usual feed-line F, to the receiver.

E. C. Cork; M. Bowman-Nani-

fold and J. L. Pawsey. Applica-
tion dates February 9th and June 30th, 1937. No. 493738.

HIGH-FREQUENCY OSCILLATORS

A PIEZO-ELECTRIC crystal is frequently used to stabilise the frequency of short-wave generators, though for wavelengths below 5 metres tuned Lecher wire circuits are to be preferred. However, even the latter prove difficult to adjust on wavelengths of two metres or less, because the length of the connecting leads between the electrodes and the Lecher wire circuit may be insufficient to prevent the whole system from oscillating at a single natural frequency.

According to the invention, the split anodes of a magnetron valve, used for generating wavelengths of the order of one and two metres, are connected across voltage nodes
Recent Inventions—continued

- Combined wavelength of the valve element can be varied by connecting wires can be made equal to that of the Lecher wire output circuit so that the two circuits will oscillate as one at this stabilized frequency.


- **DIRECTION FINDERS**

  The ordinary direction finder gives the minimum or maximum reading (as the case may be) at two points diametrically opposite to each other. It is therefore necessary to indicate which of the two readings is the correct one from the point of view of "sense." This is usually done by coupling the frame to a vertical aerial, and then tuning a little above the first intermediate frequency of the set, the "unbalanced" voltage produced across these circuits by any initial minima or maxima, being applied to correct the mistake. In assembling the sets, however, it is found to be difficult to pre-set the frequency of the two "off-set" circuits with sufficient accuracy to produce the required results. The object of the invention is to simplify the operation.

- As shown in the Figure, the anode of one of the IF valv~es V of a superhet receiver is connected to the HT supply through a resistance R, and is coupled to the two discriminator circuits A, B, through condensers C, C1. When assembling the set the movable connection L is first placed on the contact 2 as shown, and the two circuits A, B, are then tuned exactly to the IF frequency. The method of facilitating the initial adjustment of AFC circuits.

- **SECONDARY-EMISSION MULTIPLIERS**

  ZWORYKIN and Malter have discovered that it is possible to obtain a much higher ratio of secondary electrons from a target when a target electron, when the secondary material, such as cesiated silver, is separated from the metal backing plate by a very thin layer of insulating material. The target is therefore subjected to an initial bombardment of electrons which appear to have a polarizing effect, so that the composite surface of the target is made less sensitive to direct current. So much so that it will release as many as 3,000 secondary electrons for each primary electron which strikes against it. This so-called "anomalous" emission compare with a ratio of nine or ten—which was previously considered to be the best obtainable. According to the invention, a target electrode, capable of giving anomalous secondary emission, is prepared by depositing a very thin layer (of the order of one-thousandth of an inch) of an alkaline-earth base upon a metal backing plate, and then covering the base with an evenly thin layer of cesium.

- **AUTOMATIC TUNING CONTROL**

  For automatic frequency control it is usual to provide two "discriminator" circuits, one connection L is next moved over to the contact 2. The tuning of both circuits thus being altered by equal and opposite amounts. The connection L is then permanently soldered in position. The required AFC voltage is taken off, as shown, from the lead resistance R1 of the diodes D, D1.

- **FIDELITY CONTROL IN TELEVISION**

  When televising a scene, say, from a cinema film, the volume of sound heard from the television remains the same, irrespective of the apparent size of the actors. That is to say, it is the same when a large figure is being shown, where the actors appear comparatively small, as when a close-up is being given of one of the principal characters. In order to produce a more perfect illusion an automatic frequency control is applied to make the speech heard during a close-up sound as though it came from a nearer source than that heard during a normal scene.

- **ELECTRON CAMERAS**

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NEW TELEVISION AERIAL

An inside-the-building Television 3-wave aerial, with centre-connected feeder and adjustable antenna, suitable for use as aerial or reflexor. The feeder is taken off from the centre of the aerial inside the building.

List No. C/L.19. For indoor use only. Without feeders.
List No. C/L.20. 50' Coaxial Feeder. 8/-6

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Special Interference Suppressor
Suitable for connection in the mains leads of small motors, for example intercoms, transistor sets, etc., it is compact in size, and gives full protection. Wire wound or ceramic types are available. Each 1/-6
CHF.R 900 85/1 1.5 25
CHF.R 600 0.5 5 23

AERIAL INSULATOR AND ARMREST
An aerial lead-in insulator and armrest with fuse and two internal safety devices. Special moulded bell-insulators provide a long dry break, path under all weather conditions, 10 years use.
List No. C.L.1. EACH 4/-

INTERLOADER SCREWED CHURES

Interloader 'Model 444' The Challenger "Model 444" custom-built 12-valve superhet radiogram.


Reprinted from "Wireless World" TEST REPORT on this model sent on request.

An Inexpensive PRECISION Instrument

The D.C. VOMITOR

Real Price-Measuring Instrument

This instrument provides precision testing facilities at a truly modest cost. Incorporating a fully jewelled moving-coil movement and a 30-turn, scale, it permits accurate readings of milliamperes, volts and ohms, with ranges adequate for the majority of normal circuit, battery and resistance tests. The total resistance of the metre is 1,000,000 ohms; full scale deflections of 300v. or 600v., is obtained for a current consumption of only 3mA. and 6mA. respectively.

In case, complete with leads, interchangeable crocodile clips and terminals, and with comprehensive instruc
tions booklet.

CHASSIS, VALVES & 2-12" P.A. SPEAKERS £14-0

MODEL 444 The Challenger "Model 444" custom-built 12-valve superhet radiogram.

CHASSIS, VALVES & 2 SPEAKERS Price 30/-

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FURTHER COMPONENTS INTRODUCED BY BULGIN

New and improved Encoders, a moulded trans-istor, less than 30", clear sound is given at any angle. With moulded terminal connection. List No. C/D.48. Red
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List No. C/D.48. Yellow

CHALLENGER RADIO

The most comprehensive range and the greatest value ever. Direct-to-the-public cash sales and the greatest service satisfaction—and you'll never be disappointed.

An inside-the-building Television 3-wave aerial, with centre-connected feeder and adjustable antenna, suitable for use as aerial or reflexor. The feeder is taken off from the centre of the aerial inside the building, the greatest service satisfaction—and you'll never be disappointed.

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NEW RECEIVERS AND AMPLIFIERS

BANKRUPT Stock-Brand new 1939 radio sets to
makers' returns with guarantee at less than half retail prices.
Includes FM, A.G.C., 10-Watt t.r. made for you by Armstrong of
London, S.E.1, and cheques and money orders should be made
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WANTED.-Communication receiver or
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CAR RADIO

Car radio Aerials, improved type, chromium plated.
356-8. 1938 Armstrong "Superphone" complete.
WANTED to carry in stock for immediate sale.

RECEIVERS AND AMPLIFIERS, CLEARANCE, SURPLUS, ETC.

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New Variable Selectivity Model AW1529
12-V. 5-Band All-Wave Radio/Chassis
(12-350 Continuus, 1000-2000 m.)
with R.F. Pre-Amplifier, 2 1/2 stages with Variable Selectivity.
Manual R.F. gain control and 10 watts R.C. coupled Triode
P.F. Output.

£17.17

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A few extracts from The Wireless World

Test Report, Jan. 5th, 1939

"If compiling the specification of this receiver the makers
have shown upon the value of both long-range communication
sets and quality amplifiers for local station reception.
A few extracts from
test apparatus in the hand the output must have been very close to the
optimal. The actual result was not far removed from the
desired value. The output was 1.7 watts at 1200 Kc/s.
This was the highest frequency reached by the
receiver in test apparatus, and the output at a lower frequency
was 0.75 watts at 600 Kc/s.

CABLE DIALS, Ltd.—See our advertisement on Page
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50-WATT OPERATING KEYING, all signal conditions, with negative feed back, separate rectifiers for output, screen and plate, 500 v., 5 ma., 500 watts push-pull. Each, c.w. 


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[continued from previous page.]

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PREMIER Transmitter Control, 50 or 100 watts, £10; Micro

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Baker's New Corner Horn Speakers set a New High Standard in the Realistic Recreation of Speech and Music. Will Appeal to All Music Lovers; your present receiver or speaker taken in part-exchange.


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MOTOR. Generator Set, input 250 v., 50 cycle, output 400 v., 0.2 amp, and 12 v., 6 amps, with batteries, including rectifier and setting up; £12.

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For further details, write, Day Ltd., 19, Linne St., E.C.4.

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-Personal recordings from 57/6; amplifiers, microphones, phone equipment when, quality counts.


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FOR Hire of Microphone and Amplification Equipment

A BAKER Corner Horn Cabinet will Immensely Enhance the Quality and Suction of Any Modern Receiver. 

A.C., D.C. amplifier, push-pull output, moving coil mike; stand, 12/-.

PORTABLE Amplified Electric Guitar, A.C., D.C. amplifier, push-pull output, moving coil mike, £15.

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2 Valve Short-Wave Receiver Kit

1 Valve Short-Wave Superhet Converter Kit

1 Valve Short-Wave Superhet Converter Kit

is supplied with a steel Chassis and Panel and uses Freq. Changers, 7/6 each. 'Full-wave and Half-wave Rectifiers, used, £10.

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DE-LUXE SCRATCH FILTER

A PROVED NON-REVERSIBLE DENTAL FAX IN TWO STAGES.

A DE-LUXE SCRATCH FILTER consists of two chambers, each equipped with a rubber ball, which are connected and in communication through a flexible tube. The rubber balls are fitted with a small hole in the center, and the outer surfaces are covered with a thin layer of black rubber. When the rubber balls are in contact with the scratch, they are forced apart, thus allowing air to pass through the flexible tube and enter the chamber. The air then passes through the second chamber, where it is forced against a filter paper, which removes the scratches. The air then passes through a second filter paper, which removes any remaining scratches. The final air is then released into the atmosphere. The process is then repeated until all the scratches are removed.

DE-LUXE SCRATCH FILTER

A DE-LUXE SCRATCH FILTER is a device that is used to remove scratches from glass, plastic, and other materials. It consists of two chambers, each equipped with a rubber ball, which are connected and in communication through a flexible tube. The rubber balls are fitted with a small hole in the center, and the outer surfaces are covered with a thin layer of black rubber. When the rubber balls are in contact with the scratch, they are forced apart, thus allowing air to pass through the flexible tube and enter the chamber. The air then passes through the second chamber, where it is forced against a filter paper, which removes the scratches. The air then passes through a second filter paper, which removes any remaining scratches. The final air is then released into the atmosphere. The process is then repeated until all the scratches are removed.
COMPONENTS—SECOND-HAND, CLEARANCE, SURPLUS, ETC.

R. Telephone: Holborn 4501.

Radio Clearances Lad., Ltd., Holborn, W.C.1. Open :Monday to Friday, 9 a.m. to 5 p.m. Special new receivers and components, etc., maintaining their reputation as the leading Mail Order House for surplus radios.

BRITISH Belmont 8-valve Plus Magic Eye All-wave Receiver: Two 8-valve, two short, medium and long, fitted latest Mallardctal base American type valves. Complete with 2000.0, 2500.0, 1000.0, 2000.0, 1000.0, and 2500.0 plates.

BELLEWEIGHTED TWIN ENAMELLED TINNED COPPER, 22 N.G., Oxygen Cleaned, 1½-in. long. £1.30, 224-in. long, 50c.

WIRELESS DIRECTION FINDING,” Third Edition. Price 25s. net. Post free 3s. 9d.

GALPINS ELECTRICAL STORES

COMPONENTS—SECOND-HAND, CLEARANCE, SURPLUS, ETC.

Radio Clearances, Ltd., 63, High Holborn, W.C.1.

GALPINS ELECTRICAL STORES


EARPONES with a frequency response of 50/8000 c/s!

These new High Fidelity Earphones produced by Marconi-Eko (manufacturers of electrical measuring and testing equipment including electro-mechanical apparatus) leave ordinary earphones far behind. Study the abridged specification given herewith, and you see that for quality broadcast-listening (particularly for defective hearing), for engineers’ sound monitoring and for medical purposes, they stand supreme.

SPECIFICATION: Extremely high sensitivity; Input Impedance 77 ohms. Maximum Input 500 milliwatts. Frequency response 0.1 to 20,000 cycles/sec. Weight 4 ozs., complete only 15 ozs. Double earpieces with band.

Electrodes with leaded, E.K. Single earphones with moulded handle, £4.4.0.

Write for full details and copy of “Wireless World” report, to

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Electra House, Victoria Embankment, W.C.2

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Have excellent LOCK-UP SHOPS available in good main road positions in:

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OCTOBER 2ND, 1939.

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EDITORIAL COMMENT

A “People’s” Television Set
Is It Possible?

GREAT efforts are being made this month to push the sale of television receivers because it is recognised by the Government and the B.B.C. that further developments in television on the programme side, or additional stations elsewhere in England, can hardly be proceeded with until evidence is forthcoming of more enthusiasm on the part of the public in the area already served in London.

We doubt ourselves whether enthusiasm for television is lacking, because wherever demonstrations are given attendances are good. It is merely, we believe, that the public is very cautious because of the novelty of this form of entertainment and for the reason that in spite of assurances to the contrary there is still a feeling that there will be big changes in television in the near future. Political uncertainties, too, have affected the campaign now being carried out to popularise television in the United Kingdom.

Is there not an opportunity for our industry concerned with the sale of television receivers here to learn from this a lesson?

Standardisation

We have repeatedly suggested in these pages and have brought directly to the notice of manufacturers the view that British producers of television sets ought to co-operate to achieve standardisation as far as possible. Standardisation of parts would have the effect of reducing prices for the standard model and facilitating service to a very great extent, because those engaged in this work would concentrate on acquiring an expert knowledge of a standard instrument instead of having to become acquainted with a variety of different models.

If we push standardisation to the extreme length of getting all British manufacturers of television sets to sit round a conference table, as was done in the case of the “People’s” receiver, and work out a standard set, in the manufacture and sale of which all of them would participate, it would be very necessary to see to it that such a set did not interfere with the sale of the more expensive types.

A “People’s” television receiver would use a small cathode-ray tube.
It should be housed in the plainest of cabinets and should have no luxury frills about it, but should give a clear and satisfactory picture and accompanying sound.

The longer such a project is delayed the more difficult it will be to realise, and if a "People's" television receiver has already had the consideration of the Television Advisory Committee and the manufacturers and yet has not been proceeded with, we feel that the reasons ought to be disclosed for public information. After all, the public, via the Treasury, has a big stake in television and it is equally as important that the public should get the best service on the receiving side as that the best efforts of the B.B.C. and others concerned should be put into the production of programmes.

Broadcasting and Peace

"Across the Frontiers"

EIGHTEEN distinguished personalities in this country recently issued a manifesto appealing to the nations of the world to save civilisation from war. In the course of the manifesto the statement appears that "It is time, if we are not to be too late, that men of good will who value the fruits of civilisation . . . should speak 'across the frontiers' to those who feel as they do in order that they may use together their gifts of heart and mind to co-operate in preventing the supreme catastrophe." Here, we think, is a direct challenge to broadcasting to undertake a task for which it stands alone as the ideal medium for its fulfilment.

Will the opportunity be grasped while there is time or is broadcasting to wait to become instead an instrument not of peace but of war?

We believe that those eminent men who have signed this manifesto would have the backing of the whole country if they were entrusted with the task of organising the use of broadcasting time to the project which they have so much at heart.

The broadcasts in foreign languages at present put out by the B.B.C. seem to be the responsibility of nobody in particular, and the broadcasts themselves, though fulfilling, no doubt, a useful purpose, seem to have no policy behind them and fail lamentably to offer any guidance; they are corrective perhaps as news broadcasts confined to statements of fact but not constructive, nor is there anything in them which constitutes an appeal to the "heart and mind" of listeners.

Suppressing Ignition Interference

Effect on the Engine

In our issue of January 12th we urged the early publication of precise information on the effects of fitting interference-suppressing devices to the ignition systems of motor vehicles. At the same time we put forward the opinion that these effects were not serious, but that car owners could hardly be expected to go to the trouble and expense of fitting suppressors in the absence of an authoritative pronouncement on the subject.

Although no statement has yet been issued by any of the bodies or companies believed to have carried out quantitative investigations, we are able to publish in this number an article that does much to clear up the position. From opinions formed from first-hand experience of the subject, including the results of tests made with dynamometers, the author comes to the conclusion that the ease of starting and the power output of the ordinary engine are not adversely affected by fitting suppressor resistors of the usual kind. Although the spark is admittedly weakened, sufficient margin is allowed in the design of ignition systems to ensure satisfactory firing of the explosive mixture.

All this applies to engines in good condition, and troubles may occasionally be provoked by the suppressors when the ignition system is suffering from prolonged neglect.

The position would, therefore, appear to be fairly satisfactory, but it certainly does not warrant any relaxation of efforts to devise methods of suppression that have not affected engine performance under any conditions. To do so is obviously difficult, as the ignition spark is believed to depend for its intensity on the oscillatory nature of the discharge. But something might conceivably be done by deliberately shifting the predominant frequency of the oscillations to a value at which the radiating properties of the ignition wiring are low.

B.B.C. Programmes

Inflexibility of Time Schedules

ANY times complaints have been made against the B.B.C. because of the autocratic way in which items are faded out when they overrun their scheduled times. It is not only those who have been the victims of such treatment before the microphone who have complained, but also the listening public who have been deprived of the finish of some musical or other item.

This obsession on the part of the B.B.C. to adhere strictly to its time schedule takes practical shape far more often than most listeners are aware. Particularly on such occasions as debates, the parties concerned often find themselves embarrassingly hurried, or their scripts cut in order to finish on time.

Perhaps one of the worst of recent examples of silly adherence to a time schedule was when the B.B.C. broadcast their usual news service in German at a time which overlapped with Herr Hitler's speech. How could they have expected that German-speaking listeners would provide an audience for their news on that occasion?

We suspect that this inflexibility in the matter of time schedules is largely dictated by the fact that the published programmes in the Radio Times go to press at an early date and by the fear that changes made afterwards would lay that publication open to criticism on the grounds of inaccuracy.
Short-wave Oscillator

AVOIDING PARASITIC OSCILLATION

By W. T. COCKING

ONE of the greatest troubles encountered when putting a new short-wave receiver into commission is parasitic oscillation. If a well-tried design is followed exactly, of course, one is unlikely to meet with any difficulty, for the designer has found and remedied the various sources of parasitic oscillation in his original models. The trouble starts, as a rule, when a design is modified or when an entirely new set is being tried out.

Parasitic oscillation is most noticeable in the oscillator of the frequency-changer, but it can occur equally readily in a reacting detector, and is possible but less likely in an RF amplifier. The symptoms of such oscillation depend upon its type, for there are a good many possible modes of oscillation. Perhaps the commonest gives rise in a frequency-changer to a series of spurious signals. As the tuning control is rotated, the band seems full of strong signals which bump in and out. Some of them are, indeed, genuine signals, but others will be found especially strong, and at first are apt to be mistaken for true carriers.

Optimum Oscillator Volts

They are, however, generated in the receiver itself, and in the writer's experience are almost invariably caused by excessive amplitude of oscillation at the correct frequency. A typical circuit is shown in Fig. 1, and a milliammeter is connected in series with the oscillator grid leak R1. This meter should preferably have a full-scale reading of 1 mA. The peak oscillator voltage on the grid is approximately 1.2 times the product of the grid current in amperes, and the resistance R1 in ohms.

Valve makers give a figure for the optimum oscillator grid voltage, and it is thus an easy matter to adjust it. The efficiency of the frequency-changer, however, does not vary greatly with the voltage, provided that it is not much less than optimum. As the voltage always varies over the waveband, there is consequently a temptation to make it rather higher than the optimum.

The Marconi and Osram X65, for instance, has a conversion conductance of 0.2 mA/v. for 4.5 volts peak oscillator amplitude. The optimum is 0.225 mA/v. at 10 volts, and it is still about 0.21 mA/v. at 25 volts peak. Below 4.5 volts the conversion conductance falls off rapidly, and at 2.5 volts it is only 0.135 mA/v. Unless care is taken in the design of the oscillator itself its output may vary in the ratio of perhaps 2:1 over the waveband. With a 500 µF tuning condenser it may vary more. At first sight, therefore, it seems desirable to make the mean amplitude about 70 volts, so that over the band it varies between about 6 volts and 14 volts, and the conversion conductance does not vary much.

This course seems satisfactory on the high-frequency end, and when the valve is right for the middle of the band the output is too low at higher frequencies. The simplest course is then to choose R2 so that the output is a little more than is wanted at the highest frequency, and then to shunt L2 with a resistance.

The value of shunt resistance required will depend upon the inductance and efficiency of the tuned circuit, but will usually lie between 2,000 ohms and 20,000
Short-wave Oscillator Problems—

Ohms. With a little juggling of this sort it is usually possible to keep the oscillator output fairly constant over the band.

Little difficulty arises in carrying out the adjustments until one gets below 20 metres. The reaction coil oscillator then becomes rather troublesome, but in a different way. The parasitic oscillation effect just described does not occur because even without added resistance the amplitude of oscillation is likely to be below optimum.

In order to improve efficiency an attempt is often made to increase the amplitude of oscillation by increasing the number of turns on the reaction coil. When this is carried too far, however, the valve oscillator is much easier to deal with and there is little difficulty in obtaining the necessary amplitude down to 5 metres. The modified Colpitt's oscillator is shown in Fig. 2, and is particularly free from parasitic oscillation, only one mode being commonly found, and one which it is easy to overcome.

If the amplitude of oscillation is too great, it can be controlled by shunting L2 by a suitable resistance, by reducing C3, or by connecting a condenser between grid or anode and cathode. Such a condenser should be adjustable with a minimum capacity of about 1-2 μF, and a maximum of some 6-10 μF. Additional capacity in either of these latter points enables the effective tapping point on the tuned circuit to be changed. Normally, the tapping point is provided by the valve capacities—the grid-cathode and anode-cathode capacities being in series across the circuit.

Unless care is taken, parasitic oscillation is likely to occur at a frequency of the order of 75 Mc/s, but determined chiefly by the valve and wiring. This oscillation is more likely to occur with large values of tuning capacity than with small, and it sometimes happens that the circuit will behave normally at low capacity settings of the condenser. As the capacity is increased, however, a point is reached at which the frequency ceases to fall and suddenly jumps to a high value and is hardly affected by a further increase in frequency determined by the circuit having the higher dynamic resistance, measured across Cga. A small value of Cr results in the valve's being effectively tapped down the high-frequency circuit, for the valve is across the other capacities C1 and Cac, Cga, and CgC represent the anode-cathode, grid-cathode and grid-anode valve capacities; C1 is the grid condenser and Rt the grid leak. The inductance of the wiring is represented by the coils L2 and L3.

There are two possible modes of oscillation for such a circuit. One is the normal one at a frequency determined by L1 and the total capacity which comprises C1 and Cga in parallel and also in parallel with the series value of Cac and CgC. At this frequency the reactance of L2 and L3 is usually negligible.

Parasitic Oscillation

At some higher frequency, and especially when C1 is fairly large, the reactance of this condenser is small compared with the reacanceof the valve capacities, and with the reactance of L2 and L3. At this frequency the tapped circuit is made up of L2 and L3 with a capacity comprising Cga in parallel with the series value of Cac and CgC, the whole in series with C1. The coil proper, L1, then merely acts as an RF choke across C1. The valve will usually oscillate at the frequency determined by the circuit having the higher dynamic resistance, measured across Cga. A small value of C1 results in the valve's being effectively tapped down the high-frequency circuit, for the valve is across the other capacities.

The Colpitt's Oscillator

On the ultra-short waveband one might use three turns for L2, and the reaction coil L3 should then not exceed 2-2.5 turns. To obtain oscillation the coupling must be very tight and the windings must be inter-leaved. In general, below some 7 metres it is useless to worry about the amplitude of oscillation, for it is difficult enough to make the valve oscillate at all and still cover the required tuning range. An amplitude greater than about 5 volts can hardly be expected.

These remarks apply to the reaction-coil oscillator. The Hartley or Colpitt's oscillator is much easier to deal with and there is little difficulty in obtaining the necessary amplitude down to 5 metres. The modified Colpitt's oscillator is shown in Fig. 2, and is particularly free from parasitic oscillation, only one mode being commonly found, and one which it is easy to overcome.

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Short-wave Oscillator Problems

The total capacity on the lower frequency circuit is increasing and its dynamic resistance is falling so that conditions for oscillation at the lower frequency get less favourable. Eventually, the higher frequency conditions are better than the lower and oscillation changes over to the former.

The remedy is usually very simple and consists merely in arranging the condenser Cr very close to the valve and connecting it with the shortest possible leads. Long leads to the coil circuit itself will not cause parasitic oscillation, but will only add to the inductance of the coil.

This course results in the equivalent circuit of Fig. 4. The main wiring inductance L2 and L5 is now only in series with L1 and it does comparatively little harm.

The Hartley Circuit

The reason for this will be clear from Fig. 6, which shows the valve capacities. There are actually two tapping points on the circuit—one is provided by the coil tapping and the other by Cgc and Cac. If C1 is large in relation to these capacities, the "condenser earth" has little effect and the circuit functions as a true Hartley oscillator. When C1 is small, however, the capacity tap can by no means be neglected, for it is sufficient to make the circuit oscillate without the inductance tap.

Unless the inductance tap is correctly adjusted in relation to the capacity tap, therefore, it is only to be expected that peculiar results will be obtained. The condition to be arrived at is to tap the coil at the point which would be at earth potential even if this tap were omitted; in other words, the tap should be at a nodal point.

This is, in practice, difficult to achieve, and experience shows that on ultra-short waves the circuit works much better if a resistance or RF choke is inserted at the point X in Fig. 6. Although often so called, the circuit is no longer that of a Hartley oscillator, but is really the modified Colpitt's. The only difference between it and that of Fig. 3 is the point at which the HT supply is connected. This gives it an advantage in that the tuned circuit is less affected by the HT feed resistance or choke. For receiving purposes, this advantage is often more than outweighed by the inconvenience of having to provide a tapping on the coil.

Oscillation at one time very troublesome, does not often occur nowadays because it is customary to use a fairly low value of grid leak and to employ a resistance feed for the HT supply. Squegging is much more likely to occur if a direct feed is used as in Figs. 5 and 6, or if an RF choke is employed in place of the resistance shown in the other circuits. This is easy to see when the mechanism of squegging is considered. What happens is that the valve oscillates violently and it draws a heavy grid current. This drives the grid potential so negative that the valve stops oscillating and does not start again until the charge on the grid capacitor has leaked away via the grid leak.

A reduction in the value of the grid leak at first does little more than increase the frequency of the squegging, for it allows the charge on the condenser to leak away quicker. At length, however, it tends to prevent it, because when it is very low the rectifying action of the grid circuit loses efficiency and the valve is no longer driven to anode current cut-off.

The use of a resistance feed to the anode is a disadvantage, however, because it permits the anode voltage to rise as the grid is driven negative and so shifts the point of current cut-off to a more negative grid potential. With reasonable values of components squegging hardly ever occurs, but it is a distinct possibility when the HT supply is fed directly to the valve or through decoupling circuits of high time-constant.

Acoustic Measurements at the N.P.L.

In a recently issued pamphlet the testing services offered by the Acoustics Division of the National Physical Laboratory, Teddington, are described in detail together with the fees charged in representative cases where the work is of a routine character. Apparatus which may be sent for calibration includes microphones, loud speakers, telephone Receivers, noise meters, gramophone pick-ups and deaf aids.

The sensitivity of microphones, expressed as the e.m.f. generated by unit sound pressure, may be given for plane progressive waves or for actual pressure on the diaphragm. In the former test the sensitivity at frequencies above 250 c/s is measured in a lagged chamber and below that frequency is inferred from measurements usually made with stationary waves set up in a pipe. The charge for eight determinations at frequency intervals between 62.5 and 6,000 c/s is £6. Additional measurements at frequencies down to 30 c/s or up to 10,000 c/s are undertaken for a supplementary fee of £1 10s. per frequency.

Load speakers are tested for frequency response in the open air over a band of frequencies from 30 to 10,000 c/s. The fee for a characteristic taken on the axis under one of five standard conditions of test is £4. Measurements of electro-acoustic efficiency or harmonic distortion, if undertaken at the same time as the frequency, cost £5, for each frequency.

In addition to tests on instruments the Department also undertakes to investigate the properties of sound-insulating materials and to measure the characteristics of audito-remes and suggest methods of treatment where necessary.
Motor Car Interference

INTERFERENCE radiated from engine ignition systems has hitherto been discussed mainly in relation to its effects on built-in car receivers. In these articles the subject is treated from the point of view of reception (and particularly television reception) external to the vehicle.

The first instalment of this article dealt mainly with the cause and effects of ignition interference, and its contents may be summarised briefly as follows: The interference is due to the high-voltage part of the ignition system of internal combustion engines and comprises a highly damped train of oscillations, the frequency of which is of the order of 40 Mc/s. The duration of the train is not generally greater than 2.5 microseconds. The maximum instantaneous current involved may reach the colossal value of 100 amperes, and the resultant electro-magnetic wave is substantially vertically polarised.

The effects of such a form of interference upon the audio response of a television receiver is likened to a machine-gun in action. On the visual channel the picture is covered by bright spots or bands of spots in which an individual spot is observed as a horizontal elongated blob becoming smaller in size as the intensity of the interference falls off.

This part of the article will deal with methods employed in reducing, partially or completely, this very undesirable effect. The alleviation or suppression of any form of electrical interference may be obtained by two distinct methods: (a) suppression at the source, (b) suppression at the receiver. Suppression at the source, that is, the removal of the phenomenon itself, is theoretically the correct method of attack.

Although electrical interference with medium and long-wave broadcasting is of such a nature that a great deal may be done at the receiving location, at television frequencies the position is different, and the writer puts forward his personal view that very little can be done at the receiving point either by the use of mains filters or elaborate aerial systems, particularly in the case of ignition interference.

It is unnecessary to delve deeply into the reasons for these views except to state that, first, the electro-magnetic waves of ignition interference are identical with those used for the television transmission, both in polarisation and physical properties. Secondly, their peak amplitude is very high, and aerials require to be removed at least 100 yards from traffic routes in cases where signal field strengths are low. Also the successful screening and balancing of aerial feeders against interfering fields at television frequencies is a doubtful achievement. Directional aerial systems are of real assistance, but it is surprising how rarely in practice the listener finds himself in a position to avail himself of the discriminating property of a directional aerial system.

Here, therefore, is a real case, technically and economically, for complete or at least adequate suppression at the source itself. Furthermore, the fact that certain ultra-high frequencies have been earmarked for Government Services, in addition to present and contemplated television services, indicates that legislation with respect to ignition interference must be enforced sooner or later.

We will now consider the ways and means of suppression and will first refer to Fig. 1, which depicts a typical coil ignition circuit applicable to automobiles. The heavy lines are those concerned with the high-voltage part of the circuit and comprise the interfering portions of the network. It is known that the interference produced in the primary circuit of the ignition system is negligible in its effect upon television reception, although it can cause trouble when used in conjunction with receivers designed for use in the automobile itself.

Both the contact-breaker and the rotary distributor arm are mechanically connected to the engine crankshaft in such a manner that the contact-breaker provides the necessary primary current and subsequent high-voltage secondary pulse at the appropriate firing time, while the distributor arm selects the appropriate sparking plug.

If the whole of the high-voltage system, including the distributor and sparking plugs, could be screened by some kind of highly conductive material a very considerable degree of suppression would obtain. It is not a simple matter, however, to effect such screening, remembering the requirement of accessibility to the various parts requiring periodical attention. Automobile designers, looking ahead, could undoubtedly design an efficient wholly enclosed ignition circuit, but not without an additional manufacturing expense, which might be considerable.

Partial screening of certain portions of the high-voltage circuit may result in the required degree of suppression, but the disposition of such screening for successful suppression appears to vary between different makes of cars according to the layout of the ignition system.

In any case, screening, partial or complete, calls for care in locating the correct earthing point, which appears to vary between different cars. In fact, it is known that if the earthing of the screening is not carried out with meticulous care after much laborious experiment the resultant field of interference may be worse than before. At ultra-high frequencies mechanical shielding does not necessarily mean electrical shielding, and very often the correct disposition of the earthing of a poor mechanical shield may result in a generally greater suppression than the indefinite earthing of an elaborate and expensive system of shielding.

Taking the broad view, the writer does not feel optimistic about screening, unless it is incorporated during the manufacturing process; and a further technical consideration indicates that this method should be placed in abeyance since more successful suppression schemes are available.

It should be made quite clear at this stage that methods of ignition interference suppression which prove very satisfactory when applied to medium and long-wave reception on receivers installed in automobiles need not necessarily render television receivers immune. The physical aspects of the problem are wholly different because of the wide separation between television and
Motor Car Interference—

normal broadcast frequencies. This is a point which may be forgotten but is far too important to neglect.

The means of suppression remain, namely, the fitting of resistors in the high-voltage leads to the sparking plugs and/or distributor, or the substitution of high-frequency chokes for these resistors.

High-frequency chokes of low inductance may be used with a high degree of success when connected in series with the sparking plug leads very close to the plug terminal, particularly if a short length of the lead is shielded and earthed to the plug body. It is not known whether such a method of suppression would be successful in all cases, but it is known that the suppression afforded occurs over a comparatively narrow band of frequencies and is by no means as uniform with frequency as that provided by resistor suppression. There is little doubt that greatest attention has been focused upon the inclusion of a suitable non-inductive high-resistance in the plug and/or distributor lead of the ignition system.

The effect of including a resistor in the high-voltage lead is to increase the electrical damping of the circuit and probably render the oscillatory bank current more uniform. By so doing there is considerable attenuation of the high-frequency component of the subsequent spark current pulse, thus reducing very considerably the intensity of the resultant interfering field. It appears after considerable experiment by the Electrical Research Association that resistor suppressors up to 20,000 ohms, each fitted in the plug lead close to the plug terminal and in the distributor lead close to the distributor head, effect an average suppression of 30 db. If the high-voltage leads are made up as a distributed resistor, in other words, a number of resistors in series making up a total value of about 20,000 ohms, the suppression is rather greater than that obtained by the same value of resistor lumped at one spot. If a distributed resistor is used the inclusion of a small amount of earthed screening over the lead close to the plug results in a further degree of suppression leading to ultimate attenuation of the order 40 db. A typical arrangement, which is, incidentally, effective for car radio, comprises 5,000 ohms fitted in series with the lead from the coil where it meets the distributor head and 15,000 ohms in series with each plug lead, as close to the plug terminal as possible. From the television interference viewpoint adequate suppression is often obtained by the use of the 5,000-ohm resistor in the distributor lead only, but this depends upon the type of car concerned, and researches are insufficiently advanced to warrant any recommendations in this respect.

We now find ourselves on very dangerous ground. It has been averred, evidently with some truth in certain circumstances, that this form of suppression interferes with the proper functioning of internal combustion engines.

It is obvious that the fitting of these suppressors shown fitted between the distributor and the plugs of a modern four-cylinder car.

Now, it must be remembered that these tests were in all cases conducted on a new and carefully tuned engine. It cannot, therefore, be taken as granted that the same results will obtain under practical conditions.

For further information on this point one must resort to the experience of intelligent car owners. By intelligent one means those who have sufficient sense to pay a little attention to such matters as the maintenance of correct sparking plug gaps and contact-breaker spacing.

It does not need much imagination to foresee that an engine on the verge of misfiring through want of attention or adjustment to the ignition circuit may misfire and be difficult to start when suppressors are fitted. It is the writer's personal belief that most of the stories regarding the deleterious effects of suppressors on engine performance emanate from motorists who will not give their engines attention until they cry out for it by bad running or difficulty in starting.

It is known that certain types of high-compression engines as fitted in a few makes of expensive automobiles are prone to slow-running difficulties, but this does not appear to apply to most popular makes of vehicle.
Motor Car Interference—

The writer has fitted suppressors to the three makes of car he has used over the past three years and has not observed the slightest trouble as a result (with one exception). There have been no suggestions of plugs oiling up, poor starting, increased petrol consumption or loss of power. The one exception concerns the present car, which requires a sparking plug gap width of 0.04in. In this case misfiring was noted occasionally, but it was discovered to be due to the fact that the sparking plug gap had, to the writer’s shame, been allowed to increase to 0.06in.

Finally in this matter there has not yet been attained, and an anxious radio industry awaits with great patience the considered verdict of the investigators. On their findings will depend a great deal of the future success of television as an industry and a unique art in which we are proudly foremost.


Ekco Television

THE problems of television demonstration and installation are being tackled by E. K. Cole, Ltd., in an especially interesting manner. This firm has equipped a 15-cwt. van, illustrated below, for the purpose.

Standard Ekco dipole aerials, vision units and receivers are carried as well as spare valves and CR tubes, drums of coaxial cable and transmission line. Test gear, including high-voltage meters and signal generators, is also carried, while there is a complete range of tools.

An extending ladder is carried on the roof, and also two gilt, collapsible masts. The ladder is naturally for use in aerial erection and the masts are for demonstration purposes. The aerial used is a special dipole with reflector made of duranum and weighing less than one pound.

In common with all other vans and cars owned by this firm, the engine is fitted with suppressors to eliminate interference on television.

The receivers marketed by this firm are the model TS701 at 26 guineas and the TA301 at 22 guineas. The vision equipment is similar, but whereas the former gives both sound and vision the latter must be used in conjunction with an existing broadcast set for sound. Actually, the output of the sound channel is connected to the pick-up terminals of the existing receiver.

The picture size is 6in. by 5in., and electromagnetic deflection and focusing are used. Larger models will be available shortly.

Manual Tuning Correction

Suggested Adjunct to Press-button Systems

IN all types of automatic tuning systems some form of correction, or provision for fine adjustment, is a desirable adjunct to the automatic station-selecting mechanism; in some cases correction may, indeed, be a virtual necessity. It is usually carried out by electrical AFC circuits, but it is also possible to apply manual control by means, say, of a so-called "vernier" condenser shunted across the main condenser.

Considering the latter method, suppose that a station has been selected and automatically tuned and the vernier has been brought into action and the precise tuning accomplished. Now suppose that automatic tuning is needed for another station.

The automatic tuning system is operated and, before tuning is effected, it is clearly desirable that some device should come into play whereby the vernier is returned to a predetermined setting, say, midway in its range. Thus the automatic tuning of one station, which may well be correct in itself without reference to the vernier, is not upset by the fact that the vernier has been already offset for the tuning of a previous station.

This system is also capable of extension to a receiver when used for normal manual tuning where, if the vernier device is not automatically returned to its preset position, the tuning scale would show inaccuracies of reading.

"Safety First" in Battery Works

Methods of Reducing Casualties

ALTHOUGH the battery industry is not one in which there is exceptional risk to life or limb, minor injuries to those working with lead and lead oxides may always lead to dangerous complications, and so full precautions must be taken.

All accidents involving loss of time in the Exide battery works are investigated by a committee of fifteen members, of which four are appointed by the company and eleven are elected by the employees. One result is that workers who are found to be particularly prone to accidents can be transferred to those departments where the risks are smallest.

Minor accidents are dealt with immediately by the Resident Medical Officer's staff. Every encouragement is given to employees to undergo precautionary treatment for apparently trifling injuries, with the gratifying result that, although attendances at the Accident Room have doubled of late, accidents involving loss of workers' time have been halved.

PROBLEM CORNER—6

Try Working this Out

A

OTHER exercise in logical deduction from the correspondence of Henry Farrad.

1, Keel Row,
Hull.

Dear Mr. Farrad,

Having heard that you are that good at solving wireless puzzles I am sending you this one, hoping you will be able to enlighten me. As often as not my reception of Regional programme is all mucked up by a terrible whistle. After a while I noticed that we never got whistle when our next-door neighbours were out. Being friendly with them I asked if they noticed whistle, but they said no. However, they generally listened to long-wave National. They have one of these new all-wave receivers. I must say it's a champion set, and I must be thinking of getting a new one myself. Do you think it would get rid of whistle?

Yours truly,
Jonah Ironbotham.

Would you recommend Mr. Ironbotham to get a set like his neighbour's, and why or why not? Solution on page 142.
Output Stage and Loud Speaker

A SURVEY OF THE PROBLEMS OF MATCHING

By F. LANGFORD
SMITH, B.Sc., B.E.,
M.Inst.R.E. (Aust.)
A.M.I.E.E., A.M.I.E.
(Aust.)

DISTORTION is considered in relation to the permissible limits for varying degrees of fidelity, and particularly in regard to spurious combination tones and cross modulation. Elliptical loading produces harmonic distortion, and the usual graphical treatment of elliptical load lines is shown to be only an approximation. Triodes, also tetrodes and pentodes with and without negative feedback, are compared on various types of loading, and the design of loud speaker transformers is considered in relation to each. The article is based on a paper read before the World Radio Convention organised in Sydney by the Australian Institute of Radio Engineers.

The Wireless World, February 9th, 1939

By F. LANGFORD

The performance which may be expected of the output stage concerns the frequency range, amplitude distortion, phase distortion and response to transients.

The limits which may be set for varying degrees of fidelity have not yet adequately been determined, but some indication of the requirements is given in the list below.

- Mediocre reproduction for wide frequency range, results in increased output together with decreased output.
- Reasonable assumption, pending further investigation.
- Indistinguishable from original.
- Barely perceptible.

Harmonic distortion is audible, either directly or through any indirect effects associated with it. If the frequency range is restricted, it is probably that 10 per cent. second harmonic distortion is barely perceptible.

Higher Harmonics

Higher order even harmonics may in most cases be neglected as being small in comparison with second harmonic distortion, while contributing generally similar effects.

Higher order odd harmonics are much more disquieting, both directly and indirectly, as will be shown later in this paper, and a limit of half that for second harmonic distortion appears to be a reasonable assumption, pending further investigation into the subject. This gives the limit of third harmonic distortion as 2.5 per cent. for wide frequency range and 5 per cent. for restricted frequency range.

The indirect effect of harmonic distortion, particularly that due to higher order odd harmonics, is to produce spurious combination tones together with cross modulation. These matters are considered individually.

(c) Phase distortion has not, so far, been found to have any audible effect on sustained tones, while its effect on transients, within certain limits, is probably quite small. Extremely bad cases of phase distortion are known to have an audible effect on the reproduction of certain types of sound.

(d) The response to transients is an extremely important factor which does not seem to have been given the attention which it deserves. No method of testing has so far been standardised owing to problems still not fully investigated.

The mathematical and graphical treatment of a triode valve on a resistive load has been given on many occasions [see bibliography next week, 1 (1) to 1 (7) inclusive]. The output of a class "A" power triode valve is generally given in terms of 5 per cent. second harmonic distortion, it being realised that a lower load gives increased distortion, combined in most cases with a slight increase of power output. An increasing load gives decreased output together with decreased distortion. It will be shown later that a loudspeaker reflects an equivalent load which may vary in a ratio of 6 : 1 or even more, and therefore in considering an output valve it should be treated in conjunction with a load of impedance varying from a certain minimum up to six times that value.

The graphical treatment and calculations of a pentode or tetrode valve on a constant resistive load are well known. For maximum power output combined with reasonable distortion the load resistance of a pentode is usually adjusted to give zero second harmonic or low percentage of second harmonic, combined with about 7 per cent. of third harmonic distortion. A tetrode valve such as the 6L6 cannot conveniently be arranged to produce such low values of second harmonic distortion, and about 10 per cent. second harmonic distortion is usually found in such a valve. In the 6L6 the third harmonic distortion is reduced to about 3 per cent. and in this regard is different from a pentode.

Pentodes and Tetrodes

If a pentode valve is adjusted to give approximately zero second harmonic on a stated load resistance, an increase of the load resistance will result in an increase of the third, fifth and higher harmonics, together with an increase of second harmonic distortion. A decrease of load resistance, which rarely occurs in practice on a loud speaker load, results in increased second harmonic distortion but decreased third and higher order harmonic distortion. A tetrode valve behaves in a somewhat similar manner in that third harmonic distortion decreases as the load resistance is increased, and increases as the load resistance is increased, under conditions of maximum grid voltage input, but zero second harmonic does not occur until the load is increased considerably above that for normal output.

The power output of pentode and tetrode valves increases as the load resistance is increased provided that reduced grid excitation is used, but with maximum grid excitation the maximum fundamental
Output Stage and Loud Speaker—

Power output occurs with a load resistance only slightly greater than that for normal output. Beyond this point the distortion becomes so severe that the fundamental output is reduced, although the total power output continues to rise due to the rapid increase of harmonic output.

Reactive loads that normally occur in a power stage may be divided into two principal classes, the first when an inductance is in series with a resistance, and the second when an inductance is in shunt with a resistance.

In the case of series loading, an increase of inductance results in an increase of impedance at any particular frequency. As may be shown on the $L_E$ characteristic, the addition of an inductance in series with the resistance load results in a decrease of plate current excursion, and an increase of plate voltage excursion corresponding to that with a resistive load equal to the resultant impedance. The distortion is therefore only slightly higher than that with a resistive load of the same resultant impedance.

The case of shunt loading is very much more serious and is found to occur particularly at low audio frequencies due to the shunting effect of the inductance of the loud speaker transformer. A similar effect occurs at the higher audio frequencies in cases where a condenser is shunted across the load to form a “tone control.” It has been stated [see bibliography next week 3 (4), 3 (5)] that the elliptical load line to be applied to the $L_E$ characteristic is a true ellipse, but further consideration has shown that this treatment is on the assumption that the alternating component of the load current is of sine wave form. Since this assumption is not valid under most conditions for power valves, it appears that the treatment previously given is approximate only.

The procedure previously adopted in drawing the ellipse on the $L_E$ characteristic has been to make the ordinates passing through the points of extreme excursion along the resistive plate load line tangential to the ellipse. If the valve to which this is applied does not have any second harmonic component, the ellipse will be placed centrally on the load line, but if any second harmonic is present it is necessary to arrange the ellipse so that its minor axis does not pass through the working point on the load line. An examination of Fig. 1 will show the results obtained by applying the simple existing method. In these diagrams the reactance ellipses (and hence the resultant ellipses) are arranged to fit the load lines. In the case of the 60 in which the second harmonic is quite low, this does not cause any appreciable displacement. In the case of the 6L6 a very considerable displacement of the ellipse is necessary and the errors of the simple treatment are made very evident. Until further investigation has produced a more satisfactory treatment of the question, it appears that the arrangement illustrated in these diagrams is sufficiently satisfactory to indicate the major effects of the shunting of a resistive load by an inductance. In these three diagrams for triode, pentode and tetrode respectively, the inductance shunting the load was calculated so as to be proportional to the load in each case so that the three diagrams may be comparable. It will be seen that in each case the resultant ellipse reaches the point of zero plate current and appears as though it would cut this axis. A little consideration shows that it is obviously impossible for these lines to cut the zero current axis, and this being the case it is most unlikely that the path of the elliptical load line will be followed exactly in the region approaching zero plate current. It is suggested that the true shape of the load line will be modified so that a point of sharp curvature is avoided. This is confirmed by an examination of oscillograms.

Loud Speaker Impedance

In considering the relationship between the power output stage and the loud speaker it is essential to consider the characteristics of the loud speaker itself. The loud speaker does not present a constant impedance at all frequencies, but one which varies very widely from a minimum at a frequency slightly below 400 c/s to a maximum at the bass resonance frequency and also increasing steadily at high audio frequencies. The curve of impedance against frequency of a typical tine cone loud speaker with slight under-excitation on the field coil is shown in Fig. 2. It will be seen that the impedance at the resonant frequency of 71 c/s is approximately six times that at 400 c/s, while the impedance at 10,000 c/s is almost equal to that at the bass resonance frequency.

The power factor of a loudspeaker load is not constant but varies very widely over the frequency range. In the speaker used for the curves the impedance of the speaker is inductive below 71 c/s, and has unity power factor at 71 c/s where the bass resonance occurs. Between this frequency and that of 100,000 c/s, the curve of impedance against frequency is capacitive. The resistive condition at 100 c/s occurs at the point at which the static and motional inductances are equal but opposite in sign. Above this frequency the loudspeaker is inductive up to the highest audio frequency.

The equivalent circuit diagram of a loudspeaker is shown in Fig. 2, which has been checked experimentally and found to agree very closely with the actual loud speaker used for the tests of imped-
Output Stage and Loud Speaker—

dance and phasing at frequencies up
to 400 c/s. Of the values of the equi-
valent circuit diagram L is the only one
which remains constant. The remaining
values all vary with frequency above 400
c/s. Provided that the necessary treat-
ment is made with the values of L, R, 
and C, all being functions of the fre-
quency, the same equivalent circuit dia-
gram may be used to cover the whole
band of audio frequencies. From this cir-
cuit it will be seen that the loud speaker
is equivalent to a parallel resonant circuit
tuned to the resonant frequency, in
series with an impedance. At frequencies
near this resonance point, or near its
harmonics or sub-harmonics, the loud
speaker needs to be considered as a tuned
load, discriminating between the fre-
quency of the input voltage and its har-
monics. Further consideration will be
given to this characteristic later in the
paper.

One of the most important character-
istics of a loud speaker is its response to
transients. It is generally agreed that
good transient response is given by a
combination of good frequency coverage
together with good damping. Of the two,
it is the opinion of the writer that damp-
ing is more important than frequency
response, and tests which have been made
on loud speakers having poorer frequency
response, but extremely heavy damping,
have shown that the reproduction is pre-
ferable to some critical ears to that of a
loud speaker having a wider frequency
range but poorer damping. In consider-

the impedance at 400 c/s is equal to the
ideal resistive load for the valve, then
the load impedance is resonant to the
resonant frequency and at high audio frequencies
will be very much higher than the ideal
load. It will be seen from Fig. 2 that in
the regions of high impedance the varia-
tion of impedance with frequency is su-
cient for the load to discriminate between
the fundamental and its harmonics. In
cases in which the load to a harmonic
is greater than the load to the fundamental
the amplitude of the harmonic voltage in
the output will be increased in relation to
that of the fundamental, and vice versa.

The Bass Resonance

In the case of a triode valve with an
input voltage at the bass resonant fre-
quency there will be a decrease of all
harmonics due to the high load imped-
ance, and a further decrease due to the
load presented to the harmonics being
lower than that presented to the funda-
mental, although the reduction of distor-
tion may be partially offset by additional
distortion due to the elliptical load line.

At frequencies below the bass resonant
frequency the loudspeaker, acting in a
manner equivalent to a tuned circuit as
previously explained, selects harmonics
where they occur at the resonant fre-
quency. Thus with the fundamental at
half the resonant frequency the second
harmonic output may be much greater
than the fundamental.

At the higher audio frequencies there is
also an accentuation of harmonic distor-
tion due to the in-
crease of load im-
pedance with fre-
quency. This will,
in the case of a
triode valve, offset
the reduction of
harmonic distortion
due to the increase of load impedance
presented to the fundamental.

These effects are shown by the curves of
Fig. 3 (a), which
is due to the combined effect
of the falling impedance of the voice coil,
or offset by the leakage inductance of the trans-
former which is sufficient to cause a slight
drop above 4,000 c/s. The drop below
about 70 c/s is due to the combined effect
of the falling impedance of the voice coil
and the shunting effect of the primary
inductance. It will be observed that the
peak which would be expected at 70 c/s
is much suppressed by this shunting
effect. If a perfect transformer had been
used, the shape of the output curve would
have followed the general form of the
impedance curve except that the peaks
would be far less pronounced.

Advantages of Triodes

The comparatively level output curve of
a triode valve on a loud speaker load
is due to the good regulation of such a
valve, which can be looked upon as a
generator supplying power to a load.
With perfect regulation, that is with a
valve having zero plate resistance, the
output curve would be perfectly straight
horizontal line, however the load imped-
ance might vary. An ideal loud speaker,
driven by a power valve of negligible
plate resistance, would give uniform
overall response. A practical power
triode is a very close approach to this
ideal of perfect regulation.

A pentode or tetrode valve has a com-
paratively high plate resistance, and
hence also poor regulation, since varia-
tions in the impedance of the load cause
large variations in the voltage applied
to the load. It is for this reason that pen-
tode or tetrode valves accentuate the
response at the bass resonance frequency
and at the higher audio frequencies. This
rise in load impedance at audio frequen-
cies is necessarily accompanied by in-
creased distortion, as shown in Fig. 3 (b).
If by means of a suitable shunt filter net-
owork the impedance of the load is main-
tained constant at all frequencies, the dis-
tortion will also be constant provided that

![Diagram](image-url)
Output Stage and Loud Speaker—
the power factor is unity at all frequencies. It will therefore be seen that if a pentode valve is used to provide an accentuated response at the extremes of the audio frequency band, this can only be done to the accompaniment of increased distortion.

Fig. 3 (b) shows output and distortion curves for a pentode valve loaded by a typical loud speaker. Since these measurements were made with full grid excitation the output curve does not show an appreciable peak at the bass resonant frequency, the waveform having a severe flat-top on one half-cycle. With reduced grid excitation the output peak at the bass resonant frequency becomes very pronounced since overloading no longer masks the effect. A similar effect also occurs at the higher audio frequencies.

The harmonic distortion curves of Fig. 3 (b) are influenced by frequency discrimination in a similar manner to those of a triode in Fig. 3 (a). It will be seen that the distortion in the region of 100 c/s is considerably less than would be expected from a constant resistive load equal to the impedance at the bass resonant frequency. At the higher audio frequencies the second harmonic distortion rises very rapidly, due to the combined effects of high load impedance and frequency discrimination. The third harmonic indicates a partial cancellation above about 2,000 c/s. In these curves the inductance of the loud speaker transformer acts as a shunt and reduces the effective impedance, and therefore the output voltage, at low frequencies.

New Apparatus Reviewed
Recent Products of the Manufacturers

SIMMONDS HT UNIT
MESSRS. SIMMONDS BROS., of Rabone Lane, Smethwick, are marketing a range of HT supply units of the vibrator type. They are made in two sizes with outputs of 120 volts 10 mA and 135 volts 20 mA, and each is available for an input of 2, 4, or 6 volts.

The model 210 is of the smaller type and for a 2-volt accumulator; the makers claim that the current taken is 1.2 amps, giving 70 volts at 1.6 mA, an output of 70 volts at 1.6 mA is provided, giving 70 volts at 1.3 mA and 90 volts at 1.8 mA.

On test the unit functioned well and drove an all-wave battery set satisfactorily, interference on all bands being negligible. The 10 mA models are priced at 13 s. 6d., and the 20 mA type at 17 s. 10d., while replacement vibrators cost 13s. 6d. for the 2- and 4-volt types, and 19s. 6d. for the 6-volt, 1.8 mA.

In these curves the inductance of the loud speaker transformer acts as a shunt load and reduces the effective impedance, and therefore the output voltage, at low frequencies. (To be concluded.)

The Wireless Industry
The proposed meeting of those interested in the formation of a trade radio service organisation (mentioned in the Correspondence section of our issue for Jan. 19th) is to be held in London on February 24th. All those interested are invited to communicate with National Radio and Television Service Company, 4-4 4, Clapton Road, London, E.5.

"Suppression at the Source" and "Radio and Electrical Accessories and Complications" are the self-explanatory titles of two catalogues recently issued by Bellon and Lee, Ltd., Cambridge Arterial Road, Holloway, London, N.10.

A leaflet describing the Ardente "Touch-plate" system of load speaker intercommunication has been issued by Ardente Acoustic Laboratories, Ltd., 11-12, Pollen Street, Mad- don Street, London, W.1.

Erie Resistor, Ltd., wish to emphasise the fact that they distribute their products themselves direct to wholesalers, trade, service specialists and retailers. To assist in the campaign for reduction of ignition interference, Erie "parking plug suppressors have been reduced in price to 1s. 6d.

New leaflets on Trix sound equipment are available from Trix Electrical Company, Ltd., 65, Belvoir Street, Great Portland Street, London, W.1.

The 1939 catalogue issued by Premier Radio Company is now available at a cost of 6d. In addition to general components and accessories, it deals at length with transmitting gear, communication receivers and specialised short-wave equipment. Amplifiers, tuning units, etc., are also described. Address: Jubilee Works, 167, Clapton Road, London, E.5.

The London office of Claude Lyons, Ltd., has been moved to Queen's House, 180-182a, Tot- tenham Court Road, London, W.1. Telephone: Museum 3023.
The Amateur Transmitting Station

Part VI.—Designing and Building the Power Supply Unit

All the preliminary tests of the transmitter units can be carried out with the HT taken from a standard type receiving power pack giving about 350 volts at 60 to 80 mA but with the addition of a potential divider to maintain a reasonable minimum load and also to provide the 250 volts needed for the oscillator valve.

As a temporary measure such a source of power is quite satisfactory, but we would not build a unit of this kind for a transmitter, as its voltage regulation is hardly good enough. A receiver, unless it includes some form of Class "B" output stage, which is most unusual in mains sets, takes a steady current from the power unit once the valves have attained their working temperature.

In a small transmitter which is being used for telegraphy work the HT current will be continually changing from a few milliamps to, say, 60 mA or more, and unless the voltage regulation is very good we shall find the output varying from the normal calculated value of, say, 350 to nearly 500 volts.

This comes about because with the orthodox rectifying circuits in which a reservoir condenser follows the valve, the no-load DC voltage across this condenser takes a steady current from the power unit, and the valves have attained their working temperature.

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Voltage Regulation

Whilst a higher DC voltage is obtained with the reservoir condenser, the regulation, as indicated by the slope of the curve, is by no means as good as that without this condenser. One point, however, must not be overlooked: the output voltage is of the same order in both cases when only a few milliamps are taken from the supply unit. The choke input filter arrangement only gives good regulation when the load current exceeds a certain critical value, and this varies with different types of rectifying valve.

The best regulation is obtained with a valve of low internal resistance and preferably one in which the voltage dropped across the valve does not change to any extent with the load current.

Mercury-vapour, or similar gas-filled rectifiers, exhibit this feature, but their use is really only justified when fairly heavy current loads have to be considered, such as 200 mA and over; for other purposes a vacuum-type rectifier will usually suffice.

It is always necessary to include a loading resistance across the output terminals of a power unit having a choke input filter, and this resistance must have such a value that it passes slightly more than the critical current to give good regulation. This resistance is generally referred to as a "bleeder resistance."

When choosing a smoothing choke for a condenser input filter of the orthodox kind, the characteristics required are, reasonably constant inductance at different current loads and a sufficiently low DC resistance to avoid unnecessary voltage drop. Its inductance should also be high enough to give the required amount of smoothing with the input and output condensers fitted.

With the choke input filters a different set of conditions is encountered. In the first case quite high peak voltages are developed across the choke so that its internal insulation has to be exceptionally good. Its inductance should vary with the load on the supply unit since there is a critical value for light loads and an optimum value for the full working load.

Fig. 13. The conventional reservoir condenser circuit (a) compared with a choke input filter (b).

Fig. 14. The output voltage of a condenser input filter (A) is lower but better regulated than that of a choke input filter (B).
The Amateur Transmitting Station

The method of arriving at these values will not be discussed here, but the information can be found in most handbooks dealing with amateur transmitting equipment. Actually no advantage would accrue by going deeply into the matter as the choice of suitable chokes is limited to two or three models at the most.

The requirements for the input choke are that its inductance should be high with only the critical value of current flowing, and moderately low with the full load current. An ungapped choke satisfies these requirements, and "swinging" chokes, as this type is called, are marked with two inductance values, such as "10/30 henrys, 150 mA," for example, or does not exceed 5 per cent. of the HT voltage it is usually satisfactory for the power amplifier of a CW telegraph transmitter. For the oscillator, frequency doublers and pre-amplifiers 1 per cent. of ripple is tolerable, while for telephony transmitters the ripple must be reduced to at least 0.25 per cent.

A single-stage filter as shown in Fig. 15(a) will give a supply with a 5 per cent. ripple with an effective inductance of 10 henrys and a 2 mf'd. condenser, but for 1 per cent. ripple or better a two-stage filter as Fig. 15(b) will be needed. For example, a two-stage filter with L1, 10/30 henrys; C1, 2 mfds.; L2, 25 henrys (constant inductance choke) and C2, 4 mfds. will have a ripple content below 0.2 per cent., and as this will satisfy all requirements it might be a good plan to build our supply unit on these lines.

The RMS voltage is usually satisfactory for the power amplifier of a CW telegraph transmitter. For the oscillator, frequency doublers and pre-amplifiers 1 per cent. of ripple is tolerable, while for telephony transmitters the ripple must be reduced to no more than 0.25 per cent.

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The Amateur Transmitting Station—

The Amateur Transmitting Station—sers are concerned, we want one of 2 and one of 4 mfd., but as the output DC voltage is not likely to exceed 650 at the most with a bleeder resistance in circuit, condensers of 750 volts DC working would suffice. A 7,000-volt working type would give a better margin of safety and the oil-impregnated type are now obtainable at quite reasonable prices.

In addition to the high-voltage secondary we shall require some low tension windings for the filament supply of the valves. In a receiver power pack all the windings would be accommodated on a single transformer, but it is often more convenient in a transmitter supply unit to use a separate filament transformer. The LT winding for the HL rectifier can be on the transformer which supplies the HT, making this a self-contained unit, so that the HL can be switched off by fitting a switch in the primary circuit, but leaving the valves in the transmitter alight and ready for immediate operation after a period of listening.

The Tungsram RV 200/600 rectifier has a 4-volt filament and consumes 2.8 amps, and as it is a directly heated type there is no delay after switching on, so HT is available immediately.

The filament transformer has to supply the oscillator stage, which in our case has a 4-volt indirectly heated valve, the Tungsram APP4g, taking 2 amps, while the power amplifier if a TZ05 20, needs 6 volts at 1.1 amp. If a TZ08/20 is chosen, then 7.5 volts at 1.1 amp must be provided. Both these valves are of the directly heated kind.

Now, it is quite permissible to use a common filament supply for both kinds of valves, while the difference in voltage can easily be overcome by tapping the wind-

windings. However, if we are going to have tapped windings, the best policy is to arrange for alternative filament voltages, so that different valves can be tried in the various stages.

The suggestion put forward here is that one of the windings should give the choice of 4 or 6.3 volts, while another be included to give 6 or 7.5 volts. This combination will meet not only our immediate requirements, but it caters also for future needs, at least so far as we can legislate for at this juncture.

The high-voltage secondary windings are anchored to the terminal saddle seen in the top left-hand corner in this underside view of the chassis.

The complete circuit of the power supply unit thus works out as shown in Fig. 16. Resistances R2 and R3 not only serve as a bleeder resistance, but they also form a potential divider for obtaining the 250 volts required by the exciter unit. If R2 is made 15,000 ohms, which is a convenient value, it will pass 16.6 mA at 250 volts. R1, which is required to drop 100 volts, has to carry this current in addition to the 30 mA that will be taken from the 250-volt tapping. Its resistance is therefore 2,150 ohms; the nearest standard value being 2,000 ohms we will use it.

There is some advantage in fitting resistances that permit of easy adjustment, such as the wire-wound variety made by Bulgin and by Dubilier. Intermediate voltages can then be obtained by fitting an extra tapping band on one or both resistances. So far as rating is concerned, the 20-watt is quite large enough, and, indeed, provides a very big margin of safety.

The curve in Fig. 17 shows the mean.

<table>
<thead>
<tr>
<th>D.C. OUTPUT VOLTAGE (IN 100'S OF VOLTS)</th>
<th>LOAD CURRENT (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>400</td>
<td>12</td>
</tr>
<tr>
<td>300</td>
<td>11.17</td>
</tr>
<tr>
<td>200</td>
<td>10.78</td>
</tr>
<tr>
<td>100</td>
<td>10.39</td>
</tr>
<tr>
<td>0</td>
<td>10.00</td>
</tr>
</tbody>
</table>

**List of Parts**

1. Mains Transformer, (T1) 625-0-625 volts 100 ma, tapped 450-0-450 volts 4 volts 2.8 amps, CT Premier
2. Filament Transformer (T2) 7.5 volts 1.1 amp, tapped 6 volts 4 volts 2.8 amps, tapped 4 volts (CT) Premier
3. Swinging Choke, 10/30 H., 150 ma (C1) Premier, Type "A"
4. Tungsrnam APP4g, taking 2 amps, while another be included to give 6 or 7.5 volts. This combination will meet not only our immediate requirements, but it caters also for future needs, at least so far as we can legislate for at this juncture.

**"Bleeder" Resistance Value**

The Tungsram OS-12/500 rectifier is essentially a pentode RF power amplifier designed for SW operation. Fitted with a 7-pin base and a top anode connection, it has a heater rated at 0.7 amp, at 12.6 volts. The maximum anode current is 40 mA, at 500 volts and the screen supply should be 200 volts. The maximum rated anode and screen dissipations are 12 watts and 8 watts respectively.

<table>
<thead>
<tr>
<th>Load Current (mA)</th>
<th>Output Voltage (in 100's of Volts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>400</td>
</tr>
<tr>
<td>11.17</td>
<td>300</td>
</tr>
<tr>
<td>10.78</td>
<td>200</td>
</tr>
<tr>
<td>10.39</td>
<td>100</td>
</tr>
<tr>
<td>10.00</td>
<td>0</td>
</tr>
</tbody>
</table>

**Fig. 17. Output voltage curve for the unit described.**
I DON'T know whether it is a sign that I am getting old or that my liver needs decarbonising, but I must confess to a growing feeling of irritation at the way in which the myrmidons of the B.B.C. constantly use the phrase "SOS messages," although I would hasten to add that in this case I do not blame the B.B.C. as, after all, they probably know no better and are merely following popular superstition in this respect.

The letters SOS in morse are not, of course, and never were, the international distress call used by ships. It would be just as true to label the distress call as VTB, VMS, EITGI or a host of other letter variations which the highly imaginative can evolve from the combination of morse symbols of which the international distress signal consists. Actually it represents no letters of the alphabet whatever and was never intended to. Consisting, as it does, of six morse characters, it could never represent even one letter because four symbols are the maximum, used to form any letter of, at any rate, the English alphabet, although for aught I know there may be a dozen to represent letters in some alien tongues.

I think that the letters SOS were first evolved from the signal by some highly imaginative novelist who wanted to work in the rather dramatic phrase "Save our souls." Prior to the adoption of the present distress signal, a combination of three letters actually was used, namely, CQD, this being made up of CQ, the general call for all stations, and the prefix D, used to denote an urgent "priority" message, and having nothing to do with the phrase "come quick, danger," which was, I believe, also evolved by the fertile imagination of a novelist—probably the same one.

Death-ray Wavelength Wanted

MANY of you will no doubt recollect the spate of death-ray inventions which made their appearance in the years immediately following the war. In his reminiscences published some time ago the erstwhile Air Ministry wireless chief told us, among many other things, that one inventor who gave a demonstration at the Air Ministry proved his ability to stop a petrol engine at the other end of the room by directing wireless waves at it, a feat with which the Air Ministry people had long been familiar. The irritating point about these reminiscences is that the wavelength and other vital technical data are not given, and not even The Wireless World Information Department with which I have been in communication seems willing to divulge them. This latter point is particularly aggravating at the present moment, for I have been pestered during the past week or so by interference with my television reception, which I have definitely traced to a dilapidated car which seems perpetually parked outside my house, its owner being a fatuous young man who has recently been ensnared by my daughter Faradia. In reply to my expostulations he has explained that he is compelled to keep the engine running, as it is sometimes necessary to make a very quick getaway when Mrs. Free Grid comes into the room. All I can say is that although in my young days we had no cars, I think that if we had had them we should have shown more consideration for others, and in any case we had more respect for parental authority; in fact, I can only recollect one unfortunate occasion when I came up against Mrs. Free Grid's mother. It so happened that I was accustomed to hitch my horse to the gatepost when I called, and one evening the future Mrs. Free Grid

played one of Chopin's Nocturnes to me in such a realistic and touching manner that I fell asleep, and when I finally woke I found that my horse, en-ergued by the long delay, had eaten the best part of a young sapling which had been planted by the front gate by Mrs. Free Grid's mother. However, I digress.

I have only got to watch a university-trained French scholar trying to buy himself a meal in a French restaurant in order to realise its futility. It is quite easy to do this in Paris and other places in France where foreigners forget that since the waiters always understand English and also anglicised French, but it is far different in certain country districts. I well recollect some years ago, when on a walking tour in a remote part of France, coming across a haggard-looking individual with a haunted look in his eyes, who turned out to be a man whose name was world-famous as a French scholar. He had bought a railway ticket for this place about a year before I encountered him, and having arrived there he found himself in a pitiable plight. Although he had sufficient money to pay his fare, he found that he was quite unable to make the booking clerk at the station understand his French. The result was that he was absolutely marooned in the village, and I do not know what would have happened had I not come along.

He had been able to get enough to eat by entering the village inn and rubbing his stomach, and he had, so the inn proprietor told me, acquired a reputation for being an unfortunate half-wit, as all they could understand from his speech was that he had a passionate and insane desire to know the whereabouts of the pen of his aunt, which apparently the gardener's boy had stolen. He wept tears of joy when I was able, with a few rough and uncouth phrases of French patois, to purchase a railway ticket for him and see him safely in the Paris train.
A CERTAIN trade list of receivers now on the British market describes 665 models. Of these, 231 are found to be fitted with push-button tuning. Strictly speaking, I should say "automatic station selection," because I have included a few systems where switches or "telephone" dials are used instead of buttons. However, for the purpose in hand let's call them all buttons.

The previous season, push-button tuning was practically non-existent. So 231 out of 665 is a startling jump. Especially when the 665 include a number of "carry-overs" from last season. Out of the 46 manufacturers listed, 40 offer push-buttons; the remaining 6 are all comparatively small firms dealing in more or less specialised types of set. Next season . . . ? I can only judge from what I know, which is that a firm listing 3 of its 20 models with push-buttons this season has planned to appear with 10.

Is this " landslide " due to push-button tuning being invented just before the present season or to a sudden demand for it on behalf of the public, or both? As regards the date of invention: leaving out the inevitable Chinese and Egyptian claims to priority, and also some more recent ones, it can definitely be said that it was on the market at least as early as 1928, when the Zenith receivers sold in large numbers in America, and a year or two later appeared on this side under the name Zetavox. I brought one of the largest Zeniths home, where it was promptly christened "the speakeasy" on account of the rather furtive way in which the station selectors were concealed by a flap in the florid cabinetwork then in vogue in the U.S.A. They were more like typewriter keys than the modern press-buttons, and worked on what would now be described as the mechanical system. The inertia of the massive quintuple gang condenser was enormous, and a signalman's heave at the selector lever was required to move it, after which it went home with a resounding clang.

Although falling short of present-day standards in this respect, the Zenith was definitely in advance of many models now on the market as regards the ease with which the keys could be adjusted to select any station in the waveband. In the majority of models now available there is a restricted choice of stations that can be selected by any one button, and for changing the station there is hardly one that I could confidently entrust to most of the people I know.

Before going on discussing the merits and demerits of modern designs, just let me finish answering the question as to the cause of this sudden appearance of push-button tuning everywhere. Evidently it does not coincide with the date of invention. And as for public demand, those non-technical people I have heard expressing opinions seem to regard push-buttons as so many more things to go wrong, and apparently think designers are rather queer creatures for taking such a lot of trouble to "do it that way." Anyhow, neither recent invention nor public demand accounts for the meteoric rise of push-buttons. No doubt the driving motive was the usual commercial one of looking around for something to sell that makes all previous models look old-fashioned. That is not to say that there is no merit at all in the idea; personally I think it suits the needs of most people much better than turning a knob round and round, and I don't mind admitting that it suits me.

Presumably, the reason why it didn't "take on" years ago is that it is only within the last year or two that the type of set in common use has lent itself to a satisfactory and cheap push-button control. It was obviously asking for trouble to attempt it as long as receivers required a number of critical adjustments, such as reaction, to bring in a station. Thus absence of AVC was a very noticeable drawback in the old Zenith. All this pointed to the superhet. But it is only quite recently that the usual type of superhet has had as few as two circuits to be tuned for each station, and anything more than two makes the pre-set type of control rather clumsy.

Why the motor-tuned type of station selector had to wait till now I have no idea, unless it had to be caught by infection from other sorts. It does not depend on the number of variable tuned circuits, and was accomplished somewhere about the same time as the Zenith, but never came to much.

I have mentioned two types of push-button system—pre-set (in which separate tuned circuits are brought into use by each button) and motor-operated. The third, in the usual classification, is mechanical, and has this much in common with the motor type that it makes use of the same variable condenser that serves for manual tuning. The pre-set type is divisible into three main sub-types, depending on whether the tuning is effected by capacity variation, inductance variation, or a mixture of both. In practice, inductance variation is usually done by moving a chunk of iron core inside the coil, and is called permeability tuning. In the mixed systems it is, I think, always the oscillator circuit that is permeability tuned, because that is by far the most critical, and permeability-tuned circuits are more likely to "stay put" than capacity-trimmed. A special development of the full-permeability system is the one in which the cores for the oscillator and preselector circuits are ganged, with the object of bringing the pre-setting adjustment within the ability of reasonably intelligent non-technical persons.

A SURVEY OF PRESENT-DAY TENDENCIES

By "CATHODE RAY"

Most Popular Methods

Dividing the 231 push-button models I mentioned at the start into these classes they work out so . . .

- Mechanical ................................ 66
- Capacity pre-set ............................ 64
- Motor-driven ................................ 38
- Permeability pre-set ....................... 23
- Mixed, pre-set .............................. 15
- Unspecified ................................. 25

Taking a chance as a prophet, I should
Push-Buttons—say that next season the motor and permeability (including mixed) types will gain ground at the expense of mechanical and capacity. Perhaps the wish is father to the thought. As the cheapest that can be done is mechanical, it may be that in a misguided effort to have all their models "up to date," manufacturers will bring out a lot of new mechanical models and oft get the increase that is fairly certain to take place in the motor and permeability classes.

Disregarding cost, I place them in this order of merit—motor, permeability, capacity, mechanical. To interpret angry returns, I emphasise that this is my personal opinion and only then in a general sort of way; naturally, a capacity-tuned pre-set system of particularly good design might be a lot better than a misbegotten permeability system. And a bad motor-driven system might perhaps be the worst of all. It is bound to be fairly expensive, because it must either be made phonographically accurate or have a couple of extra valves for automatic frequency correction. And if it includes automatic waveband switching it is horribly complicated for servicing. But pending possible improvements in other types it is the best for station-changing and—an important point, in my view—it gives a boost to remote servicing. Moreover, it employs the normal tuning means, instead of necessitating the addition of multiple tuned circuits, and does not restrict design to the simplest and worst type of superhet.

Mechanical systems appeal on the ground of cheapness, but when it is realised that the accuracy of location of the tuning condenser setting on the medium-wave band must be within about 2 parts in 1,000 to be satisfactory, and must stay there after the family has been playing with it for about a year, the thrill appeal is seen to enclose a possible snare. And it is not at all simple to devise a system in which the "feel" of the button permits the user to all stations, and which allows for easy station-changing and adjustment.

Abolish Wave-range Switching

Pre-set systems give the station at once, instead of a period of whirring wheels and things (which may or may not add to the pleasure of the process). There is generally more or less severe restriction on the stations that can be selected by any one button; station-changing is beyond the average person, and the chances of the tuning staying so accurate that no drift can be detected during, say, a year are not very large. In any case, it is generally true that the selectivity of the system is quite enough for all stations, and which allows for easy station-changing and adjustment.

Object of making things simple for poor Mr. and Mrs. Listener if they have to think to a phone call or postcard would, however, always save any distant visitor a wasted visit in this unlikely event.

There is, of course, little justification for a prospective client to wax critical on the London Regional, and we ourselves always offer to put any receiver "through its paces." It will be appreciated, however, that good short-wave reception cannot be obtained to order, and day-time reception in an interference-troubled district cannot be as good as in the client's home. That is why we find our special listening system very popular.

A. C. S. RADIO London, W.C. 1

H. MILES (G2NK)

Harmonic Interference on USW

ALTHOUGH it is admitted that motor car ignition systems cause serious interference with television and ultra-short-wave reception, we must not overlook other offenders; in particular, we should make sure that our wireless house is in order before asking outsiders to suppress interference voluntarily.

Take harmonics, for instance. In routine testing of television receivers in the Midlands, Mr. C. Gordon has lately cut the picture if the set is correctly tuned to receive the sound and vision channels from A.P. To get good picture reception one must put up with a sound accompaniment from Daventry. Amateur transmitters, with a radiation of harmonics approaching the infinite, are even more to blame.

Occasional interference from a passing car is nothing compared with the continuous interference from harmonics produced by the transmissions of the very people commonly regarded as above suspicion. Coventry.

"TESTER."-[Presumably this refers to interference from the Empire stations; the third harmonics of GSP, GSI, GSO and GSF may be responsible.—Ed.]

HENRY FARRAD'S SOLUTION

(See page 132)

If the whistle is heard only when the neighbours are in, it seems likely that their set is causing the interference. As they listen to the Newsreel (Dreiwich), with a frequency of 200 kc/s, the oscillator of their recent all-wave model, assuming the highly probable intermediate frequency of about 45 kc/s, would be tuned to 200+45, or 665 kc/s. Any frequency of about this figure would be capable of producing an audible beat-note with North Regional (665 kc/s), which is the nearest Regional station to Hull. On the other hand, Hull is sufficiently far away for reception of North Regional to be only moderately strong and therefore liable to interference by quite a weak signal. One might reasonably judge from his letter that Mr. Ironbotham and his neighbour are quite likely to be living in one of those rows of small houses where adjacent aerials are almost touching, and a very small amount of radiation from the neighbour's receiver would be enough to cause trouble. Needless to say, Mr. Ironbotham has no cause to suspect his own set's age of being responsible, nor can he conscientiously be advised to follow his neighbour's course and thereby add to the number of the potential disturbers of the ether.
NEWS OF THE WEEK

ARE EMPIRE TRANSMISSIONS JAMMED?

Difficulties of Verification

UNSATISFACTORY rumours are continually filtering into Broadcasting House that the Daventry news bulletins are being deliberately jammed in different parts of the world.

Reports to this effect come from places as far apart as Natal and the Fiji Islands. In South Africa, apparently, no doubt exists that the news bulletins have been the subject of these unwelcome attentions, for the trouble is said to cease when the news finishes.

According to reports from Fiji, Daventry is jammed on all wavelengths, especially at night. Says a writer in the Fiji Times: 'There is no doubt that the interference with Daventry is deliberate. The interference takes the form of continuous bubbling signals not connected with beam radio or commercial stations. At the same time, Russia and Germany, Holland and France are heard clearly and with maximum volume. Reports of this kind must, however, always be expected when political situations are obscure and listeners suspicious of interruptions.'

POLICE RADIO

Mobile Transmitters and a Pocket Receiver

The issuing of the annual reports of the police forces of Great Britain shows the increasing use made of wireless in the detection of crime. The West Riding Police have just acquired a mobile transmitter which is sufficiently powerful to adequately cover the whole of the West Riding Police area. The Force is also being equipped with a further fifteen wireless patrol cars, bringing the total to ninety. These cars are fitted with compact ultra-short-wave receivers and a loud speaker.

A Lilliputian receiver measuring 4 1/2 inches, including batteries, may soon be used by the Doncaster police. This pocket receiver has been designed by a member of the Force.

The Oldham Police Force is now equipped with two patrol cars which are fitted with transmitters and receivers. Each of the fifteen drivers and operators have passed post-office tests in Morse. The police regional transmitting station, which is at Heaton Park, Lancashire, serves an area with a radius of some thirty miles. All communications are in Morse, and these are prefixed by the number of the car for which the message is intended.

A CENTRAL CONTROL ROOM at Alexandra Palace overlooks both studios and enables producers to utilise both for a single transmission or to conduct rehearsals in one while a broadcast is taking place from the other. Outside broadcasts also pass through the room, and the Farm transmission, pictured on this page, was co-ordinated on the sound and vision mixing desks shown here.

TELEVISION IS HERE—you can't shut your eyes to it. Now the farm is invaded. Last week, the television O.B. unit visited Bull's Cross Farm, Waltham Cross, Hertfordshire, where Mr. A. G. Street and the farmer piloted the Emitron cameras through the farmyard, fields and cowsheds. Contact with the Alexandra Palace transmitter was established by radio link and the quality of the finished transmission was unsurpassed.

EMPIRE BROADCASTING

A Review of Progress

THE development of the B.B.C. short-wave broadcasting service since the experimental transmissions from G.S.W. at Chelmsford, which led to the inauguration of the Daventry Empire Service, was surveyed by Messrs. L. W. Hayes and B. N. MacLarty of the B.B.C., in their joint paper on the Empire Service Broadcasting Station, read before the I.E.E. on February 2nd.

It is impossible in the available space to deal adequately with the historic side of the development (much of which is already known by Wireless Listening readers) as portrayed by the authors, but the following observations of signal strengths made abroad will be of interest.

Signal-to-noise ratios measured by a private listener in Salisbury, Southern Rhodesia, during the period from April to August, last year, show that the lowest weekly average for the 50-kW transmissions from G.S.W. on 21.47 Mc/s was 38 db., from G.S.G. on 17.79 Mc/s 40 db., and from G.S.D. on 11.75 Mc/s 35 db. The highest average for these transmissions was 53, 53 and 47 db., respectively.

The suitability of the Empire transmissions for rebroadcasting is exemplified by the results obtained at the Australian Post Office receiving station at Mont Park, Melbourne, of G.S.D. (50 kW) on 11.75 Mc/s. These show that during April last year, for only 2.9 per cent. of the total time observed was the signal poor, 5.8 per cent. satisfactory, and the remainder good or excellent. During July no observed signal came under the category of poor.

SAFER FLYING

Two New Radio Beacons

At the exhibition, which was held in association with the Conference of the Aerodrome Owners' Association, in the Central Hall, Westminster, from February lst to 3rd, several blind-landing systems were shown. Marconi's display included their new wireless beacon to be known as the Marconitrack. By using a series-phase aerial not only has the lateral radiation been greatly reduced, but the majority of the radiation is concentrated along the main approach line, with very little along the reciprocal bearing. The receiver has been designed to simplify the pilot's task of pre-setting the set's tuning.

An omni-directional 155-watt
News of the Week —
radio beacon, with a frequency range of 330-240 kc/s, was shown by Standard Telephones and Cables. A feature of this apparatus is the easily recognisable coded signals which are sent out at predetermined intervals. This equipment may be operated as a beacon or straight-forward telephone/telegraph transmitter. The apparatus in-cludes a fault indicator which indicates the section in which the fault occurs.

Features of the Standard-Adcock direction-finder, which was also on show, are freedom from “night effect” and “aero-plane error,” and the fact that the separation of the aerial system and the receiving apparatus may be as great as 3,250 feet.

WORRIED WELSH LISTENERS
IN the corner of Wales bounded by Aberystwyth in the south and Pwllheli in the north, reception is notoriously bad.

Conditions are such that the Welsh schools broadcasts in the mornings have to be relayed by Washford and Penmon. This may be a sop to the Welsh, but it displeases Mancunians, who object to the inclusion of the Welsh language in their programme.

With the opening of the Start Point transmitter, Washford will be able to concentrate on its Welsh language in their programme.

TELEVISION PROGRAMMES

An hour’s special film transmission intended for demonstration purposes will be given from 11 a.m. till 12 noon each week-day. The National or Regional programme will be radiated on 41.5 Mc/s from approximately 7.45 to 9 p.m. every day.

THURSDAY, FEBRUARY 9th.

FRIDAY, FEBRUARY 10th.
3. Vanity Fair — Spring fashions described by Betty Cameron-Smaile. 3.10, Cartoon Film. 3.20, “A Tune for Today,” a revue. 3.50, Gaumont-British News.
9. Vanity Fair (as at 3 p.m.). 9.15, “1000 — and All That,” a historical success by Reginald Arkell based on that Memorable History by Sellars and Yeatman. 10.15, News.

SATURDAY, FEBRUARY 11th.

Radio Nations Transmissions
In order to allow the Radio Nations Transmissions station at Prangins to serve as a link between America and Eastern European capitals, the English transmissions, as has happened on two occasions recently, it has been decided to start the English programme at 7.30 p.m. G.M.T. (8.30 C.E.T.) instead of 6.45 p.m. as heretofore. The English programme will be transmitted on two wavelengths: HBO, 26.31 metres (17.92 Mc/s) and HIBQ, 44.91 metres (6.675 Mc/s).
Sounds—Pleasant and Unpleasant

By N. Partridge, B.Sc., A.M.I.E.E.

Although the subject of this article may seem to be outside the normal field of this journal, a knowledge of the matter discussed is of value to all concerned with sound reproduction.

The niceties that elevate a musical masterpiece above the level of hot swing may be a little obscure; nevertheless, we radio engineers rather pride ourselves upon our ability to distinguish music from noise. We know a roll on the drum from a solo on the dustbin lid. We can spot the difference between well-chosen chords struck on the piano and those indiscriminate fistfuls of notes so readily provoked from the very young. At least we could do so before the coming of "modern" music.

This natural division of sound into music and noise, concord and discord, is universally accepted but rarely explained. The sets we design, build, repair or experiment with are intended to reproduce music as opposed to noise. In view of this perhaps a few moments given to the contemplation of sounds, nice and nasty, might make an instructive break from our usual electrical worries.

The simplest continuous sound has a sine curve wave form as seen in Fig. 1. It is the tone emitted by tuning forks and also by a loud speaker connected to an audio-frequency oscillator. By the turn of a knob a beat oscillator will glide over the whole audible range of such tones. There is certainly nothing discordant about this performance, but the sound is uninteresting, boring and decidedly without emotional appeal.

Apparently more than one pure tone is required in order to produce something audibly objectionable or pleasing. Our next imaginary experiment will therefore require two oscillators with associated amplifiers and speakers. Let them be accurately tuned to, say, C = 261 c/s (middle C), and then, leaving one at this setting, gradually raise the pitch of the other until it reaches the octave C' = 522 c/s.

When the oscillators are exactly in tune, the combined tone is little different from that of either of them separately. As they become a little off the two separate notes, but the sound begins to pulsate or beat. Fig. 1 shows how this comes about. When the two sound waves are in phase another, but as they approach phase opposition they cancel. Clearly a beat will be heard every time the lower oscillator slips a cycle behind that of higher pitch. Hence a difference of 5 c/s in the tuning of the oscillators will produce five beats per second.

The slow beats are rather fascinating, but as they get faster the effect is quite the reverse. The rapid throbbing becomes intolerable. Fortunately, the condition soon passes, and, by the time the variable oscillator reaches about 320 c/s, the beats are too fast to be followed by the ear, and the two separate notes become distinguishable. Just how pleasing these notes sound together is difficult to say, but, beyond all argument, they are preferable to the quick pulses. This state of debatable pleasure continues until the octave is reached. At this juncture a marked change occurs. The notes merge together, and the combined tone is cleaner and brighter than either sounded separately.

Fig. 2 is an attempt to plot the relative "nastiness" of the combined sound against the pitch of the variable oscillator. Only a small portion of the curve can be drawn if general approval is to be won. Any attempt to indicate relative "niceness" of the more pleasing combinations would trespass upon the field of art, and it behoves one to be discreet.

The only region of discord shown on the curve of Fig. 2 is where the two notes are near together. This is rather odd, because anybody owning a keyboard instrument, be it a grand or a piano accordion, knows that middle C' (261 c/s) sounded together with the B' (493 c/s) above it (see Fig. 2) produces a howling discord. Why have we missed it?

Waveforms

The difference between the tone of our oscillators and that of musical instruments suggests itself as a possible explanation. The gliding tone experiment cannot be repeated using two pianos because the keyboard limits the frequencies obtainable to twelve definite

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Fig. 1.—Production of a beat note between two oscillations of different frequency.

Fig. 2.—"Annoyance value" of a beat note.

Fig. 3.—The use of two violins (instead of two oscillators) for the production of beat notes.
change being that the two sine wave oscillators were replaced by two violins. The story is quite a different one. The missing discord of the seventh (C' and B") has made its appearance together with two other regions of lesser annoyance. It is very evident that tone quality has a bearing upon the matter apart from pitch, so that a brief study of waveforms becomes unavoidable.

Figs. 4 and 5 show the type of waveforms obtainable from various instruments. These curves must not be taken too literally, because both instruments and players differ in the tones they produce. 

Leon Goossens playing

The oboe sounds very different from the flute, and hence many waveforms must be possible from one instrument. Fig. 5 shows the waveforms of three different clarinets, each playing C' = 261 c/s.

It is well known that however complicated a wave may appear, it can always be shown to be made up of a number of simple sine waves superimposed upon each other. In the case of musical instruments the frequencies of the component waves are simple multiples of the lowest or fundamental note and are referred to as harmonics. The first harmonic is the fundamental itself, that of double frequency is the second harmonic, and so on.

TABLE I. Appropriate Analysis of the Tones of Typical Instruments.

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Frequency of Fundamental</th>
<th>Relative Amplitudes (%) of Harmonics.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piano</td>
<td>C = 130.5</td>
<td>1st. 2nd. 3rd. 4th. 5th. 6th. 7th. 8th. 9th. and many higher.</td>
</tr>
<tr>
<td>Piano</td>
<td>C' = 262</td>
<td>100 65 20 10 5 15 40 50 15 and many higher.</td>
</tr>
<tr>
<td>Violin (Fig. 4)</td>
<td>G' = 291</td>
<td>100 65 20 10 5 15 30 40 50 15 and many higher.</td>
</tr>
<tr>
<td>Clarinet (No. 3 Fig. 5)</td>
<td>C' = 261</td>
<td>100 65 20 10 5 15 30 40 50 15 and many higher.</td>
</tr>
</tbody>
</table>

The interval of the fifth which is produced by sounding C' and G' together (see Figs. 2 and 3) has always been recognised from earliest times as particularly concordant. It will be noted that in Fig. 3 there is a region of discord on either side of G' (301 c/s) with a gap between in which lies this especially favoured combination.

In Fig. 6 the spectrum of two violins playing C' and G' has been shown in rather a different way. The frequencies of the two fundamentals and of their harmonics are shown along the bottom, and the relative strengths or amplitudes of these are indicated by the height of the lines representing them. The third and sixth harmonics of the lower pitched instrument coincide with the second and fourth harmonics of the higher one. In addition to this the remaining harmonics fall well apart and are unable to produce beats. If the pitch of the instrument playing G' were slightly raised or lowered, the harmonics now coincident would beat against each other. This explains Fig. 3 completely.

This theory of beats being the cause of discord is the basis of Helmholtz's Theory of Harmony. Its interest to the radio engineer lies in the fact that unpleasant sounds are not caused by harmonics as such, but by congestion of the upper frequencies causing beats between harmonics.

A pure sine wave note suffers no unpleasant change from a few per cent. harmonic distortion. The fact is that 50 or 100 per cent. addition of all audible harmonics will probably result in a much more musical sound. Any number of tone qualities can be coaxed from the organ in the name of middle C. This is all done by the drastic harmonic distortion, often beyond recognition, of the tone emitted by a tuning fork C' = 261 c/s!!

A complex sound consisting of several notes played simultaneously, together with the harmonics of each, is a different proposition. Harmonic distortion will produce numbers of new frequencies, including harmonics of the original harmonics. If some of the resulting frequencies fall near together, as they surely will, there discord, unpleasantness, or what the man in the street calls distortion, will be heard.

The most objectionable number of beats
Random Radiations
By "DIALLIST"

Some Hints, Some Don't

TRYING out considerable numbers of
receiving sets, as I do, season by season, it's interesting to note how much
they vary in the amount of hum produced. My mains supply is standard 50-cycle
time-controlled AC, so that any well-designed set should be able to give a good account
of itself in the matter of freedom from hum. Most of those of good quality are pretty
well free from this unpleasant kind of noise, but I do come across examples,
amongst models that are by no means in the cheap class, of pronounced and most
annoying humming. It's a matter which should receive the very careful attention of
manufacturers, for nothing is more annoying than a receiver which never stops
making that monotonous purring noise. As often as not the nuisance seems to be due
to lack of proper screening for certain of the valves. That, surely, is a matter which
could and should be set right without much trouble or expense.

Another Mains-battery Receiver

A N officer of the Royal Corps of Signals
who is stationed in the North very kindly sends me the circuit diagram of an
ingenious receiving set, designed for operating either of two different receivers, which
works equally well from any 30-cycle AC supply with a voltage between 110 and 250,
or a 12-volt motor car accumulator. As he marks his diagram "Copyright by Reuter,
Press Association and Central News," I'm afraid that I can't reproduce it! What he has
done is roughly this. The mains transformer is tapped at 110, 220, 230, 240 and 250 volts. It is connected
through a switch to the mains plug, with a simple arrangement for selecting the particular
transmitter. Built into this set is a 12-volt vibrator converter with an output voltage of 140. This is connected
through a switch to the 110-volt and 250-volt tappings. The smoothing arrangements
are conventional but thorough, and my correspondent tells me that his apparatus works so well that on any wavelength
(one of his sets is a communication receiver) you can switch over from mains to battery,
or from battery to mains without noticing the slightest difference in performance. He is,
I understand, considering the possibility

News from the Clubs

Croydon Radio Society
Headquarters: St. Peter's Hall, Lobury Road, South Croydon.
Meetings: Tuesdays at 8 p.m.
Hon. Sec.: Mr. E. A. Cumbers, 14, Canpell Road, South Croydon.

At the meeting this evening (February 14th) Mr. A. W. Graham will discuss "Push-Pull Balancing Problems."

Cardiff and District Short-wave Club
Headquarters: The Rooms, Crown Court, Duke Street, Cardiff.
Meetings: Thursdays at 8 p.m.
Hon. Sec.: Mr. H. H. Phillips, 322, Clare Road, Cardiff.

A practical demonstration of power amplifiers will be given on "The Theory and Design of Power
Amplifiers" and at the following meeting Mr. H. H. Phillips will talk on the subject of "Research Problems in the R.S.G.B."

Mersey-side Transmitting Society
Headquarters: 368, Stanley Road, Bootle, Liverpool, 9.
Meetings: Tuesday evening.
Hon. Sec: Mr. C. E. Cumliffe, 368, Stanley Road, Bootle, Liverpool, 9.

A discussion night will be held on February 14th, and at the following meeting on February 21st, a talk will be given on "The Theory and Design of Power Amplifiers and Coupling Circuits." A practical demonstration of power amplifiers will be given on February 28th.

Maidstone Amateur Radio Society
Headquarters: 254, Penistone Road, Maidstone.
Meetings: Tuesdays at 7.45 p.m.
Hon. Sec.: Mr. F. M. H. Hodgson, 6, Hayle Road, Maidstone.

A lecture on "5-Megacycle Operation" will be given at the next meeting on February 14th. On February 21st there will be a report on "Cathode Ray Tubes."
Electron Multipliers

The electron multiplier is most efficient when amplifying small currents; as these are produced by a photo-electric cathode. If one starts with the heavier emission given by a thermionic cathode, it becomes difficult to modulate the electron stream to any great depth, so that the output contains an unduly large direct-current component.

The object of the invention is to overcome this difficulty by applying the principle of push-pull amplification to the multiplier. As shown in the drawing, the indirectly heated cathode is made up in two sections, $F$, $F'_1$, the cooperating grids $G$, $G_1$ being fed in push-pull with signal voltage from an input coil $L$. As the grid voltages vary, the electron stream passes first through an aperture $A_1$ (shaped separately in diagram (b), and then through an aperture $A_2$ in the common anode $A$. Magnets $M$, $M_1$ apply fields in opposite directions to the electrons, so that as the latter pass in separate streams through the tube, they strike against the upper and lower faces respectively of the common "target" electrodes $T$, $T_1$, etc., as shown in dotted lines. The amplified currents are finally collected by two separate electrodes, $O$, $O_1$.

STRAVING ELECTRONS

In an electron multiplier, it is found that the noise-to-signal ratio is usually higher than that to be expected from the theory of the so-called "shot" effect, particularly when the multiplier is amplifying the current produced by a relatively weak ray of light. It is thought that the trouble is due to stray electrons, which are deflected from the main discharge path and build up harmful charges on the insulating supports and other parts of the electrode system.

According to the invention this is prevented by the provision of two "strip" electrodes, which are located on both sides of the main accelerating and target electrodes and are so biased that they serve to repel any swerving electrons and restore them to their proper path. The two auxiliary strips may be replaced by a single cylindrical "guard," which is biased to a voltage equal to, or less than, that of the photo-sensitive cathode.

Piezo-electric Oscillators

A quartz crystal is mounted inside an evacuated glass bulb, the electrodes being brought out by a lamp $L$ to illuminate one cell and a small mirror $M$, is set between the frames of the electron microscope. The small mirror $M$, is set between the frames of the electron microscope. The beam is deflected by a magnetic field, and the resulting image is seen through a microscope. The best method of amplifying the image is with a cathode-ray oscilloscope, and the most suitable are those provided with a large sensitive cathode. The result is to use three or more vertical frame aerials which are rotated simultaneously about a common centre. In such an arrangement any horizontally polarised waves are balanced out, when the frames are set parallel, with the direction of the incoming signal.

Radio-controlled steering system for boats, aircraft, etc.

Radio-controlled steering system for boats, aircraft, etc.

Viewing Screens

Owing to the curvature of the bulb end of a cathode-ray tube, the picture details which fall on the outer edges of the fluorescent screen may be considerably distorted. The effect is most noticeable at the four corners of the "mask" within which the picture is usually centred.

In order to minimise this defect, a small strip of ground glass is placed at each corner of the mask, where it cuts off a part of the angle, and so prevents the worst of the distortion from being seen. This necessarily diminishes the total field of view to some extent, but since the screening strips are made of translucent or ground glass, diffused light from the screened corners of the fluorescent screen is allowed to pass through. The general illumination of the received picture is therefore, not noticeably diminished.

Recent Inventions

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

The Wireless World, February 9th, 1939

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

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NEW RECEIVERS AND AMPLIFIERS

Baker's New Quality Receiver and Cornet Horn.-Details from Baker's Salisbury Radio, South Croydon. (1939)

EIGHT BAND CHASSIS.-Outstanding Mark, from the press-button model at £17 12/6 to the latest variable selectivity model at £21 17/6.

ARMSTRONG Announcement Model A46/FV Amplifier.—This new unit is a 6-watt push-pull amplifier having in addition to the normal flat frequency response, both a high- and low-frequency treble _and bass_, the high-frequency upper limit is 25,000 c.p.s. at 0.5% distortion. (1939)

ADVENT Details of the New Amplifier, together with particulars of our standard 6-watt amplifier model A40/F at 9 ps., the 12-watt amplifier model 127/FX at 12 gs., and the local station feeder unit RF2/4 at 3 ps., are available on request.

ARMSTRONG.-The 13- and 15-20 Metre.-30 Unit, £7118/6.


EIGHT BAND.—Quality amplifiers, 6 watts output, tuned push-pull output, latest British output tube values (6.68). (1938)

QUALITY AMPLIFIERS and Microphone Equipment for Hire or Sale.—Daily & Sons, 116, Cambridge Rd., Southport. (1939)

LEONARD.—New series of standard and improved all metal tuners, adjustable, temporary or permanent; bookings—10s. for 50. (1939)

10 WATT Marconi Speaker Model P.8.3, 7R, horn, and suitable fittings, £7 15s. (1939)

ARMSTRONG MANUFACTURING CO., 100 St. Pancras Way, Camden Town, N.W.1

Further extracts from The Wireless World

TEST REPORT, Jan. 5th, 1939

...a really live performance on all wavelengths

By judicious selection and rejection of "false" the circuit has been optimised in a chassis which can be produced with British valves and components throughout at an attractive price without sacrificing anything on the score of efficiency in the first essential of performance. Every detail of the assembly and wiring is neat and workmanship, the controls are smooth and well graded.

The oscillation breaking is good and the sensitivity is unusually well maintained throughout the whole range of the receiver. Whereas one desires to select for adoption, whether it is the 1.7-metre band at the lower extremity of the range, the so-called "false" band or the long waves, one finds the same characteristic quality which maintains on 50 stages and two good if amplifiers pulling their weight.

The three degrees of selectivity give clearly defined increases in band width. They have been well chosen.

The volume control is smooth and the output stage operates all the set will give it without showing distress.

Copy of complete Report FREE upon request.

DEMONSTRATIONS

Extended hours for convenience of customers. Engineer in attendance until 5.30 p.m. on Saturdays and 7.30 p.m. Monday to Friday. All Models Gladly Demonstrated

ARMSTRONG MANUFACTURING CO., 100 ST. PANCRAS WAY, CAMDEN TOWN, N.W.1

'Phone: GULiver 3105

"Radio Data Charts," A Series of Abaco Post free 4/10

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Readers who hesitate to send money to advertisers in these columns may deal in perfect safety by availing themselves of our Deposit System. If the money be deposited with "The Wireless World," both parties are advised of its receipt.

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"Radio Data Charts," A Series of Abaco Post free 4/10

PUBLIC ADDRESS

VORTEXION P.A. Equipment.

IMITATED, but unequalled.

WE Invite You to a Demonstration.

10 WATT Receiver Amplifier, for A.C.C.D. communication, and speaker; £12 12/6.

15-20 WATT Amplifier, 20,40,60,90 cycles, crude to fine. £31 10/6. £15 10/6.

COMPLETE Steel Cases for Above; 12/6.

15-20 WATT Portable Amplifier, in case, with speaker £25 10/6.

30 WATT Output £4 10/6; under 60 output conditions, with negative feed back, separate rectifier for anode, screen and bias, with better than 4 regulaions, level response, 25,25,25 cycles, excellent filter driver transistors and output transformer cutting 3,000 volts into impedence electronic mixing for mike and line up, with tone control, complete with wires and plug, £135 10/6.

COMPLETE in Case, with tone control; R.H. Piano finish and simulated mahogany, £20 10/6.

260 VOLT £22 10/6, Full Wave Speaker, field supply backwards, £35 10/6.

ALL P.A. Accessories in Stock.

VORTEXION, LTD., 122 The Broadway, Wimborne, B.W.9. 'Phone: Lib 2814. (1939)

CAR RADIO

Car Roof Antenn, improved type, chrome plated, 27½ feet; complete; vertical telescopic type, 12½; American upright aerial, single disc, 12½; All U.S. aerials, rubber covered, 26½-27½ pair; carriage price.

WIRELESS SUPPLIES, 46 Essex House, Stratford, E.15. (1939)

If you own a Car Radio, it is bound to go wrong: always try a good firm first. We belong to the Luscombe Motor Car Company, and offer wireless free quotations—home-accommodates Co dirs. Radio Department: Wireless Exchange Works, Maxwell Hill, N.18. (1939)
USED SETS FOR SALE

HMV

Toleration, crystal model, as new, under 100s guarantee, cost £47/5, accept £32.

HMV


MISCELLANEOUS

Super Seven Power Park, perfect, bargain, 25.—

27, Bishop's Park Rd., S.W.16. [1997]

"WIRELESS WORLD," W.W.H. High Adaptor devices, 10.—

whiles, of new. 25.—27, Smeeth Rd., Watford. [1990]

NEW MEASUREMENTS

V.

VORTONION Supply C.G.O., B.B.C., L.P.T.V. Why not you?

ALL Models Super Shadored. Prices and terms

ANY Model fitted £5 or 6/—. Filaments, if Required.

500 £500 150 m.a., 4v., 2s., 4v., 2s., 2v., 4v., 2s., 4v., 2s., 2s., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s., 2v., 4v., 2s.
NEW COMPONENTS

ANGLO AMERICAN RADIO (and MOTORS), Ltd.

MIESSENBURG 1939 Products.

Just Arrived.

47/6 — New 6.8-lm. pushbutton tuner, can be used with either 45 or 78 r.p.m. records. Requires only 5 volts direct current. Tuning range 110-210 metres. 78 r.p.m. only. 45 r.p.m. only. 5 volts direct current. 2.5 volts in each section; ten minutes to fix.

£12 10/0 — Miesseburg signal shifter is completely assembled, wired and fitted with a set of coils and has its own power supply. Three provision make, 2 or 3 in each section. 1/4 volt in each section; 10 minutes to fix.

£10 17/6 — All-wave tuning unit.

ANGLO ALL-WAVE TUNING ASSEMBLY IS THE COMPLETE HEART OF THE PREMIER R.F. TUNER. 90 cat. 3, 10.5, 28.8, 56.5, 113.2, 226.4, 453.6, etc., metres, individual coils, between 200-250 volts. Complete kit, 113.2, 226.4, etc., metres, individual coils, between 200-250 volts.

ANGLO TUNING UNIT, 100 volts, 2.5 watts, 190-250 volts, complete.

ANGLO ALL-WAVE TRANSFORMER KIT—Comprising of 6800 or 5000 ohms, 6 watt for each hand, low inductance, 350 volts. A.T. Transformer, new and bored; 100 watts, 11/6 each. ANGLO Mains Supply Transformer, complete. 2/50 each.

ANGLO MINIATURE TUBES, 3 volts, 1/6 each.

ANGLO 200-250 VOLT TRANSFORMER, complete. 2/50 each.

ANGLO TELE TUBES, 100-150 volts, 600 watts, 600-750 volts, 600 watts, 600-1200 volts, 600 watts. A.T. Transformer, new and bored; 100 watts, 11/6 each. ANGLO Mains Supply Transformer, complete. 2/50 each.

ANGLO 44-47 VOLTS TRANSFORMER, complete. 2/50 each.

ANGLO 200-250 VOLT TRANSFORMER, complete. 2/50 each.

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**SOUND SALES CATALOGUE AND TECHNICAL BULLETIN**

much earlier than we expected.

The new edition will contain all the latest modifications and additions to our "Tri-Channel Amplifier" special equipment and components, together with many items of special interest to the Quality Radio enthusiast. We think YOU will find it even more interesting than ever before.

**MAKING YOUR PLEASURES TO FORWARD A COPY?**

Specified by the Experts

**SOUND SALES**

MARLBOROUGH RD.

(Upper Holloway, London, N.10.) LIMITED.

Tel. Archway 2681/23 (For Contracts to the G.P.O., etc.)

Hours of Business—Monday to Friday, 8.30 a.m. to 6 p.m.

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I've just missed a good story.

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* * *


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The Wireless World

December 9th, 1939

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Advertisements

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NAME

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w.w.

9 39
A new output valve in the Octal Base range

TYPE KT61

The utility of the OSRAM range of 6.3 volt valves with the international octal base is now extended by the introduction of a high sensitivity beam Tetrode Power Valve, type KT61. The Osram KT61 gives the following points of advantage:

1. It has a high mutual conductance giving great sensitivity.
2. It provides a large undistorted Power output — over 44 watts.
3. It operates with moderate values of anode and screen voltage.
4. Its heater voltage of 6.3 volts enables it to be used in parallel with standard 6.3-volt valves in previous stages.
5. It is fitted with the “International” self-locating octal base.

CHARACTERISTICS

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LIST PRICE 10/6

Write for descriptive leaflet with characteristic curves and full operating data.
EDITORIAL COMMENT

Electric Shock
Familiarity Breeds Contempt

In drawing attention to what is described as "the increasing danger of electrical death or maiming which exists in present-day amateur transmitters" the journal QST, official organ of the American Radio Relay League, raises a matter to which we should certainly not close our eyes. But any alarmist tendency to exaggerate the danger would be equally out of place.

Not only transmitters, but wireless apparatus of every kind should be handled with the greatest respect. Indeed, one of the recent casualties among those wireless workers, both professional and amateur, who think nothing of trusting their lives to a few mils of insulating material or even to something far less substantial.

Happily, fatalities have so far been few in this country, but there have probably been a number of unreported accidents causing permanent disability. We do not propose to make our readers' flesh creep by describing some of the more gruesome effects of electric shock, but the warning that familiarity should in this case breed respect instead of contempt is certainly not out of place.

Code Abbreviations
An Annoying Affectation

A MATEUR transmitting is on the whole extremely well conducted in this country, but a complaint must be registered against the growing habit of the fraternity to use "Q" code abbreviations in telephony in cases where plain language would meet the case. It should hardly be necessary to point out that the code was devised for telegraphy, not telephony.

The essence of smart operating is speed and clarity. Why say "QRM" (three words, when spoken) or, more clumsily still, "Quebec, Radio, Montreal" when "jamming" would be shorter and more intelligible? A still worse piece of clumsy verbage is the spoken morse signal "dit-dit-dit-dah-de-dah" when "over" or "closing down" is meant.
Ganged Permeability Tuner

DESIGN OF A PRESS BUTTON UNIT

Press button tuning for radio receivers has gained in popularity to such an extent that practically every set maker now features a receiver fitted with this interesting accessory.

Whether press buttons will remain an accessory to the "manual" tuning control, or will eventually displace it by some ingenious scheme giving an unlimited choice of stations upon a limited number of buttons, remains to be seen. In any case it cannot be denied that press button tuning and the various methods of accomplishing it still occupy the minds of many people connected with the industry and, therefore, a description of a permeability tuner designed for press button control may be of interest.

Various systems of permeability tuning have, of course, been in use for some time in connection with automatic tuning, but they are generally of the type using separate iron-core adjustments for the aerial and oscillator circuits. A distinction is claimed for the unit about to be described, inasmuch as the iron cores controlling the inductance of aerial and oscillator circuits are "ganged" to a common operating spindle and, therefore, tuning is accomplished by a single adjustment.

The writer does not claim credit for this idea, which, he believes originated in America, but after some months of development a number of snags were overcome, and a satisfactory tuner was evolved suitable for English valves and conditions.

Briefly, the advantages that can be claimed for a tuner of this type are:

1. Frequency stability. The circuit is tuned by the movement of iron dust cores having a low ratio of inductance change to core movement, and stable fixed silvered mica tuning condensers.

2. Simplicity; adjustment for stations are effected by means of a single tuning control.

3. Medium- or long-wave stations directly obtained on the press buttons irrespective of the position of the normal wave-change switch.

4. Ease of installation into any standard superhet chassis.

A first consideration in the development of this tuner was to obtain the maximum tuning range with each coil in order to restrict the number of different coils necessary to cover the medium and long wavebands. In the present design, complete coverage of the medium waveband with sufficient overlap is obtained with three coils, and to cover the useful portion of the long waveband one coil only is required.

Fig. 1.- (a) The simple iron-dust core used in the tuner and (b) a complete coil assembly.

By using more complicated and consequently more expensive iron cores, it is possible to improve upon these results, in fact, the entire medium waveband can be covered with one coil. Since, however, several coils must be used according to the number of press buttons desired, the cost of these special cores in duplication would increase production costs considerably.

Fig. 1 (a) illustrates the simple iron cores used in the tuner and by employing thin coil formers and winding shape shown in Fig. 1 (b), a maximum effective permeability of 2.45 is obtained. This figure gives a tuning ratio of 1.57 and, therefore, a tuning range in this particular example of from 1,500 kc/s to 955 kc/s.

Coil Unit Construction

The arrangement of a single coil assembly is shown in Fig. 1 (b), coil A representing the signal-frequency winding and coil O the oscillator winding.

Single windings are employed to avoid additional switching that would be necessary with inductive coupling windings. Reference to Fig. 2 will indicate how these single windings are used in the signal-frequency and oscillator circuits.

In fixing the values of signal-frequency coil inductances, two considerations recommend the choice of a low L/C ratio. First, low inductances mean fewer turns, and, therefore, a higher tuning ratio, because the iron cores have more effect upon compact windings. Secondly, the fixed tuning capacity will be relatively larger and will help to swamp variations in stray capacities found in production receivers, thus helping the final alignment problem.

The requirements of the oscillator sec-
Ganged Permeability Tuner—

The coils are not so easily fulfilled. To ensure correct tracking it is necessary for the oscillator circuit to maintain a constant frequency difference (the intermediate frequency) above the signal frequency throughout the tuning range.

Satisfactory results may be obtained by using similar form factors for aerial and oscillator windings and iron cores of different permeabilities, or by using cores of similar permeabilities and different form factor windings. In the present design the medium-wave coils are wound with similar form factors, and have cores of different permeability, while for the long waveband both form factor and iron core permeability differ from the input circuit in order to achieve satisfactory tracking.

The accuracy of tracking finally obtained when the tuner is wired into a receiver, depends upon how closely the values of the circuit constants adhere to the values assumed when the initial calculations were made. There are several factors which combine to cause tracking errors; these are:

(a) Slight errors in the inductances of the coils.
(b) Errors in setting the distance of the coils relative to the associated iron cores.
(c) Variations in circuit capacities from the given values for which the coils were designed.

The last variation may be obvious, such as excessive strays, or it may be caused by the use of an incorrect frequency change with high-slope oscillator, causing excessive coupling and a high reflected capacity across the grid circuit, in which case the remedy is obvious.

Fortunately, there exists an expedient which compensates for most of the unavoidable errors and, therefore, in practice mistracking is not nearly so serious as might be imagined. This expedient requires that the input coils be wound in such a manner as to be initially free to slide along the former. The procedure for adjusting and compensating the coils is then carried out in the following manner:

When the tuner is wired into the receiver and ready for operation, a signal generator is connected to the aerial and earth input. A modulated signal having a frequency approximately midway in the range covered by the particular coil under adjustment is fed into the receiver. The iron core operating spindle is then turned until a response is obtained in the speaker. The signal-frequency coil is next moved over the former until maximum output is obtained, after which it is fixed to the former in this position, either by means of a strip of adhesive tape or by the application of a suitable wax.

The tuners may, of course, be adjusted in this manner when temporarily connected to a test receiver having characteristics as near as possible to the production receiver, so that when the tuner is finally installed no further alignment procedure is necessary.

Curves showing frequency in kilocycles against turns of the iron core adjusting spindles for each coil are given in Fig. 3. A comparison between the performance of the permeability tuner and an efficient set of conventional variable capacity-tuned iron-cored coils is of interest. Measurements were made on a receiver having a circuit shown in part by Fig. 2. The change-over...
Gaussed Permeability Tuner

from "manual" to automatic is made by
an extra position on the normal wave-
change switch as shown.

Sensitivity curves of the two
tuning systems are given in Fig. 4. A
certain loss in sensi-
tivity in the per-
meability tuned
cils is unavoid-
able, although the
difference is not
dected aurally be-
cause of the action
of the AVC system.

The selectivity of the
465-ke/s inter-
mediate frequency
amplifier of the
first receiver was
35 kc/s at 100
times, and 30.5
kc/s at 1,000 times
resonant input. The
overall selectivity of the receiver with con-
ventional coils was 35 kc/s at 1,400 kc/s
and 19.5 kc/s at 200 kc/s at 1,000 times.

View of the under-
side of the tuner,
showing switching
mechanism.

With press-button coils the figures were
36 kc/s at 1,400 kc/s and 22 kc/s at 200
kc/s at 1,000 times.

Fig. 4.—Sensitivity of manually tuned cir-
cuits, shown in full lines, compared with
that of press button circuits (dotted lines).

No attempt has yet been made to design
3-circuit (i.e., signal-frequency input, RF
amplifier and oscillator) permeability
tuners. This is partly due to the substan-
tial increase in production cost, and also
to the fact that 2-circuit press-button

tuners are being successfully used in
superhets having three manually con-
trolled circuits. The difference in sensi-
tivity, however, due to the RF stage when
switching from manual to automatic is
very noticeable.

The progress of permeability press-button
tuning depends more at the moment upon
the production of switches with increased
switching combinations. Later types of
permeability tuners in preparation will
include press buttons for selecting the
"manual" short- and medium- and long-
wave coils, in place of the separate rotary
wave-change switch in addition to press
buttons for pretuned stations.

The Radio Research Board

ASPECTS OF THE YEAR'S WORK

The Annual Report of the Department of
Scientific and Industrial Research,
which has just been published (H.M.
Stationery Office 25.), contains an interest-
ing summary of the investigations carried
out on behalf of the Radio Research Board.
This work has been done mainly by the
Radio Department of the National Physical
Laboratory at its research stations at
Slough and Leuchars, although a certain
part of the work on the study of the iono-
sphere has been accomplished at Cambridge
University under the direction of Prof.
Appleton.

The properties of the upper atmosphere,
more commonly referred to as the iono-
sphere, have been further investigated by
projecting wave-trains of short duration
from a transmitting station, and studying
the echoes received. By observing the critical
frequencies of the waves at which the
various regions are just penetrated, and so
close to supply an echo, much useful in-
formation concerning their effective height
and the maximum ionisation density has
been gathered. At the same time, a con-
siderable amount of work has been carried
out regarding the propagation of ultra-short
waves along the ground and through the
lower atmosphere. Investigations have been
undertaken from 410 to 34 Mc/s (0.73 to 8.8
metres).

Direction-finding has been another of the
major subjects of research during the year,
more especially at comparatively long dis-
tances. Observations have been made up to
30,000 miles, the wavelengths used being be-
tween 30 and 45 metres. The utility of
direction finders designed to work on ultra-
short wavelengths between 6 and 10 metres
has also been investigated and some very
encouraging results obtained. A special
form of direction-finding apparatus, operat-
ing on this band, has been developed for the
Meteorological Office for the location of its
radio-sounding balloons.

Field-strength measurements have also
been investigated, and here again, ultra-
short waves have received a large measure
of attention. Researches have also been
carried out on the source and waveform of
various types of atmospherics, and prelimi-

ary investigations indicate that there are
distinct types of oscillatory patterns in
the atmospheric waveform.

A subject that is of more immediate
practical application is an investigation into
the effects of temperature on components
used in oscillatory circuits, and various
methods of compensating for temperature
variation in condensers and tuning coils
have been gone into. The possiblility has also
been examined of using the deflection of a
focused beam of electrons as a basis for
construction of amplifying valves for use
on microwaves below one metre.

PROBLEM CORNER—7

Henry Farrad as Adjudicator

A NOTHER letter to Henry Farrad is
published for readers to test their
powers of observation and deduc-
tion. The answer is given on p. 170.

My Dear Henry,

I should be very much obliged
if you would give me some advice about my wire-
less. Last week it suddenly broke down,
and I cannot get a sound from any station I
Tune to, nor does the green light in the
"magic eye" move at all, as it used to.
I asked the man who
sold it to me to come round and see what
was wrong, which he did, and now I have
sold a letter from him saying it will cost
£2 3s. 6d. to put right. He said it was the
transformer or something—I had better
quote his letter to make sure I get the tech-
nical terms right—:

"From tests applied to your receiver
I have ascertained that a filter condenser
has broken down causing damage to the
rectifier valve and the HT winding of
the mains transformer. These three items
will have to be replaced, and I have
replaced in quoting you £2 3s. 6d. for the
rewinds, inclusive of fitting and testing."I
It seems quite a lot of money, and as I
therefore have to be replaced, and I have
4, Weir Avenue, Watchet.

Your very sincerely,

Emily Simple.

Was the proposed charge reasonable?
Cathode Bias and Feed-back

HOW AUTOMATIC BIAS WORKS

It is now the usual practice whenever indirectly heated cathode valves are used to obtain grid bias by inserting resistances in the cathode leads. Each valve is then independently biased and a change in the bias of one valve has no direct effect on that of the others.

The basic circuit is shown in Fig. 1, where R3 is the cathode bias resistance and R1 and R2 are parts of the input and output couplings. Actually these couplings need not be resistances, and in practice they often are not.

The anode current i of the valve flows in the direction shown by the arrows, since it flows from cathode to anode inside the valve. This current flows through R3 and sets up a voltage drop across it which is equal to iR, current being expressed in amperes and resistance in ohms.

Now this voltage drop makes the cathode positive with respect to negative HT, to which the grid is returned through R1. There is normally no grid current, so the grid is at the same potential as negative HT. The cathode is thus positive with respect to grid by the same amount that it is positive with respect to negative HT. Consequently, the grid is negative with respect to cathode.

As a condenser does not pass direct current the steady conditions are clearly unaffected and the bias remains unchanged. Rapid changes of voltage, however, are largely absorbed by the condenser.

Suppose the grid potential is changed rapidly in a positive direction. The anode current rises but the potential across R3 does not rise at once. The increase of current does not flow through R3 but is supplied by a loss of electrons from the upper plate of C. If the grid is maintained at its new potential, of course, C cannot continue to supply electrons and the current is diverted to R3. The process is gradual; C supplies the initial electrons for the current, but there is a continual and gradual change over to R3. As time progresses, the electrons supplied by C fall off and the current through R3 increases.

Now instead of keeping the grid potential at its new value, we can apply an input which swings the grid rapidly in a positive direction, then falls back to normal, swings an equal amount in a negative direction, and finally returns to normal. The anode current will at first rise for the positive grid voltage change, then fall to its normal value, and then fall below it to correspond with the negative grid voltage change, finally returning to normal.

The condenser C will supply the initial current by losing electrons from its upper plate, but before the potential across it has had time to rise appreciably, the total current will have fallen again and gone below the normal value. The condenser will now gain electrons through R3. Although the anode current is lower, the current through R3 is hardly changed, for the condenser C takes the surplus current.

It will thus be seen that although the anode current fluctuates to follow the changes of grid voltage the current through R3 does not, for the condenser C

WITH the usual system of obtaining grid bias negative Feed-back occurs along the cathode resistance and reduces the amplification. It is well known that the use of a large-capacity by-pass condenser enables this effect to be avoided, and the mechanism involved in the feed-back is discussed in this article.

<table>
<thead>
<tr>
<th>R1</th>
<th>HT+</th>
</tr>
</thead>
<tbody>
<tr>
<td>R2</td>
<td></td>
</tr>
<tr>
<td>R3</td>
<td></td>
</tr>
<tr>
<td>LT-</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 1.—This diagram shows the basic cathode-bias circuit.

The input signal is applied across R1 and swings the grid potential positive and negative relative to negative HT. The grid is always negative relative to the cathode, however, because of the voltage drop across R3; that is, provided that the signal is not larger than the grid bias.

When the grid swings positive the grid potential is less negative than before with respect to cathode, so that the anode current increases. The voltage drops across R2 and R3, therefore, increase as well. With respect to negative HT the anode is less positive than it was and the cathode is more positive.

When the grid swings negative exactly the reverse happens, the anode current falls and the voltage drops across R2 and R3 are decreased. Consequently, the anode becomes more positive, and the cathode less positive relative to negative HT.

It is therefore clear that when a signal is applied both anode and cathode potentials fluctuate, and that the change of anode potential is in the opposite direction, and the change of cathode potential is in the same direction as the grid voltage change. All potentials are reckoned with respect to negative HT. The output voltage at the cathode is thus in the same phase as the input and the output voltage at the anode is in the opposite phase.

Negative Feed-back

Now the voltage which is effective in operating the valve is not the signal voltage across R1, but that which appears between grid and cathode. As the grid potential changes, the cathode potential changes also in the same direction; therefore the voltage between grid and cathode is less than the input across R1 by that developed across R3. If the input voltage is E1 and the cathode voltage is E2, the grid-cathode voltage Eg is E1 - E2; alternating voltages or changes of steady voltage are here referred to.

This is a form of negative feed-back, and the gain of the stage is reduced because the full input to the stage is not effective in operating the valve, being offset by the voltage across R3. The gain obtained is the same as if there were no feed-back but the AC resistance Ra of the valve were increased to R3 + R1 (1 + µ) where µ is the amplification factor. Viewed from the anode circuit the valve also behaves as though its AC resistance were this high value.

In most cases this feed-back is disadvantageous, and it can be avoided by shunting R3 by a condenser as in Fig. 2.

Fig. 2.—Feed-back along R3 can be avoided by using a large-capacity by-pass condenser C.

The Wireless World, February 16th, 1939.
Cathode Bias and Feed-back—

absorbs the difference. When the anode current swings below normal, electrons flow into the upper plate of $C$ and represent the difference between the normal and instantaneous currents. When the anode current swings above normal, electrons leave the upper plate of $C$.

Another way of considering the matter is on the basis of impedance. The condenser $C$ has a reactance which is in parallel with $R_3$ so that the impedance of the combination is lower than that of either. If the condenser is large enough its reactance is very small so that a given alternating anode current will develop a correspondingly small voltage across it. Therefore there will be little voltage to oppose the input voltage, and the negative feed-back effect will be small.

The reactance of a condenser is inversely proportional to its capacity and to the frequency of the alternating current. If even amplification of all audio frequencies is wanted, therefore, it is necessary to make the condenser large enough for its reactance to be very small at the lowest frequency required.

In practice, it is usual to use a capacity of 25-50 $\mu F$ in AF amplifiers and this is large enough for most purposes. When valves of unusually high mutual conductance are used, a larger capacity is sometimes needed. For IF and RF amplifiers the capacity is usually $0.1 \mu F$, and in short-wave equipment it is often $0.01 \mu F$, or even smaller.

Problems

THOUGHTS ON HENRY

THE appearance of "Problem Corner" is not, I hope, intended to suggest that problems can be tucked away into a corner of the field of radio. The said field of radio seems to me to be about ninety-nine per cent problems—and don't ask me too suddenly what the other one per cent consists of, because I would need time to think. The serviceman obviously has a full-time job solving problems; so has the designer. Even the listener is constantly faced with the problem of deciding whether the noise he is hearing is due to the neighbour's new ultra-violet-ray apparatus or a leak in his own wiring, or whether his amplifier is deteriorating or if it is a bad OB line " beyond our control."

In solving problems it is obviously an advantage to know as much as possible about the subject. But this is not everything. In my exam. days I often managed to do less badly than some who really knew their stuff. This was not due to what you probably suspect, but to the fact that I had sufficient self-control to refrain from writing anything at all for fully 15 minutes after being presented with the paper; while the brainy people were busily dispatching pages of perfectly correct answers to questions which were not exactly the ones asked. I throw this out as a hint to any readers who may suffer from examination-fright.

Following False Scents

In practical problems, too, it pays to study the data carefully and not waste time following up scents that could be seen to be false. Henry Farrad and his followers have the advantage—unfortunately denied in real life—that the information supplied is sufficient to enable a logical conclusion to be drawn, and can either be assumed to be correct or else implies the correct data. In earning our living we are usually faced with the difficulty that the data may be insufficient and its accuracy unknown, as that we may have to set about collecting our own data. If somebody for whom you fixed up a receiver some time ago complains that

"it is making a funny noise, what is wrong?" the information certainly seems absurdly inadequate. It must not be forgotten, either, that the person concerned is probably quite incompetent to pick out the symptoms that would be helpful in drawing a conclusion; and one has to be prepared for terms to be used in ways that are misleading to a technical person. "Distortion" may be used to describe hum, and "hum" to describe microphonic howl. It is no use getting angry with the informer; he (or she) has not been through a technical college. I had a complaint from a semi-technical quarter that a certain battery superhet didn't give enough output. As the perpetual difficulty with battery superhets is to obtain sufficient undistorted output without excessive battery consumption, I wasted quite a lot of time in finding the receiver to be up to standard in this respect and reporting it as. Whereas the real complaint was that (due to a lower value of AVC delay voltage) it was not possible to get a feeling of " punch " by grossly overloading the output stage at maximum setting of the volume control. In fact it had been designed to avoid this cause of distortion.

So when getting information second-hand it is more important to know what the informer means by his words than what you would mean by them. This is especially so when asking him for further clues. Then he may not be very helpful when pressed for details; like the patient who, when the doctor said " Well, now, what's the matter?" replied "That's what I pay you to tell me! " But incidental knowledge may eke out apparently scanty information. In a Henry Farrad problem the usual conventional weather reports are sure to be quite wrong. The locality of the receiver, in relation to broadcasting stations or possible sources of interference, is often important. Knowledge of the type of person using it, or making the complaint, helps in the interpretation to be put on the information. I have often been told that a certain result is critical, whereas others refer quite mildly to distortion that is dreadful beyond words. If they are known to be of the type that switch on every morning and switch off at bedtime, a worn-out valve is more reasonably suspected than if they listen to nothing but the News.

When the problem can be examined direct, one possible source of confusion is eliminated. The speed and certainty of solution then depend mainly on one's mental and instrumental resources. I suppose most people in this game have come across cases that seem to run contrary to the laws of nature, and tempt one to give up striving against a thing that seems to have the supernatural on its side. The trouble may be due to one's own incomplete knowledge of the laws of nature, which are many. A resistor may indicate 1,000 ohms on an ohmmeter, and yet with 10 mA. through it the voltage across its terminals may not be the 10 volts that one would expect on the ground of Ohm's Law. The resistance value might happen to depend on the current passed.

Take Nothing for Granted

Then apparently conflicting and absurd results may be due to unsuspected faults in the parts that are being assumed to be dependable. The 50,000-ohm coupling resistor in an amplifier may be passing 2 mA., and yet show no voltage across it when measured by the same multi-range instrument. But it is possible for the meter to develop a fault on one range! Or current may fail to pass between two points that are joined by a short piece of thick flex that gives a satisfactory zero resistance test. But flex does sometimes develop a break that is concealed by the covering, and which makes contact when brought into the testing position and opens in the working position.

It is well to remember that nothing can be really " impossible," and the apparently conflicting results can be reconciled by close enough examination.

The usual retort to the advice about patiently following a systematic sequence of tests that (in the words of the adviser) yields the correct result to be a valuable cloak of logic, is that life is too short and a serviceman who followed this method would get the sack. Certainly there must be a happy medium between rigid system on the one hand and random shots on the other. The moderate thing is, perhaps, to take a method it by experience and common sense.
**All-Glass Valves**

**NEW METHOD OF VALVE CONSTRUCTION**

The development of the technique of radio valve manufacture was assisted in the early stages by the experience gained in the production of incandescent lamps. Although originally developed for the lamp, the glass bulb and foot, with its pinch, were adopted for the vacuum-tight envelope of the valve. Recent receiver development, however, has raised problems which are difficult of solution with the existing valve technique. This is especially so in the case of short-wave and television apparatus.

Some of the difficulties encountered in the original method of construction, as developed from incandescent-lamp manufacture, can be summarised as follows:

1. In certain valves of the old construction it was found necessary to connect anode and control grid to the opposite ends of the valve, which sometimes complicates receiver design.
2. Long internal connections from the electrodes to the external contacts considerably increase the actual capacities and inductances of the electrodes. This gives rise to serious difficulties when dealing with short waves.
3. Long connecting leads from the electrodes to the contacts also cause appreciable variation in the effective inter-electrode capacities. This effect is made worse by the presence of the "getter" deposit in the neighbourhood of the pinch.
4. The bakelite used in the manufacture of the base of the valve is rather unsatisfactory, partly because its dielectric constant varies with temperature, and this causes some change in the effective valve capacities during the warming-up period after switching on.

In an attempt to solve these problems the Mullard "All-glass" valves have been introduced, and in most respects they prove to be a satisfactory solution, readily adaptable to mass production. The photo-

![Diagram of All-Glass Valve](image)

The seal between the bulb (B) and the glass base forms the flange (C). The "getter" deposit (D) is located exclusively at the top of the bulb. The exhaust tube (E) is part of the glass base, and both the exhaust tube and the base are covered with a metal screen (F), which is provided partly to give mechanical protection of the exhaust tube and partly to allow of external electrical screening between the control grid contact (G1) and the anode and heater contacts.

The provision of a locating spigot (H) facilitates the correct insertion of the valve into the socket. This is similar to the method employed in the octal base.

**The External Contacts**

When inserted in the specially designed socket the silver-plated chrome-iron contacts at the base of the valve have a contact resistance of 5 to 8 milli-ohms, which compares favourably with other existing bases.

This method of making the connections has the advantages that there are no soldered joints on the valve, and there is no base which can become loose. More important, the connections between each electrode and the point where the external circuit wiring is soldered to the contact springs on the valveholder are very short.

**The Internal Leads**

The arrangement of the leading-out wires in a typical small valve—the EF9—with a pinch construction is shown in Fig. 2. The wires run more or less parallel with each other inside the foot for a length of approximately 35 mm., compared with 15 mm. in the all-glass construction.

In Fig. 3 the total length of the connection from the cathode A to the cathode contact soldering tag B on the valveholder is compared for the EF9 and EF90. This length is of importance in short-wave work, particularly at the wavelengths used for television, and the diagram shows that it can be reduced from 65 mm. to 45 mm., a decrease of more than 35 per cent.

Further advantages are obtained by the elimination of the bakelite base, since bakelite has comparatively high dielectric losses and a dielectric constant which varies to some extent with temperature change. As a result of this and other causes the capacity variations of valves during the warming-up period give rise to considerable frequency drift; eliminating the bakelite base assists appreciably in the improvement of this defect.

The effect described is well brought out...
All-Glass Valves—

by the figures of Table 1. These measurements were made at a frequency of 15 Mc/s and an ambient temperature of 25°C.

As shown in Fig. 1, the control grid connection of the EF50 has been taken to the base. In the pinch construction this would not be permissible, because it would give rise to insufficient screening between the control grid and the anode heater. The external screen (F) and the internal screen ensure very small anode-to-grid and heater-to-grid capacities in the EF50. The anode-grid capacity is less than 0.002 mmfd, and the grid-heater capacity is less than 0.003 mmfd.

These values, which include the capacities of the socket, are quite as small as those measured on the EF9 with the control grid lead taken out to the top cap. It has been found in practice that the input and output capacity tolerance of the EF9 cannot be reduced below ±0.6 mmfd, the input capacity being 5.0 ± 0.6 mmfd, and the output capacity 7.0 ± 0.6 mmfd. On the other hand, the all-glass type EF50 can be made with input and output capacity tolerances of only ±0.2 mmfd. In some applications this is an important advantage.

It is possible to work to these reduced tolerances because the lead-out wires in the pressed-glass base are always the same distance from each other, and these distances are greater than in the normal pinch construction. Further, the "getter" deposit is at the top of the bulb and no longer influences the capacities between leads, and the mechanical stability of the electrode system is greater in the new construction.

An additional advantage of limiting the "getter" deposit to the top of the bulb is the reduced risk of bad insulation between the support wires, thus obviating the necessity for the well-known white insulation material on the pinch, which can give rise to cracking noises.

In the conventional pinch construction all lead-out and supporting wires in the pinch are in one plane. This necessitates the well-known dome mica construction. In the all-glass valves the supporting wires are arranged in a circle (see Fig. 4). This increases the mechanical stability of the system to such an extent that the additional support of the dome mica construction is not required.

The dimensions are of the same order as those of other types of small valves as shown in Table 2.

A point of special importance to set-makers is the possibility of transporting sets with the valves in position without risk of the valves shaking out. With this object in view the socket for the all-glass valve has been designed on the bayonet-lock principle. This has the advantage that the valve can be firmly secured in its socket by applying comparatively light pressure, followed by a twist, after which the valve cannot be removed unless a twist is applied in the opposite direction.

<table>
<thead>
<tr>
<th>Table 2. Valve Types.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length in mm.</td>
</tr>
<tr>
<td>Diameter in mm.</td>
</tr>
<tr>
<td>Weight in grammes</td>
</tr>
</tbody>
</table>

This socket has proved entirely satisfactory for use in apparatus designed for aircraft.

The Wireless Industry—

By LESLIE DIXON AND COMPANY, of Elec.

tradex House, 218, Upper Thames Street, London, E.C.4, have just issued a Pamphlet on "Noise Measuring Apparatus." This pamphlet describes noise measuring apparatus, including receivers, meters, generators, recorders, etc., and is available for Indian conditions who are not already in touch with manufacturers of receivers suitable for Indian conditions and who are not already represented in that country. Letters addressed to this office will be forwarded.

A firm of importers in India wishes to get into touch with manufacturers of receivers suitable for Indian conditions and who are not already represented in that country. Letters addressed to this office will be forwarded.

The footnote to the Film Industries advertisement last week suggested that the F.I. 15-watt amplifier is for the trade only; actually, the instrument is available to the general public at the price given.

Marconi-Ekco Instruments, Ltd., Electra House, Victoria Embankment, London, W.C.2, have issued a pamphlet on "Noise-Measuring Apparatus."
Variable Output with Uniform Regulation

In experimental work it is frequently desired to arrange that the voltage output of a power unit shall be variable over a limited range. The normal methods of effecting this control employ either a variable series resistance or a potentiometer, but both of these have serious disadvantages. The introduction of series resistance does give satisfactory control of output voltage provided the load is constant, but it results in poor voltage regulation, the output voltage falling rapidly with increase of load.

With the potentiometer method regulation may be made as good as desired, provided that the power output required is but a small fraction of that available from the rectifier, for it is essential to the working of this system that the potentiometer shall take considerably more current than the external circuit; otherwise its action becomes almost identical with that of the series resistance.

In the system to be described these disadvantages are largely overcome, and the effect of the control is to shift the regulation curve bodily up and down without materially altering its slope over the normal working range. The circuit used is shown in Fig. 1 and its simplicity will at once be apparent. It is applicable to all circuits having a condenser input to the smoothing filter, and the control of voltage is carried out by varying the reservoir impedance. It is well known that changes in the capacity of the condenser cause changes in the terminal voltage, but since an 8-mfd. variable condenser is scarcely a practicable proposition, control by this method can only be made in steps.

The inclusion of the resistance \( R \), however, makes continuous variation possible. The results are very satisfactory, although the effect is not identical with that produced by changing the capacity, since the introduction of resistance into the filter input impedance brings into play certain factors too complicated to be dealt with here. It may be said, however, that the voltage and current stresses upon the rectifier, transformer and condenser are all somewhat reduced by the insertion of \( R \), and that when the resistance is made very large the circuit becomes, in effect, a choke input filter.

Fig. 2 indicates the results that may be obtained when using perfectly standard equipment. The transformer was designed to give an output of 120 volts and the rectifier, which is an American type 5Z3 valve, which is practically the equivalent of the British U.18 and U.52. The choke had a nominal inductance of 20 henrys and a resistance of 250 ohms, being a component intended for use with a condenser input. It is very probable that with a choke designed for use without a reservoir condenser the regulation at lower voltages would have been still further improved over that shown by the curves.

The curves given in Fig. 2 show the output voltages obtained when \( R \) is given the values of 0 and 2,500 ohms, with two additional curves, shown dotted, indicating intermediate positions when \( R \) is 500 and 1,000 ohms. It will be seen that a voltage range of over 100 volts is available; even when the maximum value of \( R \) is limited to 1,000 ohms the range at 150 mA is 90 volts, or 20 per cent. of the nominal output of 450 volts. All these figures relate to the use of an 8-mfd. reservoir condenser, and it should be borne in mind that a reduction of this capacity will reduce the control range available.

It is evident that the resistance \( R \) does not dissipate any DC power, but there is, however, a considerable alternating current flowing through it and the component must be chosen accordingly. The accompanying table gives the measured values of this current for various resistance values, together with the corresponding calculated powers, and it is obvious that a high-wattage component is needed, particularly where high transformer output voltages are used. It will be seen that the AC power absorbed by the control circuit is an appreciable percentage of the total output power, which, though negligible in amateur receiver and transmitter experiments, makes the method uneconomic for controlling the voltage of high-power rectifiers. For lower transformer voltages the power dissipated in the resistance is reduced in proportion to the square of the voltage ratio. To illustrate this point, extra columns have been added to the table giving the estimated powers and currents for other values of nominal power-unit output voltage.

The most suitable of several different kinds of resistance that have been used appear to be either the Claude Lyons Standard Clarostat or the Bulgin range of 60-watt variable resistors. The former, owing to its unusual construction, has a power rating almost independent of its resistance value, and thus can carry the heavy currents which flow at the low resistance end of the range, although its power rating is only 15 watts. It has, however, a minimum value of about 100 ohms, which will slightly reduce the maximum voltage output of the unit. The Bulgin resistances must be chosen to carry the heaviest current to be expected, as they are essentially current rated. For voltages in excess of 500 the Power Clarostat with a range of 50-2,500 ohms would be suitable.

In conclusion, it should be pointed out that the use of this principle will reduce to a certain extent—depending on the value of resistance in circuit—the smoothing effect of the reservoir condenser. The filter circuits should, therefore, be designed rather more generously than would otherwise have been the case. Where there is any doubt the safest plan would be to follow a design for a filter employing a choke input, as the added condenser and resistance will then no longer be essential to the smoothing.

<table>
<thead>
<tr>
<th>Value of Resistance ( R ) (ohms)</th>
<th>Nominal Output Voltage</th>
<th>Current (mA) Power (watts)</th>
<th>Current (mA) Power (watts)</th>
<th>Current (mA) Power (watts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>400</td>
<td>50</td>
<td>250</td>
<td>150</td>
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<td>500</td>
<td>350</td>
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<tr>
<td>2500</td>
<td>150</td>
<td>100</td>
<td>50</td>
<td>250</td>
</tr>
</tbody>
</table>

The above table shows the measured and calculated currents and powers in the resistance for various values of \( R \) (Fig. 1) and nominal voltage. These figures are used in the choice of a suitable component.
Television Topics

A READER living in Coventry experiences interference on the Alexandra Palace vision signal from the Daventry short-wave stations which he attributes to harmonics radiated by these stations. Such interference is quite possible when the receiver is at a fairly short distance from the transmitter, because it is extremely difficult completely to prevent the radiation of such harmonics.

When a receiver is near a transmitter operating on certain frequencies, and especially when it is a long way from the vision transmitter and the receiver is consequently operated at high gain, a certain amount of interference is likely. If the receiver is in a suitable location the easiest remedy lies in the use of a suitable aerial system.

The use of a highly directional receiving aerial is not necessarily advisable; it is more important that it should possess the property of giving no response to signals of erecting the aerial and reflector and shows also its polar curve. At (b) the aerial is depicted poled for maximum interference, and it is clear that there is a big reduction in interference for only a small reduction in the wanted signal.

The setting of the aerial for minimum pick-up is much more critical than for maximum and must be carried out experimentally by rotating the aerial system and observing the effect of each change. This method of avoiding interference naturally fails if the interfering station is situated on the same side of the receiver as the vision transmitter. It may also fail in the case shown in Fig. 1 if there is any appreciable degree of reflection of the interfering signal.

In the case of interference from harmonics of the Daventry stations, however, this is not the only way of tackling the problem. Interference can be avoided by designing the receiver appropriately.

With double sideband working and a frequency response up to 2 Mc/s, the band-width extends from one particular direction. The familiar dipole with reflector is of this type. As usually erected, the reflector is placed behind the dipole so that reflector, dipole, and transmitter all lie on the same straight line. This gives the maximum signal strength and it also gives the minimum pick-up from an interfering signal if this is located on the same straight line projected backwards.

In general, however, the interfering station is not so conveniently placed, and the best results are then obtained by poling the aerial to give not maximum signal pick-up from the vision transmitter but minimum interference. This is illustrated in Fig. 1, where (a) indicates the usual way from 43 Mc/s to 47 Mc/s; with single sideband operation it can be 43-45 Mc/s or 45-47 Mc/s. To cause interference the harmonic of a signal must fall within one of these bands. The table shows the frequencies within which the interfering signal's fundamental frequency must lie for interference to be experienced, for harmonics up to the fifth.

With both sidebands retained trouble may be found from the following bands: 2nd harmonic of GST, GSG on 21.55 and 21.53 Mc/s; 3rd harmonic of GSP, GSI, GSO, GS, on 15.31, 15.46, 15.18 and 15.14 Mc/s, and 4th harmonic of GSD on 11.75 Mc/s. With single sideband working using the band of 45-47 Mc/s, all these possibilities remain, except GST and GSG, but if the band of 43-45 Mc/s is chosen none of them is present except GST and GSG.

Under these circumstances, therefore, the use of single sideband reception will be decidedly advantageous. If the IF amplifier is provided with a response cutting off sharply outside its pass-band of 2 Mc/s, the possibilities of interference from this source are greatly reduced, even in close proximity to the transmitters. If the bandwidth is slightly reduced, say to 1.8 Mc/s, and the accepted band is 43-45.2 Mc/s, all interference can be avoided.

It is necessary, however, to make sure that interference is really due to harmonics of the transmitter, for it is quite possible for it to occur through second-channel interference. If the intermediate frequency is i, and the band-width is 43-47 Mc/s, then if the oscillator frequency is lower than the signal frequency second-channel interference may be found from signals in the band 43-2f, to 47-2f Mc/s.

A common value for i is 13 Mc/s, giving an interference band of 17-21 Mc/s. Within this band are GSG and GSV. For single sideband reception the bands are approximately 17-19 Mc/s and 10-21 Mc/s. The former contains GSG and GSV and is the band effective if conditions are chosen to avoid harmonic interference.

By working with the oscillator at a higher frequency than the signal, however, the interference band is 43-2f, or 47-2f Mc/s, or with i = 13 Mc/s, 69-73 Mc/s. This is a vacant band at present and the use of the higher oscillator frequency effectively prevents the possibility of second-channel interference.

By adopting single sideband reception of the band 43-45 Mc/s and operating with the oscillator at a higher frequency than the signal no interference from the Daventry short-wave stations should be experienced in any locality. The oscillator will of course be set at 58 Mc/s, and the IF band should be 13-14.8 Mc/s. The sound intermediate frequency is 16.5 Mc/s.

It should be emphasised that in the vast majority of cases no interference is experienced, but there is the possibility which a correspondent has pointed out of such interference in certain localities. Fortunately a remedy is possible at the receiving end.

<table>
<thead>
<tr>
<th>Harmonic</th>
<th>Double-Sideband</th>
<th>Single-Sideband</th>
</tr>
</thead>
<tbody>
<tr>
<td>2nd</td>
<td>21.5 - 23.3</td>
<td>21.5 - 22.5</td>
</tr>
<tr>
<td>3rd</td>
<td>14.3 - 15.7</td>
<td>15 - 16.7</td>
</tr>
<tr>
<td>4th</td>
<td>10.75 - 11.75</td>
<td>10.75 - 11.25</td>
</tr>
<tr>
<td>5th</td>
<td>8.6 - 9.4</td>
<td>8.6 - 9</td>
</tr>
</tbody>
</table>

The Wireless World, February 9th, 1939

Letter to the Editor.
We have now reached the point where a decision must be made as to whether the transmitter that has been described is to be keyed for telegraphic communication or modulated for telephony. Telegraphy obviously requires the least amount of apparatus, for it is only necessary to devise some simple way of breaking up the radiated waves into dots and dashes to achieve this object, whereas for telephony transmission equipment must be provided for amplifying sounds, such as speech or music, in order that a sufficient amount of audio power shall be available to modulate the radiated waves, or the carrier, as it is usually called.

A telegraph key inserted in the HT lead would serve to make and break the supply to the valves, but it is not good practice to key in the main supply in any but very low-power transmitters. Where there is appreciable power in the circuit, arcing will take place at the key contacts, and often when the key is "open" an arc forms and allows current to flow to the valves. The formation of intelligible morse characters will be almost impossible under these conditions.

The connection of a morse key to a transmitter is not such a simple matter as would appear at first sight. The pros and cons of the various available methods are discussed in this instalment, which also deals with the question of modulation for speech transmission.

There are, of course, ways and means of preventing arcing at the contacts, but before applying remedies it would be advisable to see if the arcing cannot be minimised by choosing a better place for the key. Arcing will be greatest where the largest current flows, so that the logical place to key is where the power is lowest. Another effect produced is that interruption of a circuit of moderately high power causes energy to surge to and fro in the circuit in much the same way as the discharge of a condenser through a path of low resistance produces a train of damped oscillations. These oscillations will be radiated either by the aerial or by the mains wiring, and possibly by both, with the result that interference may be produced in nearby receivers. These damped oscillations cover a very wide band of radio frequencies, so that such interference can extend into the ordinary broadcast wavebands.

The possession of a transmitting licence does not absolve the amateur from the responsibility for any interference caused to broadcast listeners, so that every possible precaution must be taken to suppress and remedy it. This shock-excitation form of interference can be identified by quite loud thumps and clicks being heard in a nearby receiver, and thus it has been

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Fig. 18.—In this circuit are three points, A, B and C, where a key for telegraph transmission can be inserted; the merits of the various keying positions are discussed in the text.
The Amateur Transmitting Station—described as key thumps or key clicks.

The amount of interference produced will be governed by the power in the circuit interrupted by the key, and if it is included in a high-power circuit their elimination will be more difficult than would be the case were only very little power being keyed. Accordingly, then, we must look for a place in the transmitter where the power is low and where keying can effectively be undertaken.

Referring to Fig. 18, there are three points in the circuit, marked A, B, and C, where a key can be inserted; these points indicate where terminals or jacks have been included for one purpose or another. Point A is in the screen grid lead to the APP4G oscillator valve, and the current flowing is about 5 to 7 mA. In the line where B is included, the current is about 30 mA, while at C, in the power amplifier HT supply, about the same current will be flowing. It is obvious that A is the best place for the key, as the lowest current flows in the screen circuit of the valve.

Even choosing this point for keying will not necessarily remove all trace of interference, and if a close inspection of the key contacts is made when the key is closed and opened, bright bluish sparks will often be seen. These are quite sufficient to cause interference, even though they may not be serious enough to give rise to actual arcing across the contacts.

Key Filters

A simple form of key click filter will suffice to suppress any interference due to this sparking. The filter consists of a resistance and condenser joined across the contacts, as shown at R and C in Fig. 19. A capacity of one or two microfarads is required, while the resistance should be of the order of 1,000 ohms. Where the current in the keyed circuit exceeds about 10 mA, the remedy must take the form of slowing down the surges in the circuit, and this can be done by including a high-inductance choke in the HT lead. If the inductance is too large, the current will not be able to rise to its maximum during the short time the key is closed to form a dot, so that the “lag,” as it is called, becomes too great, and either a slower sending speed must be adopted or the choke inductance lowered. A variable resistance joined across the choke provides a means for varying the time lag of the circuit. A complete key filter of this kind is shown in Fig. 20.

It may sometimes be found that, having taken these precautions, traces of interference are still noticeable in nearby receivers, or possibly in one’s own domestic receiver. This is most likely caused by conduction along the supply mains. A mains filter consisting of two RF chokes with condensers arranged as in Fig. 21 will usually effect a cure. The condenser should be the kind recommended for use in interference suppression circuits and have a rating of 1,500 volts AC test.

The chokes are connected in the primary circuit of the mains transformer supplying HT and LT for the oscillator and power amplifier stages in the transmitter, and they must, of course, be wound with sufficiently heavy gauge of wire to carry the primary current without appreciable drop in voltage. They must be effective at the lowest frequency on which the transmitter will operate, but not necessarily on the lowest frequency generated. For example, if a 7-Mc’s crystal oscillator is used, but with the output taken at the second harmonic and the fundamental not amplified at all, chokes effective at 20 metres can be fitted, as the power in the fundamental will be too low to be troublesome.

One does not want to use chokes larger than necessary, as they will have to be wound with a very heavy gauge of wire. Of course, it is possible to compensate for voltage drop in the chokes by connecting the mains to the primary tapping next below that of the mains voltage, and the only disadvantage of this is that there will be a slight rise in filament volts when the HT load is removed, such as during intervals between keying.

Throughout this series of articles we have assumed the transmitter will be used for telegraphy work, and mention of telephony has been intentionally avoided, as the beginner would be well advised to concentrate on getting a C’W telegraph transmitter to work efficiently before attempting to apply modulation.

A brief discussion of telephonic transmission will not, however, be out of place at this juncture. It is not proposed to deal with the theory of modulation, but merely to explain the basic principles and how they are applied to a transmitter of the kind described here.

The usual system adopted is that known as amplitude modulation. In this system the amplitude of the radio frequency wave is made to vary in accordance with the sounds reaching the microphone. The amount by which the RF oscillations, or the carrier, is varied is generally expressed as a percentage, being the maximum modulated amplitude minus the unmodulated carrier amplitude, divided by the unmodulated carrier amplitude and multiplied by 100. Thus if the carrier is increased to one and a half times its normal value, the modulation can be expressed as 50 per cent., while if the change is to twice the steady value the modulation would be 100 per cent. This is the maximum depth of modulation possible without distortion. Any excess of 100 per cent. is described as over-modulation and can cause serious interference to broadcast listeners.

As the process of modulation is to increase the amplitude of the carrier, 100 per cent. modulation represents a fourfold increase in peak output power, as the peak current and voltage are doubled. Thus the power amplifier must be capable of handling these peaks without damage to the valve and when operated at maximum input, voltages must be adjusted accordingly.

The advantages of fully modulating a transmitter will be apparent when it is realised that at the receiving end it is only the changes in carrier amplitude that produce the signals; thus a low-power telephony transmitter modulated 100 per cent. will appear to be as loud as one with several times more carrier power but with a much lower level of modulation.

Anode Modulation

Modulation can be effected in the anode circuit or in any amplifying stage preceding the final amplifier. If the last-mentioned scheme is adopted, the final amplifier must be a linear amplifier, such as a Class A or a Class B stage, and any system that would distort the modulated input to the valve cannot be used.

As it is desirable to operate the RF power amplifier at the highest possible efficiency (i.e., Class C) modulation is generally effected in the anode circuit of the last valve in most amateur transmitters. If pentode or tetrode valves are used in the RF power amplifier, modulation can be applied to the suppressor electrode, or a combination of anode and suppressor grid modulation may be employed.

The advantages of modulating in an early stage, in the grid circuit, or in the suppressor grid circuit of valves is that only a few watts of audio power are required, whereas modulating in the anode circuit of the final valve demands a relatively large audio frequency power. However, as for a 10- or 25-watt transmitter, the AF power required for the modulator is 50 per cent. the power input to the
The Amateur Transmitting Station—modulated stage, assuming anode modulation, a small public-address-type amplifier will suffice.

Audio frequency power amplifiers require to work into a definite load, and in the case of anode modulation with a triode valve, this load is provided by the DC resistance of the anode-filament path in the RF amplifier.

It is hardly to be expected that this will in all cases be just right for the modulator employed, and an impedance match will have to be effected. If a common HT supply is used for the AF and RF amplifiers, modulation can be effected by means of an AF choke in the HT supply as shown in Fig. 22(a). If a push-pull modulator stage is to be employed, then it can be arranged as shown in Fig. 22(c). Where a modulation transformer is used with a single output valve in the AF amplifier, the primary and secondary connections can be arranged so that the flux in the core is cancelled, or at least reduced to a value push-pull stage, as in Fig. 22(e), since the primary flux is already balanced out, but the core has to carry the flux produced by the secondary or RF amplifier anode current.

As several audio frequency amplifiers, ranging from a 33-watt model to one giving 79 watts output, have been described in The Wireless World, there is no need to discuss the design and construction of a modulation amplifier here.

A selection of those that would be suitable for the purpose is given below, though in some cases a few modifications, such as fitting an output transformer of the correct ratio, and possibly the addition of a one- or two-stage pre-amplifier for microphones of small output, may be needed.

Attention should be drawn to a regrettable error in the inscription to Fig. 14 of the last instalment. The inscription should read: The output voltage of a condenser filter (A) is higher but worse regulated than that of a choke input filter (B).

AF Amplifiers previously described in "The Wireless World"

Small Quality Amplifier (3½ watts)
Nov. 4th, 1937.

Recording Amplifier (4½ watts)
March 19th, 1937.

Push-pull Quality Amplifier (7½ watts)
Reprint of May 11th and 18th, 1934, and December 23rd, 1935.

AC/DC Negative Feed-back Amplifier (5½ watts)
November 6th and 13th, 1936.

12-watt Amplifier
April 30th and 10th, 1936.

20-watt Amplifier
September 8th and 17th, 1937.

Battery Quality Amplifier
May 17th and 26th, 1938.

**NEWS FROM THE CLUBS**

**Slough and District Short-wave Club**

Headquarters: 35, High Street, Slough.
Meetings: Alternately Thursdays at 7.30 p.m.

Hon. Sec.: Mr. R. J. Mylne, 10, Buckingham Avenue, Slough.

At the last meeting (February 14th) a very interesting talk on "Clairvoyance and Kindred Sciences" by Sir. C. James, the subject being "Psychic Telepathy and the Relation to Science." It is hardly to be expected that this will give a complete or final answer to the question, but it has been fixed, or at least reduced to a value, and it can be shown that the correct ratio, and possibly the addition of a one- or two-stage pre-amplifier for microphones of small output, may be needed.

**Bradford Experimental Radio Society**

Headquarters: 26, Green Drive, Southall.
Meetings: Tuesdays at 8.15 p.m.

Hon. Sec.: Mr. H. F. Reeve, 26, Green Drive, Southall.

At the meeting held on January 21st Mr. H. S. Cullen gave an interesting talk on "The Latest Valve-Testing Instruments," and demonstrated, among other things, a valve-testing panel, and a Wheatstone Bridge employing a mos fill instrumentation indicator. It is the second time that this has been read.

**Thorne Amateur Radio Society**

Headquarters: 31, King Street, Thorne, near Doncaster.
Meetings: Sundays at 3 p.m.

Hon. Sec.: Mr. G. B. Brown, 13, Marshford Road, Norton Bridge, near Doncaster.

At the last meeting, on January 25th, the society was founded on January 25th, 1930, and it will devote all its time to short-wave reception and transmission. A charge of 6d. will be made at every meeting.

**Croydon Radio Society**

Headquarters: St. Peter’s Hall, Lodge Road, South Croydon.
Meetings: Tuesdays at 8 p.m.

Hon. Sec.: Mr. H. C. Williams, 15, Campeau Road, South Croydon.

At the last meeting, to be held on February 21st, Mr. B. L. Bower, of the Midlands Wireless Service Co., will give a lecture entitled "The Latest Valve and Television Developments." On the following Tuesday (February 28th) a representative of Everett Edgware Ltd., will lecture on "The Radio Servicing Instruments."
GREAT BRITAIN'S NEW WAVELENGTHS?

Proposed Changes to be Discussed at Montreux

MUCH speculation has been made in the Press on the subject of the changes in wavelengths which might be expected as a result of the Conference to be held at Montreux beginning on March 1st. From a reliable and authoritative source, The Wireless World learns that many changes, some quite drastic as far as English stations are concerned, are included in the proposed reshuffle of wavelengths which will be presented at the Conference by the International Broadcasting Union, whose task it has been to prepare a plan.

All the proposed changes to English wavelengths entail a shortening of from 85 to 14 metres, and stations would, therefore, tend to lose effective coverage by the use of shorter wavelengths, which are more susceptible to fading and attenuation.

We will retain our one exclusive or nearly exclusive wavelength, which is 1,415 metres. We will retain our one exclusive medium wavelength, which is 285.4 metres (1,051 kc/s). London Regional Station, as at present, would share the 249.2 metres (1,204 kc/s). Lisuagarvey, the North Scottish station, would share the 233.5 metres (1,474 kc/s) which wavelength it is proposed to lower from 1,500 to 1,415 metres. Slaitiwhit, the North Regional, would drop to 243.7 metres (1,204 kc/s) which wavelength it would share with the 20-kW Jerusalem station, as it does its present 449.1-metre wavelength.

It is proposed that the Scottish stations at Burghhead and Westerlan, which at present share 391.1 metres with Ipswich, a 4-kW station, should share 372 metres (806 kc/s) with the Egyptian 20-kW Cairo I station. It is known that this station will shortly be replaced by one of 50 kW.

Penmon and Washford, the Welsh Regionals, would drop to 233.5 metres (1,474 kc/s) which wavelength they would share, as at present, with Greece. The station at Tassolimencia which shares this wavelength is under construction and will have a power of 15 kW.

**Exclusive Wavelengths**

One of Great Britain's two exclusive medium wavelengths would be retained by London Regional—315.5 metres (931 kc/s). Lianagarvey, the N. Ireland Regional transmitter, has virtually had an exclusive wavelength so far, for the Palestinian station, with which it was to have shared its present frequency, is not yet built. In the proposed plan they are to share 285.4 metres (1,051 kc/s).

Medland Regional has so far shared its wavelength with Chernoigov, a 4-kW Russian station. This arrangement is proposed to continue on 276 metres (1,067 kc/s). The proposed East Anglian station, about which much has been written, receives its first official recognition in the new plan—Norwich is to share the Midland Regional wavelength.

The West of England Regional (Washford) will again share with Krasnodar, a 5-kW Russian station, its proposed wavelength of 265 metres (1,132 kc/s). As in the Lucerne plan, Stagshaw (North East Regional) and Alexandria I (1-kW) would share 249.2 metres (1,204 kc/s). Hingham, a non-signatory to Lucerne, also transmits from its 625-kW station at Nyiregyhaza on Stagshaw's present wavelength.

The "Little Nationals," London, North and Scottish, is planned to drop to 243.7 metres (1,204 kc/s) which wavelength they would share with a Turkish station. That is the present arrangement, but Turkey not having utilised this wavelength it is virtually exclusive.

Aberdeen, which at present shares 233.5 metres with Greece, the station at Slaithwaite, which shares 243.7 metres (1,204 kc/s) with Danzig (0.5 kW) is proposed to lower from 1,500 to 1,415 metres. We will retain our one exclusive or nearly exclusive wavelength, which is 285.4 metres (1,051 kc/s). Lisbon shares this wavelength it is proposed to lower from 1,204 to 1,051 kc/s.

TELEVISION FROM THE THEATRE

**Monthly Transmissions from London**

FOllowing upon the success of the recent inaugural television transmission from the Coliseum stage, an arrangement has been made with Sir Oswald Stoll whereby the B.B.C. will broadcast a series of monthly television transmissions from the Coliseum. The Coliseum has been rented for Tuesday, February 21st.

It is emphasised that the new feature, "Coliseum Night," will be the straightforward televising of an ordinary performance. Television cameras will be inconspicuously placed at the side of the dress circle and the transmission will be produced for television by Mr. Philip Dorté in the mobile control room parked outside the theatre. From here the vision signals will be conveyed by cable to Alexandra Palace for retransmission.

The Coliseum has been specially wired for television, and is thus the first theatre in the world to be so equipped permanently.

**TELEVISION AND THE CINEMA**

As the result of an arrangement between R.K.O. Radio Pictures and the National Broadcasting Company of America, a ten-minute version of the new Kipling film, "Gunga Din," is being shot for television.

The presentation of "super trailers" by means of television will, it is thought, provide an amusing feature for viewers, allow them to see their favourite artists on their own screens and, incidentally, publicise the film. The arrangement introduces co-operation instead of competition between the television and cinema industries.
THE WEEK

HOME FACSIMILE SERVICE
Plan for Radio Newspapers

SIMPACTY is a salient feature of the R.C.A. home facsimile receiver which is now in production in the U.S. The receiver, which is no bigger than a radio-gramophone, when once adjusted needs no further attention, an automatic time switch setting the receiver in motion when the transmission of the radio newspaper begins and switching off again when it is completed.

It is announced that more than half a dozen stations in various American States have ordered facsimile transmitting equipment, and the Federal Communications Commission is issuing licences provided that the station undertakes to place at least fifty receivers in home service. When the services begin in the Spring or early Summer, most of the stations will transmit between midnight and dawn so that the newspaper will be completed before breakfast.

The method of transmission briefly is, that the text having been placed on the transmitting cylinder is horizontally scanned by a beam of light as the cylinder slowly revolves. The light is reflected and focused on a photo-electric cell which transforms the varying intensity of light into electrical impulses. In the receiver rolls of white paper, 8½ inches wide, and ordinary carbon paper are fed past a metal cylinder, which is synchronised with the transmitter. On the cylinder is a single spiral of wire which projects only a fraction of an inch above the surface. The fluctuations in the intensity of the incoming signals press the paper and carbon together against the spiral, thereby making marks corresponding to the light and shade of the original text.

The facsimile signals can be heard on an ordinary receiver as high-pitched tones of varying intensity.

RADIO NEWSPAPERS. The R.C.A. facsimile receiver which is no larger than a radio-gramophone.

NEW TRANSATLANTIC AIR SERVICE
Running Commentary on Initial Flight

AMERICA is soon to inaugurate the transatlantic air service with Pan American Airways' Yankee Clipper No. 17. Installation of wireless equipment which will keep the 'plane in touch with the networks of B.B.C., Pan American and the Federal Communications Commission was completed by Mr. Clyde Houldson, short-wave field technician of WABC.

The equipment built to the specifications of the C.H.S. engineering department, and Mr. Houldson, as well as operating it, will act as announcer.

The two-watt transmitter has been assigned the call letters WCHN, and has been licensed by the Federal Communications Commission to use right special frequencies within the 1,600-kc. to 23-megacycle range. It has been installed in the lower compartment of the 'plane's nose and will be remotely controlled from the radio room on the upper deck. It is amusing to record that by an agreement between C.H.S. and Pan American Airways, the weight of the equipment, "plus Mr. Houldson," must not exceed 1,000 lb.

BRITISH TRANSMITTER FOR SIAM

The Siamese Administration, which has for some time been planning an important extension of its broadcasting system, has placed the order for its new 100-kw national broadcasting station, to be erected at Bangkok, with Standard Telephones and Cables, of London. The Administration has thus followed the lead given by the B.B.C., whose two most recent stations, Stagedaw and Aberdeen, and those under construction at Sturt Point and Clevedon, are "Standard" equipments.

The order, which will amount to approximately 60,000, includes studio equipment and a "Standard-Blaw-Knox" vertical mast anti-fading aerial, and is the first of this type to be used. It has an extremely long mast which varies the constants of the radiating system.

STANDARD FREQUENCY BROADCASTS
A Tuning Note for Musicians

The lane of musicians is that of mixing instruments of various make. This difficulty has frequently arisen with international exchange programmes when the two orchestras taking part are tuned with slightly different frequencies. The German broadcasting authorities have now introduced an excellent scheme to overcome this.

Each morning from 10 G.M.T. will be broadcast from Deutschlandsender a fourteen-minute standard frequency transmission. A tuning note, the international 440-cycle o', will be broadcast during part of the transmission. The remainder of the time will be occupied by the transmission of a 1,000-c/s note, which will also be generated at the Electrical and Physical Institute of Berlin, with an accuracy of 10-6.

THOSE "MYSTERY" STATIONS

At this time of the year the B.B.C. receives a crop of reports that the long-wave National suffers from fading, and 1939 is no exception. Cornwall and Devon are the worst sufferers, but complaints also come from the Newcastle district. Fortunately, the trouble is seasonal.

An epidemic of "mystery" transmitters is also reported. These unknown stations are said to be deliberately jamming either the local station or Dortwich. Fading is considered to be the probable explanation. When signal strength is lost, distant transmitters on adjacent wavelengths make themselves heard, and the non-technical listener concludes that some malign influence is at work.

SELFRIEGE'S TELEVISION EXHIBITIO

Programmes from Model Studio

"TELEVISION is going to be the salvation of radio—five years' time," said Mr. Gordon Selfridge, jr., after a recent visit to Alexandra Palace. On Monday he presided at the opening by Mr. Jack Hulbert at Selfridge's Oxford Street Store, of what is the largest television exhibition to be held in a department store.

This exhibition, which has been arranged by H.M.V. with the co-operation of the B.B.C. and E.M.I., and includes a large television studio and a complete Marconi-E.M.I. transmitter, will remain open for seven weeks.

Every available make of television will be linked to the transmitter from which they will be fed with the normal B.B.C. programmes as well as those emanating from the model studio. In this way, a continuous programme will be available from 10.30 a.m. until 7 p.m.

The thirty-eight receivers in the exhibition hall have been arranged in separate low threecided booths, and visitors can also see the actual performance in the glass-fronted studio. A further 15 televisions are scattered throughout the store.

TELEVISION BANS LIFTED

Two television bans have been lifted by the announcement that the B.B.C. is to televise the Boon-Danahar fight for the British Lightweight championship at Harringay on February 23rd. The B.B.C. is not paying for the right to transmit the fight because it has agreed to the promoter arranging for the Gaumont-British Picture Corporation to project the transmission on the Baird large-

STUDIO B CONTROL GALLERY at Alexandra Palace. On the left is the vision mixing desk for combining the outputs of three cameras and the telecine channel. The producer's desk, with microphone for passing instructions to the cameramen, is on the right with the monitor receivers in the background. Through the window on the right can be seen the microphone boom in the studio.
News of the Week—

Radio and Television—

Screen systems at the Tatler Theatre and Marble Arch Pavilion to their paying audience.

Previously the B.B.C. has not allowed the projection of its transmissions to paying audiences at cinemas and boxing promoters have so far banned the televising of big fights.

B.B.C. STAFF ON LISTENER RESEARCH

The B.B.C. Listener Research Section is calling upon its colleagues of the general staff to help in a questionnaire based on the Sunday morning programme, “This Symphony Business.” Hitherto only the engineers on the B.B.C. staff have been asked to co-operate in this way in their spare time.

Engineers do a considerable amount of listening at home for test purposes. At times they are asked to report on signal strength, modulation, etc., and to report on the results of aerial adjustments, new microphone and other changes. Many of them have been “on duty” in their off-time, and quite a few who have been on duty in the control room all day will admit that, on reaching home, they sit up through the small hours, listening on the short waves.

B.B.C. AND THE I.R.A.

Broadcasting House, guarded like a fortress during the crisis, is once again on the defensive, following the bomb disturbances in London.

Porters and commissionaires have been warned to be doubly vigilant, and a watch is kept for any strangers who might wander in the direction of the entrance when interviews are terminated, though this delinquent is once again on the run.

Waverley

Vigilant, and a watch is kept for any strangers who might wander in the direction of the entrance when interviews are terminated, though this delinquent is once again on the run.

BROADCASTING

Electronic Interference

The Town Council of Zanzibar, the small Italian town on the Adriatic coast, has allocated a sum of money to be spent each month to combat and reduce electronic interference in the district.

Inventions Exhibition

The annual Inventions Exhibition organized by the Institute of Patents, which is being held in the Royal Horticultural Hall, Vincent Square, London, S.W. 7, opened yesterday, February 18th, and will remain open until February 25th.

Milan’s New Studios

E. I. A. E. is planning a competition, which is open to all members of the Fascist party, for the design of new studios to be erected in Milan. The total cost of the new building is not to exceed more than eight million lire (approx. £50,000), and the first prize will be fifty thousand lire.

TELEVISION PROGRAMMES

Vision 45 Mc/s

An hour’s special film transmission intended for demonstration purposes will be given from 11 a.m. till 12 noon each weekday. The National or Regional programme will be radiated on 41.5 Mc/s from approximately 7.45 to 9 p.m. every day.

THURSDAY, FEBRUARY 16th

1, Alfredo and his Orchestra. 3.25, Gaumont-British News. 3.35, 217th edition of Picture Page.

1, Alfredo and his Orchestra. 3.25, Gaumont-British News. 3.35, 217th edition of Picture Page. 10.15, News.

FRIDAY, FEBRUARY 17th

1, Grandfather's Follies. 3.35, Cabaret from Grosvenor House. 3.45, Schoolboy Howlers. 3.45, British Movietone News. 3.50, Music Makers, Ennico Gardiner (pianoforte).

9, News Map No. 11—Italy. 9:15, News. 9:30, Gaumont-British News. 9:40, British Movietone News. 9:50, Music Makers, Ennico Gardiner (pianoforte).


SUNDAY, FEBRUARY 18th

3, The Jacquard Puppets. 3.10, Gaumont-British News. 3.20, "Fat King Melon," a children’s play, by A. P. Herbert. 4.05, British Movietone News. 4.10, "Autogiros," O.B. from the Zoo.

9, "A Tune to Take Away" (2nd edition), a revue. 9.30, British Movietone News. 10.15, News.

9, "A Tune to Take Away" (2nd edition), a revue. 9.30, British Movietone News. 10.15, News.

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9, "A Tune to Take Away" (2nd edition), a revue. 9.30, British Movietone News. 10.15, News.
Simplified Variable Selectivity

The problem of varying the selectivity of a receiver, especially by methods involving variation of the response curve of the intermediate-frequency section of a superhet receiver, is one which has called forth a great variety of solutions, all more or less satisfactory. These solutions can be divided, broadly speaking, into two categories: those in which the shape of a band-pass curve is modified by variation of coupling, and those in which the detuning of the circuits in opposite directions provides the major control.

Fig. 1.—Arrangement of coupling transformer providing variable selectivity by means of staggered tuning.

The methods which may be included in the former class involve the control of an actual coupling reactance or of the mutual coupling between the two inductances. Any variation but that of "mutual" alone inevitably varies the effective tuning frequency of the circuits, and necessitates a further subsidiary control, albeit automatically connected, to maintain the mid-point of the new resonance curve at its old position. The same disadvantage, though to a lesser extent, is also inherent in variation of mutual, since, even if the stray capacity between the coils and the smaller effect of the copper of one coil in the field of the other are eliminated by means of a static screen between the coils, the self-inductance and stray capacities are affected by variation in the proximity of external screens and the static screen.

It is therefore desirable in the case of control by mutual, and essential in all other cases, to provide small additional circuit elements for the correction of the mean frequency. If these balancing elements are to be used to best advantage, ganging of the circuit is necessary not only in the under-coupled condition, but also when the over-coupled condition is being used; and it is in practice extremely difficult to obtain the ideal adjustment of a band-pass circuit in the hypercritical condition.

Because of these difficulties it is interesting to consider the alternative method already mentioned, namely, control by detuning circuits in opposite directions. As is well known, it is clear in mathematical analysis that the effect of detuning the circuits equally in opposite directions is identical, except in gain, with that obtained by over-coupling; and since the greater band-width is normally only required when receiving stations of adequate field strength, the small loss of gain is not a serious consideration.

Short-circuited Auxiliary Windings

It has in the past been suggested that this method can be carried out by using a differential condenser to transfer capacity from one circuit to the other. When, however, it is only necessary to provide a simple two-position band-width control, it is possible to use a method in which the inductances of the primary and secondary coils are altered by the short-circuiting of auxiliary windings, which are placed near to the tuned windings. One such coil would be associated with each winding on the outer ends of the common former, and connected to a switch so as to be opened or closed alternatively. The circuits will inherently be tuned to different frequencies, and the coupling will be below the critical value; adjustment of the circuit will be made so that the coils are tuned to the same frequency when one short circuit coil is closed. When the switch position is reversed the one coil will tune to a lower and the other to a higher frequency than before, and a band-pass response will be obtained. Preservation of the correct centre frequency is achieved by spacing the shorting coils so that both frequencies are changed by the same amount. The heights of the two peaks will be equal if the two circuits, in the "broad" condition, have the same magnification factors; to enable this to happen without extra damping it is an advantage to connect the transformer in circuit so that the coil which is controlled by the shorting coil in the broad condition is the one which is naturally less damped by its other circuit conditions.

The physical arrangement of a unit of this type is shown in Fig. 1. The functions of the various coils are indicated by the circuit diagram of Fig. 2, while Fig. 3 shows the response of the unit (a) with neither coil shorted, (b) with the switch in the selective position, and (c) in the broad position. In practice, good

Fig. 2.—How the windings of the transformer of Fig. 1 are connected.

Fig. 3.—Selectivity curves obtained with the shorting switch in various positions.

BOOKS RECEIVED

Processes and Machinery in the Plastics Industry. By Kurt Haudenburger. Pp. 243; 164 illustrations. Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, London, W.C.2; price 5s. Dealing with the moulding of synthetic resins and resinoid compounds; the nature of the materials and processes are fully described.

Trade Marks. By Reginald Haddan. Pp. 128. Sir Isaac Pitman and Sons (address above); price 5s. Written with special reference to the Trade Marks Act of 1938, this book deals with the nature of trade marks, their ownership, registration and protection. Notes on protection abroad are included.


Radio Facsimile. By various authors. Pp. 351; numerous illustrations. R.C.A. Institutes Technical Press, 75. Varick Street, New York, U.S.A. A collection of pages by R.C.A. engineers relating to the transmission and reception of "still" images. The history and development of "photograph" services are covered as well as the more recent methods of radio facsimile broadcasting.

USE OF "STAGGERED" CIRCUITS

By R. E. SPENCER

Fig. 1: Arrangement of coupling transformer providing variable selectivity by means of staggered tuning.

Fig. 2: Diagram showing how the windings of the transformer of Fig. 1 are connected.

Fig. 3: Selectivity curves obtained with the shorting switch in various positions.
Television and the Cinema

I was very gratified to hear, in the course of the B.B.C. broadcast debate on good manners the other evening, that somebody had the courage to get up and protest against the increasingly bad behaviour of the modern theatre- and cinema-goer. It was stated, quite rightly in my opinion, that, whereas at one time the theatre-goer was as dignified and decorous in his behaviour as the old-time Victorian concert enthusiast, all this has now vanished.

Most people seem to attend places of entertainment nowadays for no other reason than to indulge in an orgy of eating and conversation. Not so very long ago, when I was attending a concert in the West End of London, the young lady sitting next to me not only insisted upon talking loudly to her companion and noisily masticating chocolates all the time, but finally upset a cup of tea down my shirtfront. She did not offer me one word of apology, but merely made a ribald remark to her companion about "taking the starch out of him," alluding, I presume, to my ruined shirtfront.

In cinemas things are a good deal worse, and even the practice of bringing small portable receivers into the cinema is rapidly growing, the reason being that the person bringing it only wants to see one particular film on the programme, and turns the set on to while away the time when the other films are being shown, quite regardless of the fact that other people are thereby prevented from following the dialogue.

In view of the foregoing facts, I was very pleased to read in my newspaper the other day that an old idea which I put forward in these columns some years ago is now being hailed in America as a new and revolutionary invention. I am sufficiently devoid of selfish motives to be glad that the idea is being discussed and that there is a possibility of it being put into practice; it does not matter in the least to me who gets the fleeting and tinsel glory of being acclaimed as its originator.

Briefly the idea is that, instead of our being compelled to attend cinemas and to sit through hours of discomfort, the programme should all be televised from a station set up in each district by the cinema industry so that we could see the pictures in the comfort of our own homes. Faradia tells me that the scheme would be foredoomed to failure, since it is only old-fashioned people like myself who go to cinemas for the purpose of seeing the pictures.

Courtesy Cops of the Ether

As most of you know full well, there has never been anybody more enthusiastic than myself in championing the rights of wireless enthusiasts against the interference of petty fogging oficialism, but at the same time I have always been a staunch upholder of law and order. It was for this latter reason that many years ago when the oscillation nuisance was at its height I refused to join certain marauding bands in my neighbourhood who went round at dead of night and usurped the functions of the law by chopping down the aerial poles of known offenders.

My respect for law and order extends to other spheres of activity apart from wireless, and I was, therefore, exceedingly astonished to find myself ignominiously gonged when driving well within the speed limit through a residential area near London the other evening. With some show of impatience and indignation I drew into the kerb and waited for the police car to come up to me, and I was very surprised when there descended upon me two very unofficial looking individuals holding what looked like a portable wireless set.

With a polite smile they presented me with a printed pamphlet and explained that they were the courtesy cops of the ether and had stopped me because they had discovered from the portable ultrashort-wave receiver they were carrying that I was causing severe interference on the television wavelength, and as this was a district in which there were a large number of television viewers, I was marring their enjoyment of the programme. The television viewers in the vicinity, they told me, had formed themselves into a band of courtesy cops and parties of them were employed every night in stopping drivers whose cars were causing interference to television. Some were stationed at cross-roads detecting and stopping cars, and others were engaged in mobile work, as they were.

I at once protested against this unwarrantable taking of the law into their own hands and interfering with the liberty of the subject, and at the same time I protested also against their stopping me for, as I explained to them, my car ignition system was fitted with a very complete suppression installation, and I flung open the bonnet to illustrate my remarks. For a moment I was struck dumb with surprise because there was no sign of any suppressors at all, but closer inspection of the engine caused me to realise the true state of affairs, namely, that through some act of forgetfulness I must have driven off in the wrong car at the conclusion of the annual dinner of the local radio society which I had just been attending.

The two self-constituted sleuths received my explanations with some suspicion, and before I knew what had happened they had stopped a genuine police car and reported that they believed that I was in unlawful possession of the car, and not unnaturally the police were somewhat suspicious and we all had to adjourn to the police station. By the time their enquiries were completed another day had dawned, and when I finally did arrive home I ran into yet more police, as Mrs. Free Grid, after waiting up for me until 4 a.m. had dialled 999.

A Feline Fallacy

I have had several letters from readers as the result of my investigations which revealed that stroking of cats was causing interference to television, due to the well-known fact that when cats' fur is rubbed with some other substance static charges are generated. Many readers claim that widespread interference must, therefore, be caused by the well-known habits which cats have of licking and scratching themselves. This theory is quite untenable, however, since my informants obviously forget that it is impossible to generate electrical charges of any magnitude by rubbing cat with cat. The substances must be dissimilar.
Output Stage and Loud Speaker

VALVE DAMPING, NEGATIVE FEEDBACK AND TRANSFORMER DESIGN

The damping on the voice coil of the loud speaker, due to the low plate resistance of the valve, is one of the most important properties of a valve driving a loud speaker. The damping factor is suggested as being numerically equal to the ratio of load resistance to valve plate resistance, and is an indication of the degree of damping due to the plate resistance of the valve. The damping factor is calculated under static conditions, but it will be seen that in the case of the bass resonant frequency of a loud speaker the damping will be increased by the ratio of the impedance at 400 c/s to the impedance at bass resonant frequency. The damping of even a poor loud speaker is heavy, while the damping with pentodes or tetrodes is not uniform over the cycle, but varies enormously as shown in Figs. 5 (a) and 5 (b) (β = 0). It will be seen that in the case of the pentode the plate resistance varies between 3,000 and 150,000 ohms, a ratio of 44.5 to 1, over the cycle. With a positive peak of signal voltage on the grid the damping is heavy, while at other portions of the cycle the damping becomes much less, particularly at the higher negative grid voltages.

The feedback factor is not equal to the ratio of voltage divider across the load, since there is a shunting effect due to the plate resistance of the previous valve, and the grid resistor of the power valve in parallel. This latter factor is, however, constant under normal working conditions, and the feedback factor may readily be adjusted by a variation in the voltage divider. This method functions through a nodal point being developed in the plate resistor, the opposite ends of which vary in voltage approximately 180 degrees out of phase. The nodal point is not constant but shifts, due to distortion in the circuit. Due to the nodal point on the load resistor, the AC load presented to the preceding valve is less, and the gain and maximum voltage output from the stage are thereby reduced. It is essential to employ a valve having high-plate resistance in the earlier stage in order to avoid excessive shunting, and a resistance-coupled pentode is generally employed, since it also provides sufficiently high gain and sufficiently high voltage to permit the application of negative feedback, and still to be able to excite the output stage with a low percentage of distortion.

Current Feedback

The method previously described, and, indeed, all methods of "voltage feedback," result in a reduction of the plate resistance of the valve. It is possible, however, by means of "current feedback"

Concluded from page 136 of last issue

Output Stage and Loud Speaker

to obtain negative feedback which provides a reduction of harmonic distortion, but results in an increase of the plate resistance of the valve. This is the case, for example, in the well-known arrangement with self-bias with the cathode bias resistor not by-passed. With such a circuit the damping from the plate resistance of the valve is very slight, and this method is therefore less satisfactory in response to transients.

Feedback Calculations

It is readily possible to calculate the degree of feedback to give any required degree of damping. The output resistance, \( R_o \), of a valve under these conditions is

\[
R_o = \frac{1}{K - \beta g}
\]

where \( R_o \) = plate resistance of valve, \( g = \) mutual conductance, \( \beta = \) fraction of output voltage feedback. Of course \( \beta \) may be adjusted to give any required value of \( R_o \). In this expression \( R_o \) may be regarded as a differential coefficient, and may be substituted for \( R_o \) in calculations where feedback is used. For full-grid excitation it is necessary to calculate the value of \( R_o \) at several points along the load line and to plot a curve as has been done in Figs. 5 (a) and 5 (b) for values of \( \beta \) from 0 to 0.5. It will be seen from these curves, first, that there is a large decrease in the plate resistance due to feedback, and, secondly, that the variation of plate resistance along the load line is reduced. In other words, the damping on the loud speaker is both heavier and more constant, due to feedback. It is evident that by the use of sufficient feedback the plate resistance of a pentode or tetrode may be reduced to any desired required value, although a constant variation over the cycle is inevitable. This variation may not be any greater than that occurring with a triode valve, and does not appear to be serious for values of \( \beta \) of the order of 0.2.

Any phase shift in the feedback network will cause an increased effective plate resistance, while a similar effect is obtained when the load is partially reactive.

In early work on negative feedback it was accepted that the amplitude of each harmonic component was reduced in proportion to the gain reduction factor. Later research [see Bibliography 7 (4), 7 (3), 7 (4), 7 (5)] has indicated that similar simple treatment is subject to modification due to cross modulation in the amplifier. The errors in the simple treatment appear to be comparatively slight for practical cases where the distortion without feedback is not excessive, and in many cases the simple treatment may be considered sufficiently accurate.

The gain reduction factor of a negative feedback amplifier is

\[
\frac{1}{1 + \beta A}
\]

where \( A \) = the amplification of the amplifier without feedback, and \( \beta = \) the fraction of the output voltage which is fed back to the input, being negative for negative feedback.

This factor, therefore, also denotes the approximate reduction in harmonics with a resistive load due to feedback.

The application of a fixed negative feedback factor to an amplifier introducing frequency distortion is to improve the frequency response. With 'voltage feedback' the effect of the feedback with a load of varying impedance is to improve the constancy of the voltage across the load. With voltage feedback of constant feedback factor on a loud speaker load the degeneration increases as the impedance increases at the bass resonant frequency, and at the higher audio frequencies, thereby reducing the rise of output voltage which would otherwise occur at these frequencies. For this reason it is unnecessary to fit any resistance-capacity filter across the load. An obvious consequence is that no tone compensation occurs, as with a pentode valve, towards the extreme limits of frequency range, and the response approaches that of a triode valve. A further consequence is that a small condenser placed across the load is very effective for attenuating the higher frequencies. With 'current feedback' under similar conditions the effect is to approach more closely the constant current in the load.

Transformer Design

Most treatments of transformer design assume that the loud speaker has a constant resistance equal to the equivalent impedance of the loud speaker at 400 c/s. As has been shown earlier in the paper, the loud speaker impedance characteristic has a minimum about 400 c/s, rising to a peak at a certain low frequency, usually about 80 c/s, and rising again at higher frequencies. For the purpose of calculation it is suggested that in cases where the individual characteristics of the loud speaker are unknown, an impedance of six times the impedance at 400 c/s should be used as the basis of design for the extremely low and extremely high frequencies.

In the case of a loud speaker with a bass resonance at 80 c/s and whose response is required to be as uniform as possible up to 8,000 c/s, it is necessary to consider the design of the loud speaker transformer at three different frequencies. The inductance of the transformer should be designed to give satisfactory results at the low-frequency resonance of the loud speaker. In this case 80 c/s. In the case of a triode valve it is desirable to maintain transformer linearity down to the resonant frequency, and, therefore, it will be necessary in the assumed case of design for negligible drop in output at 80 c/s with a secondary load of six times that at 400 c/s. This will mean that the inductance of the transformer should, in the assumed case, be six times that given by the more usual calculations. Of course with loud speakers having improved damping, the rise of impedance at the bass resonant frequency will be less, and the inductance of the transformer may be correspondingly less. Reasons of economy generally result in the inductance being kept down to a low value, and in the case of triode valves this may be done with a slight loss in bass response, although accompanied by an increase in harmonic distortion due to elliptical loading. The power transfer efficiency is largely beyond the control of a loud speaker less at the bass resonance due to the high load resistance, but this is
Output Stage and Loud Speaker—more than compensated by the improved loud speaker efficiency at the resonant frequency.

In the case of pentode valves, the position at the lower frequencies is quite different, since the efficiency of transfer from valve to loud speaker is much greater due to the higher impedance of the loud speaker. For this reason a loud speaker, having a pronounced impedance peak at the low-frequency resonance point, used in conjunction with a wide range transformer, will generally give an acoustic output far too prominent at the resonant frequency. This may be overcome by the use of a loud speaker having a less prominent resonance, or more generally in the lower-priced loud speakers, by the employment of a transformer having an inductance considerably lower than the ideal. By this means the loud speaker impedance is effectively shunted by means of the reactance of the transformer, giving an elliptical load with a maximum impedance considerably less than that of the loud speaker with a perfect transformer. In a number of cases which have been measured, the rise of impedance of the loud speaker at the bass resonant frequency, measured on the primary of the transformer, barely showed any rise whatever. Although the frequency response is maintained level by this device, there is a serious effect on the harmonic distortion due to the elliptical load line entering the region of high distortion during part of the cycle, and in extreme cases even becoming flattened along the lower side due to the valve reaching cut-off. If the valve is operated at a low level this does not have any very serious effect. In midget receivers in which the transformer inductance is necessarily considerably lower than that of the loud speaker with a perfect transformer, the effect of the leakage reactance is much greater and in the total acoustic output must also be limited for obvious reasons, the method is reasonably satisfactory, but a valve capable of giving an output of about 3 watts under ideal conditions may only be capable of giving about one watt under these conditions of low inductance before distortion becomes distressing.

The ratio of the transformer windings will need to be adjusted in accordance with the usual design formula so as to reflect approximately the correct load at 400 c/s.

Leakage Reactance

The rise of impedance of the loud speaker at the higher audio frequencies tends to cause a very slight rise in the voltage applied to the loud speaker in the case of a triode valve, but a marked accentuation of the high-frequency response in the extreme cases. For this reason, in the case of a triode valve, it is desirable to reduce the leakage reactance of the transformer to the lowest possible level in order to maintain as much of the high-frequency response as is possible. In the case of a pentode valve the situation is of less importance, since not only does the efficiency of the transfer increase at the higher frequencies but the effect of the leakage reactance becomes relatively less as the load impedance increases. It will, therefore, be seen that transformers for operating with pentode valves may be constructed with considerable leakage reactance without any serious effect on the reproduction.

A further effect which needs consideration is the variation of the inductance of the transformer with the DC current flowing through it. This is particularly important in the case of Class "B" output stages in which the average DC current varies considerably. In all cases the inductance of the transformer should remain reasonably constant up to the extreme peak current under the worst conditions. If an appreciable change of inductance is permitted, there will undoubtedly be an additional effect on the overall distortion, which, although difficult to calculate, is obvious in its results.

Pentode and tetrode valves with feedback may, for the purposes of transformer design, be treated in a similar manner to triode valves.

Combination Tones

A non-linear device, which is supplied with two equal sine-wave frequencies, is found to produce an output consisting of each of the two input frequencies, together with a number of spurious tones of frequencies equal to the sum or difference of the frequencies of the input tones, or of either or one of its harmonics and the fundamental, or one of its harmonics. In the presence of a complex wave form input a non-linear device would produce an extremely large number of spurious tones which are not present in the original. If a perfectly linear device is fed with a number of sine-wave frequencies, the output will be exactly similar to the input without the addition of any spurious frequencies. In the case of Class "A" triodes, either singly or in push-pull, each valve being operated under conditions equivalent to those of a Class "B" valve, second harmonic distortion when operating singly, the combination tones do not appear to be objectionable. In the case of pentode valves which are operated under conditions of optimum output into a loud speaker load, even though the square root of the sum of the squares of all the harmonic components when the valve is operated into a fixed resistive load is less than about 7 per cent., the output is found to contain extremely prominent combination tones which are largely responsible for what is known as "pentode tone." This pentode tone is produced partly by the higher percentage of odd harmonics, particularly the third and fifth harmonics, together with pronounced combination tones. Cross modulation also is found to exist in the output of pentode valves [see Bibliography 9 (1)]. Cross modulation may be defined as the effect obtained when a variation in the amplitude of one input signal affects the output amplitude of another signal of different frequency but having a constant input. It may be demonstrated by feeding the grid of the valve with two frequencies, one at, say, 110 c/s and the other at, say, 1,000 c/s. If no cross modulation is present a variation in input voltage of either signal will not cause any variation in the output of the other signal. If cross modulation is present a variation in the voltage of one will cause a variation in the output voltage of the other. This effect is sometimes observed while listening to a violin or similar instrument with an organ accompaniment, the amplitude of the higher frequency sound varying in accordance with the more powerful low-frequency accompaniment.

It has been shown by Terman [see Bibliography 9 (2)] that combination tones exist in conjunction with any order of harmonic distortion, but that cross modulation does not occur when the harmonic distortion is only of the second order. This means that Class "A" triodes operated under normal conditions will not produce audible cross modulation, although there will be combination tones of small amplitude. A pentode valve operated under normal maximum conditions will produce both combination tones and cross modulation, the intensity being dependent upon the degree of distortion. It has been shown [see Bibliography 9 (3)] that the amplitudes of the combination tones are higher when the distortion is due to higher order odd harmonics, assuming constant harmonic percentage in all cases.

As indicated in the introduction, a limit of 2.5 per cent. for the third harmonic and of 0.5 per cent. for the higher odd harmonics is reasonable, and this results in an output quality which has not, so far as the writer is aware, been criticised by the most musical ear. The fact indicates that not only the harmonic distortion itself but the indirect effects in the nature of combination tones and cross modulation are not objectionable when the harmonic distortion is maintained within these arbitrary limits.

Criteria of Performance

The importance of the higher order harmonics, which is not in proportion to their amplitudes, indicates that the conventional method of indicating the total harmonic distortion as the square root of the sum of the squares of the individual amplitudes is not in accordance with the effect on the listener. The writer hopes that this method of specifying distortion will be dropped in favour of a more satisfactory method. An interesting method of "weighting" the various harmonics has been adopted by the R.M.A. [see Bibliography 10 (4)], each harmonic being "weighted" by a factor proportional to the order of the harmonic. The resultant gives a distortion factor which is much closer to the true audible effect than the older method mentioned above. In the opinion of the writer, however, even the amount of "weighting" given in this formula is not equivalent to the objectionableness of the distortion, and still heavier "weighting" of the higher order harmonics is desirable. Considerable experimental work needs to be done before a new formula could be adopted, but the hope is expressed that
The writer is grateful to Amplagamated Wireless Valve Co. Pty., Ltd., for permission to present this paper.

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7. Negative Feedback.
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APPENDIX 1

1. Plate Resistance (Ohms)
   Tube Type: A
   Load Resistance (Ohms)
   Plate Current (ma.)
   Voltage across plate load (volts)
   Plate efficiency
   Plate voltage (volts)
   Plate current (ma.)
   Grid efficiency
   Time constant (sec.)
   Output voltage (volts)
   Output current (ma.)
   Output power (watts)
   Sensitivity factor
   * * *

APPENDIX II

Comparing Triodes and Pentodes with Tetrodes with Negative Feedback.

In the following table comparisons are made between two 2A3’s in parallel, two 6L6’s in parallel and one 6L6 for the latter two the factor of negative feedback adjusted so as to give the same damping factor (R, K) as the triode combination.

Henry Farrad's Solution

No, it certainly was not! If it had been necessary to replace the items mentioned, no doubt the estimate would have been reasonable. But if the HT supply had failed it would have been impossible for Emily Simple to notice that the green light in the tuning indicator, for there could not have been any green light. Therefore, the dealer was wrong. He probably found a simple open-circuit or even a displaced valve connector on the HP side, for which he could not make a very profitable charge honestly, and intended to charge for fictitious replacements.
Random Radiations

Battery Sets and A.R.P.

THERE'S not much doubt that the sales of battery sets have been increased considerably during the last six months by Air Raid Precautions. One Government publication on the subject suggests that a receiver as part of the 'dug-out' or 'refugee-room' equipment, and the battery set is indicated since it is independent of possible blackout, which may be intentional or accidental. But, unfortunately, you can't just keep the ordinary battery set in cold store, so to speak, and just bring it out for use after not having looked at it for months. The trouble is that for 2-volt cells you need a filament accumulator, and accumulators must have periodic attention whether they are used or not. The best solution if you have such a battery set which you want only for emergency use is to arrange with a good charging station to store your accumulators for you. To guard up them in good condition. Good quality dry HTBs should have a shelf life of at least six months; they can be stored away so long as you choose a place which is both cool and dry.

Dry Filament Batteries

One obvious solution of the problem of the battery set which is intended to be kept as a standby and not regularly used is to employ the new valves with low-voltage, low-consumption filaments, and to obtain the L.T. current from a single dry cell of the right kind. Economical running is required, as no doubt it is, it's no use trying to make these valves up into small, light portable receivers, for in such there simply isn't room for the fairly hefty filament cell that is called for. You used to be able to buy, and I expect you still can do so, large square dry cells of the kind used by some of the railway companies for various purposes. I even think I am right in saying, have a guaranteed shelf life of a good deal more than six months, and one of those would run a 4-volt receiver, day after day, without blow-out. Gratifyingly, it might be of no bad idea to use the wet instead of the dry Leclanché cell. The ordinary bell cell wouldn't do, but there is one with a suitable depolariser contained in a large sac instead of a porous pot.

A New Cell

SOME three years ago, if memory serves, The Wireless World published an exclusive account of something entirely new in primary cells. It was then stated that the cell was still the subject of laboratory research work, and that it was not going into production until those responsible were satisfied with their product. I am told, however, that this cell, the Gordon, is to be available commercially very shortly. I have seen it in its final form, but, from what I read of it and heard of it originally, it seemed to have distinct possibilities. Magnesium is the most important of the materials used, and the electrolyte is just tap water. In its commercial form it is claimed that the cell will have a constant EMF of 2 volt throughout its service life, and it can be kept in its final form for months, provided, of course, that they can stand up to the load for a reasonable length of time. I am looking forward to hearing more about this cell.

Bus Conductor's Holiday

COMING home late the other evening in a cross-country bus I found myself the only passenger, and the bus conductor began to make conversational openings when he had snipped my ticket and pushed the fare. He was looking forward, he told me, to his holiday, which wasn't so very far away as he had managed to secure one of the earliest turns. When I suggested that the weather was apt to be rather a problem if one took one's spell very early in the year, he assured me that he didn't care if it snowed ink. He got plenty of fresh air whilst doing his job; his holiday would be spent entirely at home tinkering with wireless sets. His hobby was to buy for an old song sets which people had given up as hopeless. These he pulled entirely to pieces, casting out all defective and doubtful parts. Then by combining the best components selected from several cast-off receivers he was able to make himself a first-rate set at the smallest possible cost. He was very proud of the one which he was then using. It was made from the remains of three sets and cost him something under 1 pound. He had recently purchased a fine batch of discarded receivers and he intended during that precious holiday to make something that would put all previous efforts into the shade. Power to his elbow! I hope that his this year's model will be a winner.

Non-stop Noise

MY sympathies are all with those who complained recently that a neighbour's wireless set was kept going full blast for as much as ten hours a day, to their own great discomfort. The evidence showed that the noise sometimes continued until 1 o'clock in the morning, and one neighbour stated that he had had to change his bedroom to the back of the house to avoid being disturbed. The magistrate inflicted a penalty of £1, plus the best part of a river in costs, and said that he wished that the Bench had the power to confiscate the receiver. Wireless is a source of so much pleasure to such vast numbers of people that any abuse of it, whereby it is turned into an infraction, is a thing that we should all seek to avoid.

Resonance Effects

Some time ago, when I'd taken a small furnished house for holiday purposes, I had a very unpleasant sample of the maddening kind of nuisance that someone else's loud speaker can cause. The set responsible was located in a house about sixty yards far away as he had managed to secure one of the earliest turns. When I suggested that the weather was apt to be rather a problem if one took one's spell very early in the year, he assured me that he didn't care if it snowed ink. He got plenty of fresh air whilst doing his job; his holiday would be spent entirely at home tinkering with wireless sets. His hobby was to buy for an old song sets which people had given up as hopeless. These he pulled entirely to pieces, casting out all defective and doubtful parts. Then by combining the best components selected from several cast-off receivers he was able to make himself a first-rate set at the smallest possible cost. He was very proud of the one which he was then using. It was made from the remains of three sets and cost him something under 1 pound. He had recently purchased a fine batch of discarded receivers and he intended during that precious holiday to make something that would put all previous efforts into the shade. Power to his elbow! I hope that his this year's model will be a winner.

The National Wireless Register

THE response of The Wireless World's appeal to its readers to fill in and despatch the National Wireless Register form will, I feel certain, be excellent. I hope that you've sent yours in; but if you haven't, now's the time. Large numbers of people with some knowledge of wireless are sure to be wanted in an emergency (let's hope in a way that there won't be one), and the register will enable the authorities to make the best and quickest use of those who are available. Filling in the form doesn't bind you in any way; it just shows the compilers of the register that you are willing to give what help you can if you're wanted. Within a day or two of sending in the form you'll receive a letter from the Secretary acknowledging its receipt and saying that a further communication will come along presently. Don't imagine, by the way, that it's only skilled morse operators who are wanted. Anyone who can read blueprints and understands the general theory of wireless can be useful. Send in your qualifications and the Wireless Telegraphy Board will let you know whether there's any niche that you can fill in its scheme.

NEW PHILIPS PORTABLE

BASED on the design of the Type 223B portable is a four-valve superheterodyne incorporating a frequency changer, IF amplifier, double-diode triode second detector, AVC and first AF amplifier and a pentode output valve. The new instrument retains all the qualities of range and selectivity associated with its predecessor and a new loud speaker has been fitted to improve the quality of reproduction. Changes have also been made in the control panel and the metal carrying handle now sinks flush with the top of the moulding.

The average HT consumption is 8 mA and the price, complete with batteries, is £3 guineas.
Recent Inventions

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

AUTOMATIC TUNING CONTROL

In an automatic tuning correction system the correcting voltage derived from the usual frequency-discriminating circuits is applied to bring the local oscillator into tune after the mixing valve V, say at any desired degree of damping on the sound-waves. A. B. House. Application date, June 19th, 1937. No. 497222.

BROADCASTING STUDIOS

In order to regulate the acoustic properties of a studio, and particularly to modify reverberation effects, the walls are lined with a sound-absorbing material made from sheets of brown paper or thin cardboard. Several sheets, pasted or clamped together at the top edges, are separated by thin spacers, and the lower edges are left free. The action of the layer on the sound waves is compared with that of a low-pass electric filter-circuit consisting of resistance in series and capacity in shunt. The mass, or weight per unit area, of the brown paper corresponds to the capacity. Both can therefore be varied, by calculation, to produce any desired degree of damping on the sound-waves. F. J. T. W. Convent. Application date, January 22nd, 1937. No. 492635.

TELEVISION TRANSMITTERS

The picture to be televised is first projected on to a photo-electric cathode K, and the resultant feeble stream of primary electrons is focused by a series of ring anodes A1, A2, on to a target electrode T, where it is amplified by secondary emission. The reinforced stream then passes through a second series of ring anodes, A3, A4, which focus it on to a screen S of the mosaic-type. The image charges set up on this screen are then scanned by a stream of electrons from the gun G of the tube, and the resulting picture-signals are led to an amplifier A. The grid-biasing voltages for the various electrodes are tapped off from a potentiometer R.

In the ordinary way any attempt to focus the stream from a plane cathode on to a plane target would produce distortion, since all the picture points could not be brought to the same focus. This difficulty is removed, according to the invention, by making both the cathode K and target T slightly concave, as shown. H. F. Crowther. Application date, June 19th, 1937. No. 479406.

TELEVISION SYSTEMS

The picture-signals developed in an electron camera are passed directly from the scanning apparatus to the first of a series of target electrodes arranged in a projecting part of the same tube, where they are

WAVE-BAND SWITCHING

In an all-wave set the different coils corresponding to each wave-band are housed in separate compartments in one or more different drums. The drums are mounted on the shaft of the wave-change switch, and make the appropriate circuit connections as the shaft is rotated.

Each coil is associated with a tuning condenser, which can be adjusted by screws from outside the drum. The powdered-iron core of each coil can also be adjusted, as desired, from outside. Each tuning unit can, if necessary, be withdrawn from the drum as a whole, in order to replace a defective part, without interfering with the other tuning units. (Mrs.) H. Dent and C. E. Gurney. Application date, March 30th, 1937. No. 490498.
**EVRIZONE QUALITY PRODUCTS**

**COMMUNICATIONS RECEIVER 12-VALVE (+ Rectifier)**
- Incorporating the SUPER TUNER UNIT (as supplied to the B.B.C.)
- Switched Wavelengths: 60 Mc/s to 1.7 Mc/s (5 to 150 metres).
- Price: £30 16s.

**MAGIC MIDGET TRANSPORTABLE—HOME Model**
- Wavelengths: 1.4 to 8-50, 200-250, 900-2,000 metres.
- Price: 8 Gns.

**MAGIC MIDGET TRANSPORTABLE—OVERSEAS Model**
- This is the same as the Home Model except that wavelengths are from 10-250 metres only.
- Price: 9 Gns.

**AVOMINOR**
- Complete with leads, incomparable testing leads, moving-coil clip, and instruction booklet.
- Complete with leads, incomparable testing leads, moving-coil clip, and instruction booklet.
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- Complete with leads, incomparable testing leads, moving-coil clip, and instruction booklet.

**LEIPZIG FAIR 1939**
- The Leipzig Industries Fair, the oldest yet most progressive INTERNATIONAL Trade Fair in the world, offers unequalled opportunities to all buyers to inspect new products, see the latest models, compare qualities and prices, form new buying contacts, and purchase dependable merchandise.

- Over 10,000 Manufacturers from over 25 countries are representing all lines of industry and commerce at Leipzig. The efficient grouping of exhibits at 25 Fair Palaces and 17 Halls simplifies buying.

- INSPECT THE LATEST DEVELOPMENTS IN WIRELESS, TELEVISION SETS AND INSTRUMENTS — BROADCASTING APPLIANCES AND ELECTRICAL ACCESSORIES FOR INDUSTRIAL AND DOMESTIC USE AT LEIPZIG.

- The German Railways allow 60 per cent. reduction—other Railway and Steamship Companies allow similar reductions. Visas are free, and other concessions are granted to all visitors to the Leipzig Fair. Make a note of the dates and write to-day to the London Office for details and all the literature.

General Samples Fair - - - 5th to 10th March
Great Engineering Fair and Building Fair 5th to 15th March

**THE WIRELESS WORLD**, when writing to advertisers, will ensure prompt attention.
NOTICES
THE CHARGE FOR ADVERTISEMENTS—In these columns
12 words or less, 6d; and 3d, for every
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Each paragraph is considered separately and name and
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ADVERTISEMENTS for these columns are accepted up to FIRST POST on MONDAY MORNING (previous
in date of issue) at the Head Offices of "The Wireless
World," 1112/4 Deansgate, Manchester, M.1, or
ON SATURDAY MORNING at the Branch Offices 5-15, Corporation Street, Coventry ; Guildhall
Buildings, Navigation Street, Birmingham, 2; 200, Deansgate, Manchester, 3; 260, Highfield Street, Glasgow, C.S.
Advertisements that arrive too late for a particular issue will automatically be inserted in the following issue upon
unison accompanied by instructions to the contrary. All
advertisements in this section must be strictly prepaid.
The proprietors retain the right to refuse or withdraw
advertisements at their discretion.
Postal Orders and Cheques sent in payment for adver-
tisements will be accepted by C. F. S. Proprietors Ltd., crossed A. C. Co., payable to "The
Wireless World." Notes being unenforceable if left in transit should not be sent as remittances.
All letters relating to advertisements should quote the
number which is printed at the end of each advertisement
and the date of the issue in which it appeared.
The proprietors are not responsible for clerical or
printers' errors, although every care is taken to avoid
mistakes.

NEW RECEIVERS AND AMPLIFIERS

ARMSTRONG
NEW VARIABLE SELECTIVITY
MODEL AV1255P
12-V. 5-BAND ALL-WAVE
RADIOGRAM CHASSIS
(12-550 continuous, 1000-2000 m.)
with R.F. Pre-Amplifier, 2 I.F. stages with Variable
Selectivity, Manual R.F. gain control and 10
words R.C. coupled Triode
P.P. Output.
£17.17

A Few extracts from the Wireless
World
TEST REPORT, Jan. 5th, 1939
It is apparent that the specification of this receiver the
makers have done away with the selectivity features of both long-range
communication sets and quality amplifiers for local area receivers.
A momentary test up to full volume on the local station
fails to reveal any marked threshold of distortion, though judging
from the sound level the output must have been very close to the
rated upper limit of 10 watts.
Full marks are due to the designer for the skill with
which the 12-wave circuit has been composed into a chassis very
slightly bigger than that of the average 5-valve superheterodyne.

MISCELLANEOUS ADVERTISEMENTS

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ARMSTRONG MANUFACT. CO.,
100 St. Pancras Way, Camden Town, N.W.1
'Phone 1 QUiller 3105

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these columns have the perfect safety for availing
themselves of our Deposit System. If the money be
deposited with "The Wireless World," both parties
are advised to send 2d. to the Proprietors' Office.
The time allowed for decision is three days, counting
from the date of issue in which the advertisement
appeared; after which period, if buyer circulars do not return goods, they must be returned to sender.
If a sale is effected, the buyer is bound to assume
any account to seller, but if not, seller instructs us to return
the money to the buyer.

FREE Data Charts.
"Radio Data Charts," A Series of 64 Pages Post free 4/10

NAVIGATION SYSTEM

WANTED. "Wireless World" Wanted.
Sells, 1938, 156, £10 15/-, c/o The Wireless
World.

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DEPARTMENT STORES

Whists this is desired, the sum of 5/- to defray
advertisements in this section must be added to the advertisement charge, which must

ADVERTISEMENTS

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THE WIRELESS WORLD

February 16th, 1939.
THE WIRELESS WORLD

PUBLISHERS, 11B, Cambridge Rd., Southport. [7992]

ALEXANDER BLACK, Ltd., proposer of hiring microphones.

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CAR. Read Aerial's improved type, chromium plated, top end developments, with an appearance to match the sound quality. Rubber covered, 20/-; built-in, 20/-.

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MCCARTHY P.P.993 chassis, 5 months old, £5/15/-.

McCarthy, 5-valve All-wave chassis, complete with tubes, speaker, new and unused; £2.-London, C.4.

W.W.A. SUPER

W.W.A. 1936 G. Superior, phase changer. Sound Rates £4 12/- 6d. (Uns. £4 12/- 10d.) 30-100 meters, 50/6 watts. 8-ohm speaker: £10, complete.

W.W. SUPER SEVEN

WIRELESS SUPPLY, x 72, London E.15. Receiver Seven Receiver built by Dennis Parish Recording Studios, brand new, showroom condition £25.

Bubis Whitaker Rd., Derby.

NEW MAINS EQUIPMENT

V

Along Transmissions at Last Week's Prices.

VICTOR, Ltd., 2.5 W. Broadway, Wembley, S.W.8. Phone: 1/6. £2. 15/6.


CABINETS

A CABINET for Every Radio Purpose.

CONVERT Your Set into a Radiogram at Minimum Cost. £3 15/-, including delivery. £2 10/- for your own location.

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UNIVERSAL Table Console and Loudspeaker Cabinets from £2 10/-.

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15/6 each.

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Baker New Horn Speaker, type 502, price £3 15/-.

[8037]

ADVERTISEMENTS.

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SECOND-HAND, CLEARANCE, SURPLUS, ETC.

HARTLEY TUNING Drodie 40 watt, £20 or 50 watt, £30. C.3-City Road, London E.C.4. Tel: 9101.

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Bakers New Triple Chime and Orange Cone, £50. Central Electrophone, 33, Euston Rd., W.1. [5038]

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NERI, Chance to Obtain Complete Units For that One who Is Well Informed.

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HIGH Voltage Components, etc., by well known makers, at a fraction of cost. It will pay you to visit.

MARK DAVIES RADIO AND ELECTRICAL STORES.

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G-B-W.—The recognized Distributors for Valves, Transistors, Condensers, and other accessories.

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We Can Also Supply a Full Range of transistors, etc., by well known makers, guaranteed, 5/- each; also line cords, resistances and electrolytic condensers, etc., guaranteed, 5/6.

AVO, Weston, Taylor, Hunt, Triplett, Mann, H.F. and E.M.T. Brands, etc. We carry a large stock of all types, and can supply them at a fraction of the price of the original manufacturers.

SEND for Lists of Transistors, etc., and also electrolytic condensers, etc., at a very reasonable price.

F. P. DAVIES, Ltd. 38, Lime St., Manc. 558.

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T. WRIGHT, 15, Lime St., Liverpool.

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W. V. West, Taylor, Roots, Trpped, Weir, etc.; electric and mechanical, in stock, new and secondhand.

SPECIAL.—American valves in stock for all types; £2 10/- each; £6 10/- per box.

METERS, ETC.

W. V. West, Taylor, Roots, Tripped, Weir, etc.; electric and mechanical, in stock, new and secondhand.

SPECIAL.—American valves in stock for all types; £2 10/- each; £6 10/- per box.
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NO! our Managing Director is not in Wornmouth Scrub—we refer to the release of our NEW CATALOGUE and TECHNICAL BULLETIN which will soon be ready. In the meantime may we remind you that we specialise in the design and production of—

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Prices range from £20 to £200.

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A.R.P.

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Advertisements.

WIRELESS SERVICING MANUAL

By W. T. COCKING

(of "The Wireless World")

The most complete book of reference of its kind. A reliable practical guide for amateur and professional.

BOUND IN CLOTH BOARDS.

SIZE: 7 ins. x 5 ins. 288 PAGES

5/- net. By post 5/6

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DORSET HOUSE, STAMFORD STREET, LONDON, S.E.1

W.Wo.


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The Wireless World

THE PRACTICAL RADIO & TELEVISION JOURNAL

Thursday, February 23rd, 1939.

Television Output Circuits
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EDITORIAL COMMENT

The News Bulletins

Alarmit or Soporific?

A VOLUMINOUS correspondence on the allegedly alarmit tendencies of the B.B.C. news bulletins has been proceeding in the pages of The Times. Various complainants urge that the bulletins are war-mongering, emotional, non-representative, dismal, and likely to send us to our beds “with palpitating hearts and incipient nightmares.” As one correspondent puts it, “if there are jitter-bugs among us, the B.B.C. brought them themselves.”

The general trend of opinion seems to be that while “no one can reasonably expect the News Editor to gather nothing but honey when there is so much gall about,” the bulletins tend, by injudicious selection of non-representative items and by the issue of statements shorn of their contexts, to give a misleading picture of the attitude towards Britain of potential enemies abroad.

Supporters of the B.B.C., who, incidentally, seem to be in the minority this time, say that the Corporation faithfully reports the news that comes to it without fear or favour, and express the hope that it will not be led into “pandering to the ostrich mentality” by issuing merely reassuring and soothing items of foreign news in place of the “unvarnished and sometimes unpalatable truth.” Other correspondents stress the fact that the B.B.C. has to depend for its news on agencies, and judging by the large amount of space devoted by the Press to “defence news” and disquieting rumours, such items are likely to preponderate in the material supplied.

We suggest that the Corporation should set doubts at rest by giving facilities for an investigation, to take the form of a series of post-mortems on bulletins. The investigating committee, which should include at least one member with experience of daily newspaper work, would, of course, have access to the material from which the bulletins were compiled.

Broadcasting and A.R.P.

A Reader’s Suggestion

THE problem of how best to convey warnings to the public of pending air raids is one which must be of great concern to the authorities responsible.

Sirens will be effective, but their range is limited and the telephone, if that were used, has the disadvantage that its sphere of operation is limited to subscribers.

The ubiquitous broadcast receiver seems to offer the best solution to the problem of how to communicate rapidly with nearly every household in time of emergency.

Hitherto the argument put forward against broadcasting is that it would only be effective if the sets happened to be switched on at the right moment.

A correspondent puts forward the suggestion in a letter published in this issue that considering that sets are often left on most of the day there is no appreciable extra expenditure to the user involved if it is left permanently on at such times as an air raid warning might be anticipated. It would then be a simple matter, at any time of the day or night, for the B.B.C. to put out a kind of super tuning note as a warning, to be followed if necessary by instructions. The sets would only require to be left tuned to the station from which the warning would emanate.
Television Output Circuits

SYNC SEPARATION AND THE CR TUBE CIRCUIT

Most television receivers include one vision-frequency stage, the output of which is fed to the cathode-ray tube for modulating the electron beam. Its output is often fed also to an amplitude filter for separating the synchronizing pulses so that they are free from the picture signal. Sometimes, however, the sync separator is fed from the detector and sometimes from a cathode resistance in the VF stage.

The chief objection to feeding the separator from the detector is that the signal at this point is usually too small for reliable and non-critical operation of the separator. The signal at the output of the VF stage is naturally much larger, and it can be accepted as axiomatic that the larger the signal the easier it is to effect good separation of the sync pulses.

The methods of effecting separation following the VF stage are legion, and one particularly simple arrangement is shown in Fig. 1. The VF stage is conventional with a screen tetrode or pentode V1 and a corrected coupling R2 and L. It is coupled to the CR tube through the RC coupling comprising C1 and R3 with the DC restoring diode V2.

This diode conducts only on the tips of the sync pulses, and builds up a charge on C1 which maintains a voltage across R3 substantially proportional to the direct-current component of the signal. The signal across R3 is a good copy of that at the anode of V1 but with the anode voltage of V1, derived from the HT supply, removed. The phase of the picture signal is positive and of the sync pulses negative.

In addition to being applied to the CR tube, the signal is fed through R4 to the sync separator V3. With a sync pulse amplitude of 5 volts V3 is given a grid bias of about $-3$ volts by making the cathode $+3$ volts by means of R8. The screen potential is chosen so that anode current cut-off occurs at about $-3$ volts grid potential. The anode voltage is then made low compared with the screen voltage.

The shape of the grid-volts-anode-current characteristic then takes the general form shown in Fig. 2. The input signal is applied as shown, and the picture portion of the signal sweeps over the flat top of the characteristic and gives no change of anode current. The sloping portion of the curve is swept over only by the sync pulses, and corresponding current pulses appear in the anode circuit and set up voltage pulses across R5.

![Image](image_url)
Television Output Circuits—

put pulse amplitude is accordingly reduced somewhat. With a moderate value of R4, the input is of the form shown by the dash line. The main effect is a reduction in the amount by which the grid of V3 is driven positive, and results in reduced grid and screen-grid current and a longer life for the valve.

If V3 is fed directly from a detector giving large output in positive phase, the use of a moderate value for R4 is to be recommended, and by a moderate value is meant a resistance of the order of 10,000 ohms. When it is fed from a circuit such as that of Fig. 1 involving DC restoration, however, the writer's experience is that a high value is essential. With a moderate value the process of DC restoration is upset.

Sync Separation

This is clear when the action is considered. Ignoring V3 for the moment, the sync pulse brings the cathode of V2 negative with respect to its anode so that the diode conducts. Electrons flow out of C1 through the diode from cathode to anode, leaving a positive charge on C1. After the pulse, the picture signal drives the cathode positive and the diode becomes non-conductive.

During the picture signal, therefore, C1 becomes less positive because electrons flow into it through the resistance R3. For proper DC restoration it is necessary that the value of R3 be very much larger than the resistance of V2 when conducting.

Now consider what happens when V3 is in operation. The action is unchanged until V3 is driven into grid current, which occurs throughout the picture signal. Electrons now flow into C1 to reduce its positive charge not only through R3 but also through R4 and Rin. In effect, therefore, the value of R3 is greatly reduced.

It is usual to make R3 about 1 megohm, and this gives very good DC restoration when C1 is of the order of 0.005 µF, and a low resistance diode is used. It is clear, however, that the conditions are seriously upset if R4 is 10,000 ohms or so, for even if we allow that the input resistance of V3 is as high as 10,000 ohms, which is unlikely, R3 will be shunted by a resistance of only 20,000 ohms.

It is, therefore, necessary to make R4 as high as possible, and in practice quite good results are obtained when it is about 0.5 megohm. Less perfect DC restoration is obtained, and it is advisable to increase C1 to some 0.5 µF.

The drawback to this course lies in the input capacity of V3. The time-constant of R4 and the input capacity becomes so large that the steepness of the sides of the sync pulse is lost.

This makes the timing of the striking points of the time-base generators dependent on the pulse amplitude, and it may also make the line pulse timing dependent on the picture content at the extreme right-hand side of the picture. If there is a white border to the picture, for instance, the voltage on the valve may not be able to change rapidly enough for the sync pulse to follow at its proper time.

This gives an effect known as 'pulling on whites,' where a few lines may move when there is a white object on the extreme right of the picture. With care in design and adjustment this effect can be kept small, and the circuit can be made to give good results. The settings of the time-base controls, however, are more critical than with more perfect separators.

The Cathode-Coupled Circuit

An arrangement which is sometimes used to overcome these difficulties is shown in Fig. 3. The VF stage V1 has an additional resistance R2 connected in its cathode circuit, and the input is applied as shown between grid and the junction of R1 and R2, not between grid and earth. This means that the whole of the detector circuit must be floating.

The CR tube is fed from the anode in the usual way and the sync separator from the cathode. It is desirable to use a valve requiring a lower screen than anode potential, and to stabilise the screen voltage by the neon voltage stabiliser.

This automatically stabilises the screen and anode currents, and hence the cathode potential relative to earth.

As regards the cathode circuit the valve acts substantially as a triode, and
Television Output Circuits—

an amplified copy of the input appears across R1 and R2 and in the same phase as the input. The sync pulses are positive and the picture signal negative. One disadvantage is that there is negative feedback through the control-grid to screen-grid valve capacity which results in a high effective input capacity and low input resistance at high frequencies for V1. The effect is exactly the same as though a normally connected triode were used.

Sync separation is effected by the diode V2, which has its cathode biased positively by R6. This bias can be automatic, as shown, or fixed, in which case a resistance would be joined between the junction of R5 and R6 and the screen of V1. The bias is arranged to be slightly greater than the cathode potential of V1 on a black level signal.

Valve Capacities

On black level V2 is non-conductive, for its anode is negative with respect to its cathode. V2 is also non-conductive on all picture signals, for these drive its anode still more negative. The sync pulses, however, drive the anode positive, the diode passes current, and a voltage is developed across R5.

An alternative arrangement of the diode is shown inset in Fig. 3. Here the diode is non-conductive on the sync pulses and conductive on the picture modulation. It functions in exactly the same way as the grid-cathode path of V3 in Fig. 1.

At first sight this arrangement is inferior to the one in which the diode is non-conductive on the picture signal, because it cannot completely eliminate the picture signal. There is, however, little deformation of the shape of the sync pulses, since R5 need not exceed 10,000 ohms or so.

In practice, however, it often gives better synchronising, and the reason lies in the fact that the stray capacity across the resistance R5 can be exceedingly small, whereas the anode-cathode capacity of the diode is several micro-micro-farads. This capacity is much more harmful in the main circuit of Fig. 3 than in the inset arrangement, for in the former it acts as a partial short-circuit to the diode when it is non-conductive.

Any very rapid change in the picture content, as a sudden transition from black to white or vice versa, causes a pulse to appear across R5. The pulse is usually of small magnitude and of very short duration, but it is sometimes sufficient to trigger the line time-base generator. This effect is usually only important on line synchronising, and is always negligible on the frame circuit if an integrator is used. In practice, the inset circuit often gives better results than the main one.

An arrangement giving almost perfect separation is shown in Fig. 4. A tetrode or pentode separator is used following a VF stage which is exactly the same as before. The cathode potential of V2 is adjusted to be about the same as the no-signal cathode potential of V1, and the small grid capacitance can be automatically made to be slightly greater than the grid-cathode capacity of a screened-grid valve prevents any appreciable transference by this route. A triode can be used, but the grid-anode capacity may lead to some trouble just as with the circuit of Fig. 3.

The phase of the output sync pulses is negative, so that an extra phase-reversing stage is needed for many time-base generators.

There is no doubt, however, that the use of cathode coupling in the VF stage is a nuisance, for it makes a stabilised screen supply necessary, it prevents any point on the detector circuit from being earthed, and it gives a high input capacity to theVF stage.

An alternative arrangement which the writer has found very useful is shown in Fig. 5. At first sight it may seem rather wasteful, but on examination this will be seen to be more apparent than real. V1 is the normal VF stage and its output is taken through C1 to V3, R3 and V2 effecting DC restoration. V3 is a triode usually operated with equal cathode and anode resistances R3 and R4.

Under these conditions there is heavy negative feed-back along R5, and the gain measured between the input and cathode or anode is rather less than unity—0.8-0.9 times being average figures. The phase of the cathode output is the same as the input, while the anode output is of opposite phase. The CR tube is connected directly to the cathode without DC restoration and with complete safety, while the sync separator is fed from the anode.

First of all, consider the direct connection of the CR tube. In order to save
Television Output Circuits—

The DC restoring diode its grid is sometimes connected straight to the anode of the VF valve, the no-signal anode voltage being backed off by increasing the normal tube bias. This connection is rather dangerous from the point of view of tube life, however, unless the greatest care is taken, there is a great likelihood of the tube being underbiased for a few moments when switching on and off, owing to the rise and fall of the voltages in the different circuits being at different rates. In any case, if the VF fails to pass anode current for any reason, such as a broken heater or a bad contact in a heater, cathode or screen pin, the anode potential will rise straight away to the full HT voltage and carry with it the tube grid.

CR Tube Connections

As a safety measure, therefore, it is wise to use DC restoration, and in Fig. 5 it would be quite satisfactory to connect the tube grid to the grid of V3. To do this would increase the stray capacity on the intervalve coupling, and by connecting it to the cathode of V3 the circuit capacity is reduced. This permits the use of a higher value for R2 and greater gain from V1.

The direct connection of the tube grid to the cathode of V3 is perfectly safe because the voltage changes when switching on or off only drive the tube grid negative. Moreover, a failure in V3 will only result in the tube grid falling to earth potential, that is, it will change its potential in a negative direction.

There is another advantage to be gained from the cathode connection. Viewed across R5, V3 has a very low output impedance, which is usually of the order of 500 ohms. The output impedance of the valve is actually

$$R_o = \frac{(R_C + R_A)}{(1 + \mu)}$$

where $R_C$ and $\mu$ are respectively the anode AC resistance and the amplification factor of the valve.

With a valve of the MH4 class and $R_A$ having a resistance of 7,500 ohms, $R_o$ is 550 ohms. If $R_A$ is also 7,500 ohms, the total effective resistance in the output circuit is about 570 ohms.

With such a resistance the stray capacity across $R_A$ can be as high as 80 $\mu$F, for a drop in response at 2 Mc's of 1 dB. A capacity of this order is not likely to be found, but the important point is that it is tolerable, for it makes it unnecessary to strive after the attainment of very low capacity in the tube coupling. Normally, it is necessary to be as careful with the tube grid lead as with the grid of an amplifier, and this is usually very inconvenient. The attainment of a grid lead of only two or three inches in length between receiver and tube is generally difficult, and necessitates very careful design.

With this suggested output circuit, however, extreme care is no longer needed, and the connection could be several feet in length without harmful effects. In practice, it rarely need be as long as this.

The input impedance of V3 is fairly high and consists chiefly of the reactance of the input capacity, which is rather less than the sum of the grid-anode and grid-cathode capacities. There is usually some feed-back through these capacities, but that through the grid-anode capacity is in opposite phase to that through the grid-cathode capacity, and the two tend to neutralise one another. With $R_4 = R_5$ it is necessary for complete neutralisation of feed-back for the stray capacities across $R_4$ to equal those across $R_5$ and for the grid-anode and grid-cathode capacities to be equal.

The output voltage across $R_4$ equals that across $R_5$, and is about 90 per cent. of that across $R_3$ with the values given above. The phase of the signal on the anode side is negative and is coupled to the sync separator V4. The grid-cathode path of this valve together with $C_2$ and $R_6$ effect DC restoration, and the screen voltage is adjusted by $R_{10}$, so that anode current cut-off occurs at about $-2$ to $-3$ volts grid bias. The picture signal thus drives the valve beyond anode current cut-off as shown in Fig. 6. The phase of the sync pulse output is negative, which is correct for some time-base generators. Others, which need a positive pulse, will require the insertion of a phase-reversing stage following V4.

The Phase of the Sync Pulse

As compared with the circuit of Fig. 1, one extra valve is necessary if we disregard the phase of the sync pulse output. For a time-base generator requiring a positive sync pulse an extra valve is needed for phase reversing, so that the arrangement is two valves down on Fig. 1. Its performance is greatly superior, however. If the time-base needs a negative sync pulse, then it is Fig. 1 which needs the extra phase-reversing valve, and each circuit employs the same number of valves.

If we make a comparison with Fig. 3 we again have a better performance, but more valves. In making the comparison do not forget the neon voltage stabiliser in either Fig. 3 or Fig. 4: it may cost as much as a valve, and is more troublesome since it may need ageing before being used.

After considerable experience with all sorts of sync separators the writer has no hesitation in recommending the arrangement of Fig. 5, for it is the only one which he has found to be completely trouble-free and non-critical in adjustment. On setting it up the only adjustment needed is to $R_{10}$, which governs the current cut-off point of V4.

PROBLEM CORNER—8

Test Your Powers of Deduction

A

OTHER letter from the postbag of Henry Farrad, who has acquired a reputation for solving wireless problems from the most slender of clues.

Chesnut Cottage,
Little Sloham,
Suffolk.

Dear Mr. Farrad,

My boy, who I believe is a friend of yours, gave me a wireless before he went away after his last furlough just a month ago. It is a wonderful thing; when he carried it in like an attaché case someone was speaking from it; it is positively uncanny. Or perhaps I should say it was, for the last few days it has been silent except for a faint sound that soon dies away, and now there is not even that. Of course, I haven't dared look inside it, and there is no wireless expert in our village, so far as I know. The other day just before it stopped I heard the news man saying it was necessary to get a licence for it at the Post Office, but the weather was so bad I didn't get down there for a day or two, and when the wireless stopped I thought perhaps that was why it was cut off. But now I have bought a licence and it is still off. Should I write to the B.C. about it and have them to put me on again? Although probably you don't know me at all, my boy speaks such a lot about you, and I should be so grateful if you would advise me.

Yours sincerely,

(Mrs.) Millicent Midget.

What was wrong? Turn to page 195.

PORTABLE PICTURE TRANSMITTER,
developed by Siemens and Halske in cooperation with the German Post Office. Operated in conjunction with standard receiving apparatus, this device is primarily intended for transmitting news pictures from out-of-the-way places by means of telephone lines, though it is presumably adaptable to radio transmission.
Amplification by Secondary Emission

THE MULLARD EE50

For some types of apparatus, especially for television amplifiers, valves having very high mutual conductances are necessary to obtain useful amplification with circuits of only low impedance. It is also important that this high value of mutual conductance be unaccompanied by any great increase in valve capacities or input damping.

There are several methods by which a high mutual conductance can be achieved in a radio valve. For example, the cathode area of the valve can be increased to give a higher emission, which necessitates a higher cathode-heating wattage to maintain the same operating temperature; or the distance between the cathode and control grid can be reduced. Both these solutions have the obvious and important disadvantages of increased heat development, a tendency to primary grid emission and increased inter-electrode capacities. For operation at very high frequencies both temperature effects and high capacities are to be avoided.

Other methods of increasing the mutual conductance have been explored and the application of secondary emission has been found to be a satisfactory solution. Making use of this principle a valve has been developed which attains the high mutual conductance of 14 mA/v. with low input and output capacities and acceptable input damping.

The original development of the secondary emission valve was made available in the TSE4, which is now superseded by the type EE50 in the new 'all-glass' construction, providing additional electrical and mechanical advantages.

Electrons emanating from a cathode traverse the intervening grid or grids and impinge upon an electrode where secondary electrons are liberated as a result of the bombardment. These secondary electrons can move away from this electrode under the influence of a relatively positive potential at which an adjacent electrode is maintained. The electrode at which the secondary emission occurs is known as the secondary emission cathode or auxiliary cathode and its efficiency as a cathode is expressed by the secondary emission factor $\delta$. This factor is the average number of secondary electrons released for each of the electrons striking the auxiliary cathode, and usually known as the primary electrons.

The Auxiliary Cathode

The quantity and path of the secondary electrons depend upon the mechanical arrangement and the potentials of the electrodes, as well as the physical properties of the material at the surface of the bombarded electrode. The materials normally used in the construction of valves have low secondary emission factors. For instance, in a valve having a nickel electrode at 150 volts positive with respect to the cathode, $\delta = 0.94$, and it is not possible to obtain electron multiplication using nickel under these conditions because the total secondary emission from the electrode will be less than the primary current flowing to it.

The behaviour of secondary electrons in a valve depends mainly on the potential gradient in the vicinity of the electrode from which they are liberated; that is on the type of valve and its operating conditions. As an example, take the case of a triode which normally operates with the anode at a positive potential and the grid biased negatively; any secondary electrons which leave the anode soon lose their initial velocity and return again to the anode because there is no other positive electrode to attract them. The conditions in a tetrode, however, are usually different and secondary emission from the anode is drawn towards the positive auxiliary grid unless the valve has been specially designed to avoid this effect by critically spacing the electrodes.

By making use of a material having a secondary emission factor greater than unity, electron multiplication can be achieved and the method adopted is illustrated in Fig. 1.

The primary electrons pass from the cathode $K_1$ through the control grid $G_1$ in the usual manner and are then subjected to the influence of certain other electrodes, omitted from Fig. 1 for simplicity. These direct the electron stream towards the auxiliary cathode $K_2$ which is suitably treated to have a high secondary emission factor.

The Secondary Current

The secondary electrons liberated are then attracted towards the anode and form the anode current. This current is greater than the primary current by an amount dependent upon $\delta$. The grid controlling the primary current will, therefore, influence a greater anode current and a higher mutual conductance than normal is obtainable. As each primary electron liberates several secondary electrons which pass to the anode, the supply of electrons at the auxiliary cathode must be supplemented from an external source. While in normal multiple grid valves a negative charge is led away from the positive electrode, it is necessary to supply a negative charge in the case of the auxiliary cathode of secondary emission valves.

In the application of secondary emis-
Amplification by Secondary Emission—

mission for electron multiplication many problems arise. The presence of the cathode and secondary emitting electrode in the same bulb can result in the secondary emission surface becoming coated with a layer volatilised from the cathode (Ba, BaO). The effect of this is to reduce the secondary emission factor, but assuming that this and other difficulties can be surmounted by suitable design, it is of primary importance to investigate the possibilities of the application of secondary emission.

Comparing two valves designed for a similar purpose, one employing secondary emission, the mutual conductance of the secondary emission valve is appreciably higher than that of a valve not using secondary emission. Two of the factors which limit the maximum mutual conductance and anode current are the maximum permissible anode dissipation and the maximum secondary emission obtainable from the auxiliary cathode.

The Electrode System

It can be shown that for the same values of anode current and for valves of similar design, a secondary emission valve has a mutual conductance greater than a normal valve by the factor $\delta^4/\delta^8$. Moreover, its mutual conductance is proportional to $\delta^8$, under these conditions.

Except at low cathode currents the constant $\delta$ has a value of about 1.6 and the mutual conductance is therefore proportional to $\delta^4$. In a valve having an auxiliary cathode for which $\delta=5$, the mutual conductance will be $5^4/2=2.5$ times that of a valve without secondary emission for the same anode current.

The difficulty due to volatilisation of the cathode coating has been overcome in the Mullard secondary emission valve by deflecting the electron stream. As volatilisation in vacuo takes place along practically straight lines, the remedy lies in the use of a construction in which the auxiliary cathode is screened from the use of a construction in which the auxiliary cathode is screened from the auxiliary cathode by an electrostatic field.

Arrangement of electrodes and base connections. The dotted line across the valve holder indicates the correct positioning of the interstage screen located below the chassis.

Fig. 2 shows the basic arrangement of the EE50. The cathode K1, the control grid G1 and the auxiliary grid G2, which operates at 250 volts positive with respect to the cathode, are similar to an ordinary tetrode valve. The auxiliary cathode K2, operating at 150 volts positive with respect to the cathode, is protected from the cathode material by the screen S1, which together with screen S2 is at cathode potential.

The effect of these two screens at low potential, in conjunction with the anode

...
Amplification by Secondary Emission —

dveloped across the cathode resistance as a function of the cathode current, and comparing it with the line OA it will be seen that the variation of cathode current between the conditions of curves 1 and 2 is considerably reduced by the adoption of the higher value of cathode resistance.

Under the conditions usually encountered in the circuit of television amplifiers, where parallel damping resistances of less than 5,000 ohms are used to obtain satisfactory response over wide frequency bands, it can be shown that the stage gain is proportional to g/C, where g is the mutual conductance of the valve and C the total capacity in parallel with the anode circuit.

This capacity is the sum of the output capacity of the amplifier valve, the input capacity of the succeeding valve, stray capacity of the circuit and the self-capacity of the coil. The input capacity referred to will include the additional grid capacity due to Miller effect in the valve which is equal to Cg multiplied by the amplification in the valve.

Comparing three types of valve previously available, i.e., an RF pentode VP4B, a television pentode TSP4, and an acorn pentode AP4, the following results are obtained when the stray capacity of the circuit is assumed to be 6 μF.

<table>
<thead>
<tr>
<th>Valve</th>
<th>Mutual Conductance g</th>
<th>Total Capacity C</th>
<th>Ratio g/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>VP4B</td>
<td>2.0 mV</td>
<td>19.5 μF</td>
<td>0.11</td>
</tr>
<tr>
<td>AP4</td>
<td>1.4</td>
<td>12.0 μF</td>
<td>0.12</td>
</tr>
<tr>
<td>TSP4</td>
<td>4.7</td>
<td>24.0 μF</td>
<td>0.2</td>
</tr>
</tbody>
</table>

It will be clear that improvement in the ratio g/C can be obtained by increasing the mutual conductance or reducing the total capacity C, which involves a reduction in (Cg + Cw).

Thus, the acorn valve AP4 gives a slight increase in g/C compared with the VP4B, in spite of its lower mutual conductance. Moreover, it has been assumed that the stray circuit capacity would be the same for both these valves, which is unlikely in practice, and the acorn valve would probably show a greater improvement than that indicated.

Owing to the very high mutual conductance the secondary emission valve represents a considerable improvement. The ratio g/C amounts to 0.68 for the EF50, assuming the same stray capacity of 6 μF.

A Free Booklet

With next week's issue of The Wireless World will be presented a 32-page booklet entitled “Better Reception.” Dealing with all the more important aspects of reception, this booklet has been compiled with the needs of the new reader especially in mind and to these it is hoped that it will serve as an introduction not only to a deeper interest in wireless matters but also to the pages of The Wireless World.

We hope that regular readers will assist us in this endeavour by drawing the attention of their wireless friends to this special issue.

Wireless Operators' Vade Mecum


The sixth edition of this well-known work has now appeared. Although the aims of the book are not vastly dissimilar to those of the first edition of 1913, the apparatus now described is, however, in striking contrast to the spark transmitters and magnetic detectors that were then dealt with.

An important object of the book is to provide a complete theoretical course for prospective marine wireless operators who intend to sit for the Postmaster-General’s certificate of competency. As this examination is of a practical nature, no study of books can entirely replace practical work, but those who have mastered the contents of ‘‘Dowsett’’ will find little difficulty in translating their knowledge into practice.

AT THE PARIS COMPONENTS EXHIBITION. Press-button tuning devices were well to the fore at the recent exhibition organised by the S.P.I.R. (French radio trade organisation). The photographs show: (above, right) remote control press-button unit for attaching to any—
Multi-Vibrator for Ganging

SIMPLIFYING THE PROCESS OF RECEIVER ALIGNMENT

By H. HARRIS

THE alignment of superheterodyne receivers by the aid of signal generators and multi-channel systems has been frequently described. After the alignment of the IF transformers at the correct frequency has been carried out in various ways, the usual procedure is to inject, via the aerial and earth terminals of the receiver, various signals to which the receiver is adjusted by means of trimmers and padders. Calibration is set by adjusting the oscillator circuit trimmer at some point low down on the wave-band, while correct ganging of the oscillator and signal frequency circuits is arranged by the adjustment of the padding condenser at the top of the band.

Upon the accuracy of the adjustment of the padding condenser depends the sensitivity of the receiver and its preselection. The optimum performance is obtained when the oscillator circuit is tuned to the frequency that is exactly the IF away from the frequency to which the signal frequency is tuned.

Usually a fixed signal at the top of the band is tuned in and the output of the receiver noted upon an output meter. The padding condenser is then slowly adjusted while the tuning condensers are rotated slightly in one direction or the other and notice is taken of whether the output of the receiver is increased or decreased. If it increases, then the paddler continues to be adjusted in the same direction, at the same time the gang condenser until an optimum output is noted. If it decreases, then the paddler is adjusted in the opposite direction, at the same time the gang condenser until an optimum output is noted. This is sometimes a tricky operation and is dependent upon the skill and patience of the operator.

Re-trimming Necessary

Frequently the operation of padding is found to have had an effect upon the calibration and alignment at the lower end of the scale. Theoretically it is bound to do so. Thus the signal and oscillator circuits have to be re-trimmed again at the lower end of the scale and then the padding rechecked. This procedure continues until the operator is satisfied that one operation has a negligible effect on the other.

As mentioned before, these are tricky operations, and the final accuracy depends upon the patience and skill of the operator. With modern multi-waveband receivers the time taken to align a receiver properly by the method described may be considerably reduced. Any method or gear that would reduce the time would be very desirable to receiver manufacturers or large service organisations, particularly if these also lead to greater accuracy of alignment and require less skill of the operator. In this connection the writer has found that a multi-vibrator of the type to be described is an exceedingly useful instrument. The padding operation can be cut to one-tenth or less, while the skill required is negligible.

The principle of operation may be grasped by realising that in the usual method of alignment with isolated, fixed signals, when the gang condenser is adjusted to tune to a signal, what is happening is that the oscillator frequency is being varied until it is approximately the IF away from the signal in question. Thus, when the operation of padding is commenced, the gang is adjusted until the signal is tuned in and the signal frequency circuits are then tuned to a widely different frequency to that of the signal being received, but the oscillator is beating with the small signal generated across the impedance of the circuits off resonance.

Continuous Band of Frequencies

The calibration at the lower end of the scale, of course, would be set initially by adjusting the oscillator frequency to beat with a certain known signal and adjusting the signal frequency circuit to correspond. What is required, then, is a continuous band of signals so that whatever the tuning of the signal frequency circuit there will always be a signal of that frequency available. A near approach to this continuous band of signals can be obtained from a 500-cycle multi-vibrator.

The fundamental circuit of a multi-vibrator is shown in Fig. 1, and consists of two resistance-coupled valves in which the anode of each is coupled to the grid of the other. This arrangement is oscillatory and produces a signal extremely rich in harmonics. The frequency of the fundamental oscillation is dependent upon the time constant of the grid circuit. The frequency may be fixed, or locked by the
Multi-vibrator for Ganging—

Introduction into the circuit of a locking signal. This will be a multiple or sub-multiple of the fundamental frequency.

With a 500 c/s multi-vibrator, harmonics spaced by 500 cycles are produced. These can be made to extend into the high frequencies, and in the multi-vibrators made by the writer harmonics up to the thirty-thousand and beyond are usable. This means that a continuous band of frequencies spaced at 500 c/s and extending up to 15 mega-cycles (or 20 metres) is available. So closely spaced are these signals that at all radio frequencies in use in receivers they cannot be separated by tuning, and a continuous signal from top to bottom of each waveband appears. This is because the receiver is never tuned to more than 250 c/s from a signal. So that if the calibration at the lower end of a waveband is set by adjusting the oscillator trimmer to a fixed or known signal and the signal frequency circuits then trimmed, the padding operation merely consists of turning the gang to a point at the top end of the band, without worrying about exactly tuning in to a particular signal and turning the padding condenser until a maximum output is obtained. No rocking of the gang is necessary, as whatever the frequency of the oscillator there will always be a signal within 250 c/s of the one necessary to beat with the oscillator and produce the IF.

If the padding must be adjusted much, then of course the calibration at the lower end of the band will have to be reset again, and so on; but the simplicity of the padding operation is such that an enormous amount of time may be saved, as no rocking or extreme care is necessary. The audible signal received is a 500 c/s note plus multiples of the same, and is of such a character that even trimming by ear can be carried out almost as accurately as with the aid of an output meter, and padding just as easily. Normally, to adjust the padding circuit of a receiver by ear is hopeless, as the changes in signal strength caused by slightly rocking the gang and slightly changing the padding are sometimes inaudible.

**Speed and Simplicity**

With the multi-vibrator signal, on the other hand, there is no "edging" of the oscillator and signal circuits nearer and nearer into alignment, the padding merely being adjusted for a maximum output, this automatically corresponding to the optimum output obtainable in the usual way. This is because there is always a signal with which the oscillator can beat, irrespective of its actual frequency, and, therefore, the signal that is selected to beat with when padding is the one that gives the greatest output, i.e. the one to which the signal frequency circuit is tuned, as this will give the largest EMP across the circuit and will, therefore, give the biggest beat with the oscillator frequency.

Another, and important, use of the multi-vibrator is that by its means the whole of each waveband on the receiver can be checked easily and quickly by turning from top to bottom, or vice versa, and noting any variations in output, as the output from the multi-vibrator may be made fairly constant over large wavebands and does not vary greatly from point to point. Thus dead spots in the tuning range are easily observable which would pass unnoticed in the usual way of checking by means of a small number of fixed signals on each waveband. Oscillator crossovers due to incorrect choice of the beating oscillator frequency when trimming the oscillator circuit are easily seen. Of course, the use of the multi-vibrator is not to supersede a standard signal generator, or the usual fixed-frequency sources generally used for calibration checks. Rather is it to be used in conjunction with them and to enable comparatively unskilled operators to achieve a degree of accuracy and speed in aligning a receiver which was only previously obtainable by a highly skilled one. The method is now used to a great extent in American factories.

The actual multi-vibrator being used by the writer consists of two fairly low-impedance triodes used in the circuit as shown in Fig. 2. It will be noticed that a filter circuit is shown in the output circuit. This is to attenuate frequencies below 150 kc/s and to filter out the IF frequencies so that these are not applied to the input of the receiver to cause certain difficulties. The locking signal is of 50 c/s, and is obtained from the valve-heater supply circuit by means of a potentiometer and step-up transformer. The potentiometer is not essential, but was used when experimenting to find the value of locking voltage required. This is only of the order of 20 or 30 volts, and is not critical with the values and voltages shown. A difficulty experienced when the multi-vibrator was set up was to couple an attenuator of low impedance to the circuit without upsetting the working of it. Usually the output is obtained from an RF transformer in series with one grid leak, but this was found to be unsatisfactory, as a transformer to cover the band from 150 kc/s to 20 Mc/s efficiency was found to be impossible to design. It was found that the best arrangement that gave the greatest output in the attenuator on short waves was as shown, where the filter circuit and a high-resistance potentiometer are shunted across one anode resistance. The attenuator is then fed from the potentiometer output.

**Calibration**

With the final arrangement as described the variation of output between the two frequency extremes may be compensated for. The potentiometer and attenuator may be calibrated arbitrarily so that comparative readings of input to different sets may be made, or standard inputs fixed. These two controls and the on/off switch are the only variables in this extremely simple piece of gear. So simple and cheap are these multi-vibrators to make that each bench, or operator, may be equipped with one. This is simpler and better than making one large one to supply an RF transmission line, as to increase the output sufficiently to feed a line would mean very much larger valves and might...
Multi-vibrator for Ganging—
cause difficulties through interference. The maximum signal obtainable at the 150 kc/s end of the band is of the order of one millivolt. The reason for this low output, which nevertheless is more than ample, is that the output power of the multi-vibrator signal is divided very much more evenly between fundamental and harmonics than is the case usually with the ordinary valve oscillator. It has been observed in use that adjustment of the receiver for maximum output on the multi-vibrator signal appears to be very much easier than with one fixed signal only. This is probably connected with the fact that the signal consists of a 50o c/s note harmonics than is the case usually with more evenly between fundamental and strength.

The maximum signal obtainable at the vibrator signal appears to be very much receiver for maximum output on the multi-band of the upper harmonics as the adjustment of the tuned circuits is carried that the signal consists of a 50o c/s note

Thus the curtailment, of the upper harmonics as the adjustment of the tuned circuits is carried out is far more noticeable when they are strong than when they are weak.

Multi-band Tuning Indicators

USES OF POLARISED LIGHT

RECENT development work in the field of optics has provided with light polarising material which can be manufactured in the form of thin flexible sheets. This material has a useful application for indicators of various types and particularly for the tuning indicators of multi-band wireless receiving apparatus. A dial for the tuning indicator of a receiver may comprise two plates of this material, in juxtaposition, and such an arrangement is shown in the accompanying drawings.

Referring to Fig. 1, one dial plate A is cut from a sheet of the material, and a horizontal scale, for example, a long-wave horizontal medium-wave scale is arranged parallel to the "grain" of the material of the plate C, and a slot D is provided in the plate C opposite the long-wave scale formed on plate A.

An exploded view of this dial is shown in Fig. 1, but it will be understood that the plates A and B are placed together, and the arrangement is such that the slot B in plate A forms a frame round the medium-wave scale of plate C, and similarly the slot D in plate C forms a frame for the long-wave scale on plate A. A light source E is arranged behind the dial, and a disc or screen F is rotatably mounted between the light source and the dial. The screen comprises a single sheet of the same light polarising material as cut so as to be framed by the apertures M. The arrangement is such that screen F is rotated through 90 degrees, whereby the light is transmitted through the slot D and the remaining surface of the dial is darkened. In conclusion, it may be stated that although the use of the multi-vibrator for aligning superheterodynes has been emphasised, it can be employed with great advantage for aligning straight receivers. The procedure here is to set the calibration by adjusting the trimmer of the sharpened tuned circuit, using reaction if fitted, on a fixed signal and then de-tuning from this signal to the multi-vibrator signal and adjusting the remaining circuits on this. Again, the multi-vibrator signal may be used for checking response over the whole band merely by tuning from top to bottom and noting the output.

It is arranged so that the output of the line that supplies the usual fixed series of signals and the multi-vibrator output can be switched at will into a common dummy aerial and this connected to the receiver, no time will be wasted in changing from one source to the other and the full benefits of the multi-vibrator system derived.

In operation, the screen filters out all rays, and, consequently, the medium-wave scale now becomes visible, whereas the rest of the surface of the dial is darkened.

Fig. 2—Another two-band indicating scale in which the desired station names are illuminated by appropriate polarisation of the incident light.

A modification of the arrangement shown in Fig. 1 is illustrated in Fig. 2, which shows the front surface of a dial indicating long- and medium-wave stations intermixed. The dial again comprises two plates of light-polarising material; the back sheet is formed with a number of apertures, shown dotted and lettered L in the drawing to indicate stations in the long-wave band and the long-wave station names are formed on the front plate so as to be framed by these apertures. Similarly, the front plate is provided with apertures M, indicated by the full lines, and stations in the medium-wave band are formed on the back plate so as to be framed by the apertures M. The back plate is cut so that the "grain" of the material is horizontal, and the front plate cut so that the "grain" of the material is vertical.

The "graining" of the material is indicated by the shading lines, and it will be apparent that the medium-wave station names will be illuminated when the "grain" of the screening material is arranged between the light source and the dial is horizontal, and the long-wave station names illustrated when the "grain" of the screening material is vertical.

The remainder of the surface of the dial is opaque to both kinds of polarised light and remains unilluminated all the time.

A suitable light polarising material for this purpose is that sold under the trade name "Polaroid."
Death Rays in Denmark

Readers have been most kind and helpful—or, at any rate, they meant to be helpful—in writing to me about the wavelength and circuit diagram of the device which is used to stop car engines by wireless, and which is popularly known as the "death ray." Unfortunately, however, none of them have any real technical information to impart, and I am as much in the dark as ever. Some readers even seemed to misunderstand the reason for my business commitments permit me, to permission

car passed the mysterious spot again on cars were towed to a near-by garage, and it was found that the ignition system of standstill within a short period of time on account of-some mysterious happening in tion.

wiry information to impart, and I am as much ever, none of them have any real technical as the "death ray." wireless, and which is popularly known wavelength and circuit diagram of the de-

spondent, together with the victims of these car outrages, to join me in the Tivoli Gardens in Copenhagen to drink beer at my expense while we discuss the matter. Skal!

There the matter rests for the moment, although if I can get the necessary information I shall seriously think of asking the Editor's permission to publish full constructional details of a handy portable car stopper in the pages of this journal, as this is, in my opinion, the only effective way to deal with this menace to television. I feel quite sure that lofty appeals to motorists' better feelings will have but little result, and, moreover, I can claim to know something about it, as I am a motorist myself.

Eventually I hope to see some enterprising wireless manufacturer come out with a television set fitted with a neat automatic car-stopping device which the car itself actuates; that is to say, if an "unsuppressed" car passes the house of a television listener the very interference it causes will trigger off the car stopper built into the receiver.

Our rendezvous by night.

A Radio Fog Disperser

Apparently this is not the only country where very severe fogs are experienced at times, and possibly some of you may remember the disastrous blanket of fog which brooded for some days over the Liège district a few years back and caused quite a future owing to its unusual density and persistence. We are quite used to these sort of fogs over here, of course, but we don't seem to do very much about them. Other countries are less lackadaisical, however, and it was with very great pleasure that I received an invitation to visit a certain foreign country recently to inspect the new anti-fog measures employing radio principles with which they were experimenting.

As you know, one of the chief difficulties in a dense fog is for cars and other vehicles to keep to the road, and one often finds them resolutely following a tram, since the latter vehicle cannot, of course, wander off the road. It was this fact that was the cause of these experiments to be initiated. I need hardly say that I accepted the invitation with alacrity, and the same evening saw me en route for Harwich to catch the Hook steamer to the Continent. Arriving at my destination I was escorted to a car and driven along a road over which an artificial fog had been created by some method or another, probably by inviting Members of Parliament to make speeches by the roadside.

We were easily able to keep to the road, in spite of the denseness of the fog; as the needle of a small dial mounted above the dashboard deviated to left or right according to the direction in which the driver allowed the car to wander. It was done, of course, by means of a device borrowed from the shipping world, in which similar indications are given to a boat by means of a submarine cable through which modulated radio-frequency energy is pumped. In this case, however, use was made of existing lighting cables buried in the ground, and it would be possible, I was told, by using a much higher frequency, to employ the water or gas pipes, if desired, even though they were not insulated, from the surrounding earth.

In addition to the use of existing buried cables for the guidance of traffic fitted with the very simple detection gear required, it was possible for a broken-down car to summon assistance, the modus operandi being to modulate the existing carrier by means of speech frequencies generated by an additional small unit on the car. Cars so fitted could also be connected through to the ordinary telephone service of the country, so that a driver who was slowed up by the fog could notify friends that he would be late for his appointment.

Driving blind.

To my mind, this fresh application of wireless principles is one of the most important yet, and I look forward to further developments. We may even live to see the system adopted in London, although, knowing something of the attitude adopted towards new ideas in this country, I doubt it, unless we all become super-centenarians.
CINEMA TELEVISION

Technical and "Political" Aspects of the Boon-Danahar Transmission

The televising of the Boon-Danahar fight at Harringay Arena to-night, February 23rd, has created a stir in the wireless and cinema worlds. As stated last week, this is the first occasion that the B.B.C. has been permitted to televise a big fight, and also the first time a B.B.C. transmission has been shown to a paying audience at a cinema.

Commenting on the event, Cinema states that "The agreement for the broadcast on February 23rd is seen by responsible leaders of the industry as bringing in sight the end of the opposition between the B.B.C. and the cinema industry on a number of matters, covering the question of the provision of artists for broadcasting by cinema and theatre companies, and the provision of films to the B.B.C., with facilities for the public relaying of programmes as a reciprocal contribution from the B.B.C."

Technically, the broadcast is of great interest. Baird apparatus has been installed at the Marble Arch Pavilion and the Tatler store which, as announced last week, will remain open for seven weeks, to the public. The brilliancy obtained is clearly seen in this photograph. Visitors can see the performance from several localities. The tubes of the apparatus are used and have a diameter of 6 in., the picture on the tube; however, is about 61/2 in. wide only and is projected with the aid of a 14-in. lens.

The tubes are operated at 45,000 volts with a beam current of 300-400 microamperes; the normal power in the screen being about 18 watts. Each projector contains two tubes which are operated continuously. One being a stand-by which can be brought into action at once in the event of a failure.

Except for the HT supply, the apparatus is housed in a single container requiring connection only to the aerial feeder. The whole gear has been passed by the L.C.C. for public use.

A B.B.C. announcement states that permission to reproduce the televising of the Boon-Danahar fight in certain places of public entertainment must not be regarded as a precedent. It further adds: "It must not be taken that any general extension of permission for the rediffusion of B.B.C. television programmes in places of public entertainment is contemplated."

START POINT'S AERIAL
South Coast Field Strength Tests

A TEAM of B.B.C. engineers will shortly begin a tour of the principal South Coast towns for a series of signal strength measurements connected with aerial adjustments at the B.B.C.'s new station at Start Point, Devon.

The two mast radiators at the transmitter mark a new departure in B.B.C. practice, the results of which should be a marked increase of signal strength in certain directions with a minimum of power dissipation over the sea. Adjustments are critical, and with each change made during the transmission of the new station, a measurement of the results of which should in time be critical, and with each change made during the transmission of the new station, a measurement of the results should be taken that any general extension of permission for the rediffusion of B.B.C. television programmes in places of public entertainment is contemplated."

LONG-WAVE "BATTLE" AT MONTREUX
Extending Synchronisation of Medium-Wave Stations

Midnight on the last Saturday in September is expected to see the change-over to the Montreux Wavelength Plan, which is hoped will emerge without the trouble from the conference which opens on March 1st, and at which each country will be represented by its Postal Authorities and broadcasting organisations.

Opinion on the Continent is that a battle royal will be fought over long-wave bands, which has been in an unsettled condition ever since the Lucerne Plan of 1933, partly owing to the recurrence of the Lucerne station in clashing with an unauthorised wavelength. Whether this giant, in one of the smallest countries in Europe, can be made to toe the line is doubtful.

It is believed that attempts will be made to persuade broadcasting stations to extend the system of wavelength synchronisation. This may reduce the listener's choice of foreign stations, but it is argued in favour of fewer stations and better quality may win the day, experiments the signal strength measuring unit will be reporting from several localities.

It is believed that Start Point will give satisfactory signals as far as Portsmouth and perhaps beyond. The new aerial design will also combat fading. Transmission tests are expected to begin before the end of next month and an experimental service should start in May.

To fill in the gaps in the Bristol area, the Clevedon transmitter will come into operation at the same time as Start Point, replacing the West Regional transmission from Washford, and Start Point will work on the vacant wavelength of 285.7 metres. Clevedon will take over the 203.3-metre wavelength used by Bournemouth and Plymouth, which will close down.

Valve Frauds
Judge's Warning to Traders

At the conclusion of the case at the Central Criminal Court last week when George Hyman and Aaron Hitner were found guilty of conspiring to defraud Mullard's by attempting to obtain by false pretences, the Common Serjeant gave a warning to people in the wireless trade. He said: "I am satisfied that at the time this fraud has been going on—I don't say by you, but by other people—and some people seem to have taken the view that, however wrong it might be, it was not a criminal offence. I hope the result of this case will be that everyone connected with the valve trade will know it is a criminal offence and a very serious one."

It was, it is said, that Hyman, who was a shareholder in a company called Radioco, Ltd., in obtaining valves from Mullard's under a stamp representing that they were for use in sets manufactured by his company or for replacement in sets returned for repair, thereby receiving them at a much lower price than valves purchased for retailing. Valves which were specially marked were delivered to Hyman's company and, it was alleged, almost immediately taken to Hitner's promises to be sold at a much higher price.

NORTH ATLANTIC AIR MAIL
Wireless and Weather Services

Reliability in Routine Operation, on the North Atlantic air-mail now impending, will rely not only on the mechanical dependability of the multi-engined long-range flying-boats and the skill of their crews, but also on the swift and accurate working of a highly organised service of wireless and meteorology.

At Foyneys on the Irish Coast and at Botwood, Newfoundland, special long-range wireless stations have been provided to maintain contact with the ocean-going flying-boats.

Relying on wireless reports from a network of shore stations and also from ships out on the North Atlantic, the meteorological organisation is reinforced by daily reports by observers crossing the North Atlantic by steamer; this latter information dealing with wind and pressure, the information which aircraft will be operating being obtained by the send-
TELEVISION IN ITALY

ITALY'S television station, which is under construction at Monte Mario, near Rome, is to transmit on 441 lines, the same as in Germany. This fact is not surprising, as it is learned that the first transmitters to be marketed in Italy will be made by Telefunken and imported from Germany. Telefunken are also to market a television adaptor for those who already possess a broadcast receiver.

One of the USW stations at Monte Mario, that which works on 6.9 metres, is not included in the latest list of stations, which points to the fact that the modifications to this station in readiness for its part in the television service are under way.

WIRELESS FOR SMALL VESSELS

An experimental transmitter-receiver for installation in small German ships has been submitted to the German postal authorities for approval. Working on fixed wavelengths of 600 and 625 metres, the transmitter can be used for either telegraphy or telephony. The power of the transmitter is supplied by a car battery capable of providing six hours' uninterrupted service. A daylight range of fifty miles is guaranteed.

The receiver covers 15 to 2,000 metres, and the hiring or purchase cost is low enough to bring the apparatus within the grasp of most small shipowners.

LICENSE FEES IN INDIA

ALTHOUGH All-India Radio, in an endeavour to encourage listeners to renew their wireless licences, reduced the renewal fee from Rs.10 to Rs.8 in December, 1936, it has not, according to the Indian Listener, had the desired effect of increasing the percentage of renewals, moreover, the loss of two rupees on every licence has resulted in a deduction of approximately Rs.100,000 in A.I.R.'s income. It has, therefore, been decided that the concession fee for a renewed licence should be fixed at Rs.9, with the proviso that the application must be made before the expiry of the old licence.

FROM ALL QUARTERS

Television Advisory Committee

The chairmanship of the Television Advisory Committee, which had been vacated through the death of Lord Secon, has been accepted by Lord Cadman. He was created a Baron in 1917, and is chairman of the Anglo-Iranian Oil Company. Lord Cadman, who is Emeritus Professor, Birmingham University, is a member of the Advisory Council of the Department of Scientific and Industrial Research, and served on the first Television Committee, appointed by the Postmaster-General in 1941, under the chairmanship of Lord Secon, whom he now succeeds.

Obituary

We regret to announce the death of M. Paul Herché, the French radio technologist, who has been associated with our French contemporaries, L'Astrone and L'Haut-Parleur.

How the World Listens

The International Broadcasting Union has compiled an interesting list of the wireless licence figures of the principal countries of the world on December 31st last. The following is an extract:

- Germany (including Austria): 13,013,919
- United Kingdom: 2,800,610
- France: 1,700,648
- Japan (September): 3,240,044
- Poland: 2,701,472
- Czechoslovakia: 771,941
- Denmark: 752,711
- Switzerland: 565,165
- Norway: 504,549
- Turkey: 270,704
- Australia: 250,412
- New Zealand: 66,000

Long-Distance Television

Good television reception, limited only by motorsc interference, at Frome, Somerset (127 miles from Alexandria Palace), is reported by R.M. Electric, Ltd., of the receiver was a Rogers Majestic Model 11/3.75 kc, incorporating the standard British vision and sound channels, and with an additional single-stage vision amplifier.

A New Name

Radio and Electrical Marketing is in the new title of the Wireless Retailer and Broadcaster, the weekly trade paper published by the Electrical Ind., of which A. E. Robinson is supervising editor and manager. It was first published as the monthly magazine, The Broadcaster. Appealing to Pirates

As a young man, the present writer interviewed the operator of the "Radio Raleigh" licence, which was later taken over by the British Broadcasting Corporation. He was asked what he thought of the station.

"A radio licence is twice blessed. It blesses him that gives and him that takes. Take it out.

MARCH MEETINGS

Wednesday, 1st 6 p.m. I.E.E Wireless Section, Savoy Place, London, W.C.2. Symposium on "Direction finding presented by Dr. R. L. Smith-Rose, the group's secretary. A. E. Robinson is supervising editor and manager. It was first published as the monthly magazine, The Broadcaster.

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The Amateur Transmitting Station

Part VIII.—DC Mains and Battery Operation: Some Notes on 10-Metre Working

I

The foregoing articles in this series have been assumed that an electric supply of the alternating-current kind is available. Though not affecting the basic principles of the transmitter design this assumption has, of course, simplified matters in that the most suitable type of valve, irrespective of its filament characteristics and HT requirements, could be chosen.

It is hardly to be expected that all who may be beginning to take an interest in amateur transmission will be so favourably situated, for there are still large areas in the country where DC is distributed, while in others no electric supply of any kind is available.

The problem that confronts those so placed is how to operate a transmitter in these circumstances.

Let us take the case of a DC supply first. It would not be difficult to find a valve that could be used in the oscillator stage, as any indirectly-heated output pentode will answer if a strict watch is kept on the current flowing through the crystal. The RF amplifier presents a problem, for in the interests of economy the filaments of the two valves ought to be run in series, but most transmitting valves take about one ampere of current.

Filament heating from the DC mains would seem to be out of the question, and the alternative is an accumulator. So far as HT is concerned, the 200 volts or so that will be available are quite enough for the oscillator, and at a pinch could be made to suffice for the RF amplifier, but better results might be forthcoming by the use of pentodes or tetrodes in push-pull, using an alternative two triodes, or a dual triode, such as the new Mullard TVO3-10 which has top anode connections, could be used in a push-pull circuit as shown in Fig. 23. Neutralising is effected by cross-connecting the grids and anodes.

Rotary Converters

The best solution to the HT problem, however, would be found in the installation of a small rotary converter giving an AC output. A ten-watt transmitter built as described requires an AC input of about 70 watts for CW operation, while if power is increased to 25 watts the input goes up to about 90 watts, allowing a little in excess of actual requirements in both cases.

Machines of this size are readily obtainable, as they are made for operating AC receivers and small radiogramophones from DC mains. Anyone who has a private electrical installation of 25 or 50 volts could obtain the power needed for a transmitter from a rotary converter, since such machines are made for any DC input ranging from 6 volts to 250 volts.

If it is proposed to use telephony possibly the best course would be to build a DC-operated audio-frequency amplifier on conventional lines, that is to say, using AC/DC valves throughout, and if necessary employ four valves in parallel push-pull in the output stage. Twelve watts of audio power would readily be obtainable in this way, giving sufficient output to modulate a 20- to 25-watt transmitter.

Small transmitters can be operated from batteries, but strict economy will have to be exercised. The crystal oscillator gives an RF output of the order of three watts at 42 and 21 metres for a total HT consumption of 30 mA at 250 volts, so this unit alone will make a useful low-power transmitter. An extra 30 or 50 mA for a power amplifier would seem quite out of the question when the only available source of HT is dry batteries.

It is, therefore, worth while giving serious consideration to the possible alternative sources of HT. One is a small rotary machine giving, say, 250 or 300 volts DC output at 50 to 60 mA, and taking its power from a six-volt accumulator. The triode crystal oscillator could then be fitted with a 6.3-volt indirectly-heated valve, such as a 6L6G operated with moderately low screen and anode voltages, so that the total HT consumption is limited to about 25 mA.

The RF output on the fundamental and the second harmonic frequencies of the crystal will be sufficient to drive a pentode power amplifier such as the Tungsram OS-12/501 or the Mullard TZ05/20, both of which can be used with a 6-volt accumulator. As the Mullard TVO3-10 also operates from 6 volts it could be used.

Vibrator HT Units

Vibrator HT supply units can be pressed into service for amateur transmitters, but these are really more suitable for operating on a continuous load than with an intermittent load, such as that imposed by a keyed crystal oscillator and Class "C" power amplifier, as the "no-load" voltage is usually rather high. Output currents of the order of 50 to 60 mA can be obtained at 250 volts with this form of HT unit.

Since it is necessary to keep a reasonable load on the HT unit it might be best in a case of this kind to key in the amplifier stage, and the continuous oscillator load will then prevent an excessive rise in output voltage.
The Amateur Transmitting Station—

Telephony transmitters can quite well be operated from vibrator units as the load is a continuous one. Even the modulating amplifier may also derive its HT from the vibrator, provided adequate smoothing is employed.

A large 6-volt accumulator, such as one of 80-ampere-hour capacity or so, will be needed, and a spare should be available so that one is at the charging-station while the other is in use.

It is impossible in this series to deal with all the aspects of amateur transmitting; the object being to start the beginner on a path where the minimum number of snags are likely to be encountered.

There are numerous variations of the circuits described here, and it is only to be expected that, in conversation with other amateurs, he will be told that such-and-such a circuit gives the best results.

This is largely a matter of personal experience, and one of the main interests in transmission is the trying out of new ideas and suggestions.

It is a great mistake, however, to pull the transmitter to pieces and rebuild it to embrace those below ro metres, waves, which expression, though strictly speaking embracing those below ro metres, nothing has been said of the ultra-short waves, which expression, though strictly speaking embracing those below ro metres, provides a basis for comparison.

It is only necessary to set up the transmitter as for 20-metre operation except for the fitting of a 10-metre coil in the anode circuit.

Ten-metre Output

An RF output of about three to four watts will be obtained in this way, and the coil can be constructed as shown in the illustration. It consists of six turns of $\frac{1}{2}$ in. outside diameter copper tube, the coil diameter being $\frac{1}{2}$ in. with the turns spaced $\frac{1}{2}$ in. centre to centre. For the base a piece of Perspex, which is a transparent material obtainable from Premier Supply Stores, was used. It measures $\frac{3}{4} \times \frac{13}{16} \times \frac{1}{2}$ in., and six Clix power-type pins are fitted so that it can be plugged into the Eddystone base on the amplifier unit.

A single turn of No. 18 SWG enamelled copper wire is mounted inside the anode coil as a coupling for a low-impedance feeder. Adjustment for coupling is effected by bending this coil out of the perpendicular. This method of adjustment may seem a little crude, but it is perfectly satisfactory in practice.

A coil of this kind is every bit as rigid as one wound on a former. The neutralising condenser does not have to be disconnected, nor is it necessary to make any alteration in its capacity.

As previously stated this is a temporary measure, and an early opportunity should be taken to make up a frequency doubler stage to insert between the crystal oscillator and the final amplifier. The Tungsram OS-12/501 would probably function quite well as the frequency doubler, and it may be possible to go more fully into this matter at a later date.

In designing the power supply unit the possibility that an addition on these lines might be made was taken into account which is one reason why provision was made for a 6.3-volt filament supply, while the chokes and transformer were chosen to provide if necessary an output current of over 300 mA.

It was stated in Part VI that if a switch be inserted in the primary circuit of transformer T1 the HT supply can be switched off, but it is regretted that with the interconnected primaries of Fig. 10 it will not do so. Each transformer should have a separate terminal jack, and only two interconnections must be made.

An alternative place for the switch would be in the lead which joins to the centre tapping on the HT secondary winding.

The Wireless Industry

The 1939 price list of frequency control units for amateur transmitters has just been issued by the Quartz Crystal Co. Ltd., Kingston Road, New Malden, Surrey.

A well-known American company, which has produced a new high-fidelity receiver, would like to get into touch with a British firm with a view to manufacture under licence in this country. Applications for fuller information, addressed to this office, will be forwarded.

"Silverex," a chemical compound for depositing a silver surface on metals, has been introduced by Rumbaken Electrical Products, 11-13, Liverpool Road, Bennington, Manchester, 3.

Transformers of various types—power, modulation, intervalve, etc.—together with HT and LT chargers, are described in a booklet issued by the Woden Transformer Co., St. John's Square, Wolverhampton. Details of Woden amplifiers for PA or transmitter modulation are also given.

A leaflet describing the Marconi-Ekco Wave Analyser, Type TF 455, has just been issued by Marconi-Ekco Instruments, Ltd. The instrument is primarily for the direct measurement of the components of complex voltage waves of 300 microvolts to 300 volts amplitude; frequency range, 20/3,000 c/s.

The latest catalogue of new books on civil and electrical engineering published by H. K. Lewis and Company, Ltd., 136, Gower Street, London, W.C.1, includes a number of works on wireless subjects.

The Exide Company's range of accumulators and HT batteries includes types to fit recently introduced models by various manufacturers. These new sets include the Censor Model 51, H.M.V. 1401, Marconiphone 876, H.M.V. 1400, Marconiphone 872 and Alfa 30.

The Candler System Company regrets that supplies of the "Book of Facts" recently offered to readers of this journal are exhausted. A new issue is in the press and copies will be sent to all enquirers at the earliest possible moment.
Diverse Transformer Loading

PROBLEMS OF MULTIPLE-SPEAKER INSTALLATIONS

It is required to feed power to four separate loads simultaneously from an output stage having an optimum load of 3,400 ohms, the power being divided as follows:

<table>
<thead>
<tr>
<th>Load</th>
<th>Resistance</th>
<th>Percentage of Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15 ohm</td>
<td>5%</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>10%</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>15%</td>
</tr>
<tr>
<td>4</td>
<td>200 ohm line</td>
<td>50%</td>
</tr>
</tbody>
</table>

What ratios should be provided on the output transformer to achieve this result?

**The above may be reminiscent of an examination paper, but it is a very practical question. Problems of this type are frequently met in radio, PA, recording, etc.**

The needs of the radio amateur are usually limited to supplying two or more speakers of either similar or different impedances so that each receive equal shares of the output. In radio, PA, recording, etc., the main speakers behind the screen must be given more power than the monitor speaker in the operating room. The same applies in recording work, where the cutting head is the major portion of the available power and the monitor speaker only sufficient to ensure comfortable hearing. In PA work any demand may be made, and it is quite usual for an amplifier to feed several outgoing lines of different impedances and requiring power in unequal proportions.

The first step is to discover how the audio-frequency power generated in the anode load of a single transformer can be split up in any required proportions. Suppose a certain valve has an optimum load of R ohms as illustrated in Fig. 1. If the single load (R) is replaced by two loads in parallel, each of 2R ohms, it is evident that the ohmic value of the combined loads will still remain R but that one half of the power will be generated in each of the two parallel loads.

Extending this idea, the load could be made up of, say, 10 resistances in parallel, each of 10R ohms. The total load is R ohms as before, but the output power is divided into 10 equal parts. It is now possible to group these resistances in any desired way and replace the groups by single resistances of equivalent value as shown in Fig. 2 (a) and (b). The output has been divided into three parts of 10 per cent., 30 per cent. and 60 per cent. by substituting three resistances $r_a = \frac{10R}{3}$, $r_b = \frac{10R}{6}$, and $r_c = \frac{10R}{6}$, instead of the single resistance R.

This process can be generalised by imagining the load split into one hundred equal parts and expressing the required grouping as percentages of the total.

**General Statement 1.**—The AC power developed in an anode circuit of a valve can be divided into any given number of parts (say 'n') and in any stated proportions (say a per cent., b per cent., c per cent.,... n per cent.) by replacing the normal load R by 'n' loads in parallel, the values being $r_a = \frac{a}{n}$, $r_b = \frac{b}{n}$, $r_c = \frac{100R}{n}$, etc., by an equal number of transformers stepping the primary of the output transformer into a hundred ohms and the entire argument collapses. It must be noted that the foregoing is true only if $a + b + c + ... + n = 100$.

It is obvious that the output cannot be split into, say, 25 per cent. and 30 per cent., leaving the balance of 45 per cent. unused! This would be equivalent to omitting some of the resistances in Fig. 2 (a), in which case the total load would not add up to R ohms and the entire argument collapses.

Being able to divide the output power as we like, it is an easy step to replace the loads (ra), (rb), (rc), etc., by an equal number of output transformers stepping up or down to whatever impedances one wishes. Fig. 3 (a) will be the equivalent of Fig. 2 (b) providing the primary impedances of the transformers are $10R$, $\frac{10R}{3}$ and $\frac{10R}{6}$. Supposing the secondary impedances are to be $Z_a$, $Z_b$, and $Z_c$, then the transformer ratios calculated by the usual formula will be

$$\frac{10R}{Z_a} \sqrt{\frac{Z_b}{3Z_c}} \text{ and } \frac{10R}{Z_c}$$

All along we have been careful to make the combined impedance of the several loads in parallel remain R ohms. It is therefore unnecessary and uneconomical to use three transformers as suggested in the previous paragraph. A single transformer with three secondaries having the ratios calculated above, and a primary impedance of R ohms will be just as good. This is shown diagrammatically in Fig. 3 (b).

**General Statement 2.**—To feed any number of loads $Z_a, Z_b, Z_c... Z_n$ from an output stage demanding an anode load of R ohms so that the output power is divided amongst the various loads in the proportion of a per cent., b per cent., c per cent.,... n per cent. respectively, the primary of the output transformer should be designed for an impedance of R ohms and the ratios (ignoring transformer losses) should be

$$\frac{10R}{aZ_a} \sqrt{\frac{bZ_b}{cZ_c}} \sqrt{\frac{bZ_b}{cZ_c}} \sqrt{\frac{bZ_b}{cZ_c}} \sqrt{\frac{bZ_b}{cZ_c}} \sqrt{\frac{bZ_b}{cZ_c}}$$

respectively.

The problem we set out to examine has been solved, but there are probably a number of readers who, although appreciating the explanation given above, would prefer to see it illustrated with some actual figures instead of hypothetical x-y's. With this in view the question with which this article opened will be worked through.

To obtain a clear mental picture of the procedure, each step will be described in detail. The starting point is the knowl-
Fig. 3. — Equalising diverse loading by means of multiple transformers.

Fig. 4.—Explaining successive steps in solving the problem given at the opening of this article.

To have a separate transformer for each load is not economical. It is rather similar to using separate mains transformers for the HT and each of the LT windings in a power pack. The arrangement would work excellently, but it saves space, weight and money to lump all the primaries into one and link all the secondaries with this common primary. The same applies in the present case. We know that the four primaries in parallel give an impedance of 3,400 ohms, so a common primary of 3,400 ohms can be used having the four secondaries linked with it. The ratios will remain exactly as already calculated. This final step is illustrated in Fig. 4 (d).

Precisely the same results would have been obtained by substituting the appropriate values in the second general statement where $R = 3,400$, $a = 5$, $b = 40$, $c = 5$.
Diverse Transformer Loading—sufficient to enable the transformers to be correctly manufactured. The gauge of wire with which the secondaries should be wound will depend upon the percentage of the total load to be handled as well as upon the load impedance. Another difficulty is to ensure tight coupling between all windings, failing which the various secondaries may give quite different frequency response curves. However, these matters do not properly belong here and must be left for another occasion.

Letters to the Editor

The Editor does not necessarily endorse the opinions of his correspondents

Wireless and A.R.P.

A S warden in a country parish some 40 miles from London, I find difficulties in conveying quickly to the scattered inhabitants the warnings received by telephony from the chief warden of the district concerned.

Sirens are ineffective for various reasons, and few of the cottages have telephones. There remains personal communication by cycle or car, which requires time.

Most cottages and farms possess wireless sets, and this would appear, as far as country districts are concerned, to afford a means of quick communication from the nearest broadcasting station. Provided the sets were kept throughout the night tuned to the necessary wavelength, when, in the event of necessity, the B.B.C. would put out an air-raid warning in the shape of some super-tuning note and the cost of keeping the sets running would be small compared with the importance of being ready to receive a warning at any moment.

Perhaps some of your technical readers may see their way to discuss the feasibility or otherwise of some such scheme.

C. R. PINDER, M.I.M.M.
Basingstoke, Hants.

Motor Car Interference

I SUGGEST that this problem might be more easily understood by both radio and automobile enthusiasts if they would compare the process of ignition to the projection of a weight, e.g., a shell or common ball.

In a car we desire to cause a spark to jump a gap. Mechanically this is similar to firing a shell and it may be done in two ways, either by the slow building up of an adequate pressure confined so as to be applied to the projectile, or by the sudden release of pent-up energy contained, for example, in a spring.

The modern gun is the example of the confined application of pressure, the old Roman catapult is the example of the release of pent-up spring tension.

The arm of the catapult "whipped" after the release of the projectile, and it is this whipping which corresponds to the high-frequency surge of the present-day ignition system. Radio enthusiasts want to do away with this whip, and the solution is to be found in the gun or, in other words, the use of a higher voltage suitably damped.

This will probably mean oil-immersed ignition coils, better insulation, new plug design and larger distributor leaves, all adding expense to the car, so I do not expect an immediate adoption of any interference.

Free ignition systems on all cars. The solution of the problem, however, will probably improve car performance as well as reduce radio interference.

Swanley.

H. G. P. TAYLOR.

Foreign Relays and Quality

I SHOULD be interested if any reader could inform me as to how the recent relays from Germany, Boultwood's Orchestra, and of the light orchestra on the morning of February 13th, were transmitted.

The quality of reproduction of these transmissions, as received in South London via Brookmans Park, was extraordinarily fine. In view of the "quality" (courtesy title) which is normally available from our own broadcasting chain when anything more than a few miles of land line are involved, it was barely credible that the transmissions specified could have been obtained in a region several hundred kilometres of land line!

In addition, the studios used on these two occasions were very pleasantly "live," and as a result, the music was more and interesting. In many of our own broadcasts the matter sent out is handicapped from the start by production in studios that are too heavily damped. Judging from the published articles, the B.B.C. is aware of this deficiency, and it is to be hoped that the work of reconstructing existing studios will be accelerated. The increasing "liveliness," and attention to microphone placing, would often do much to render programmes as a whole more palatable.

I hope that some of our own engineers heard at least one of these transmissions and noted the effect produced. Broadcasts in Germany have long been noted for this kind of realism. My personal feeling is that I would be well pleased to do without suppressors.

J. QUARMBY.
Oldham.

SPEECH TIMER.

In addition to showing a broadcasting speaker when he is due to stop, this American (General Electric's) device also gives him a warning to begin his peroration at a predetermined number of minutes before his time is up. In keeping with the tendency to a greater volume of broadcasting, adjustments can be made in minutes and seconds.
HF Cables

CONSTRUCTION AND USE OF LOW-LOSS CONDUCTORS

By C. E. MAITLAND, B.Sc.

Baird Television, Ltd.

Here is a growing use for cables working at high frequencies for such purposes as local television redistribution in flats or hotels, public demonstrations, transmitting, receiving and monitoring systems, and for a great variety of experimental and testing apparatus.

A knowledge of the general behaviour of these cables at ultra-high frequencies, and the effect of any particular construction on the electrical characteristics and its relation to the ultimate performance is very useful in gauging relative merits, and makes an interesting study.

First of the many features marking the difference between cables at high and low frequencies is the difficulty of reducing the attenuation of the signal. Losses in ordinary insulating materials, such as rubber, impregnated cotton or paper increase rapidly with frequency, and the need for careful measurement and selection soon becomes apparent.

To illustrate how this and other requirements call for a wide variety of constructions, a drawing is shown of a number of the different calipers at ultra-high frequencies, showing how other requirements may add to the difficulty of achieving this.

No. (1) is a 1/16 in. diameter lead cable, with an inner conductor of 1/4 0.0076 in. tinned copper strand supported in the centre of a thin strip of special low-loss rubber. This strip is given a slight twist along its length to centralise it, and this method of insulation reduces the amount of dielectric used, and with it the attenuation of the cable. There is little extra loss through using a sheath of lead instead of copper since the conductor resistance loss is largely due to the inner conductor, as this is of necessity small compared with the sheath.

No. (2) is a 3/8 in. diameter fully flexible cable employing a braided tinned copper sheath with a protective covering. The inner conductor is a 1/4 0.0076 in. tinned copper strand supported in a ribbed section insulator of low-loss bitumen compound, the air spacing assisting in the reduction of loss.

No. (3) is a 3/8 in. diameter cable with a 3-star section insulator of very open construction, in the centre of which runs a 0.015 in. diameter aluminium wire. The sheath in this case consists of a wrapping of aluminium foil, covered with an open mesh tinned copper braid. Two features of this cable are high characteristic impedance and the light weight of conductor and sheath.

No. (4) is a flexible cable similar to No. (2), but with a diameter of 5/8 in. and solid insulation. This has the advantage of being more compact than previous types, but as the size of the insulator is too small to allow of air spacing, the loss is correspondingly higher.

No. (5) is similar to No. (4), but has a specially large inner conductor of 1/4 0.0076 in. tinned copper strand to give a low characteristic impedance, as is required where one line is used to connect a number of other lines in parallel direct to the supply. In this case the main requirement of the insulator is that it is tough enough to prevent short circuits of the cable when flexed; the loss is rather high.

Calculating Losses

These examples show a number of methods of reducing dielectric loss, and how other requirements may add to the difficulty of achieving this. It is thus useful to be able to find the amount of loss to be expected under given conditions, and this is done very accurately by the following formula for high-frequency cables.

\[ A = \frac{R}{C} + \frac{G}{L} \]

where \( A \) is the attenuation per unit length in nepers.

\( R \) is the total high-frequency resistance of both outer and inner conductor per unit length in ohms.

\( C \) is the capacity per unit length in farads.

\( L \) is the inductance per unit length in henrys.

\( G \) is the conductance per unit length of mhos.

(For conversion to loss in decibels, 1 Neper = 8.68 decibels.)

In this equation the dielectric loss is

Fig. 1.—Construction of various single and twin cables as used for high-frequency work. Characteristics are given in the text.
HF Cables—given by the second term on the right-hand side. From this formula the effect of different quality dielectrics on the total loss of a typical cable is shown in the accompanying graph (Fig. 2). Considering next the loss caused by the conductor resistance, it would seem that the simplest way of reducing this would be to increase the size of the inner conductor until the loss reached a low enough value. But, paradoxically enough, this may actually increase the loss instead of reducing it.

The explanation of this effect is that the characteristic impedance of the cable is lowered as the size of the inner conductor increases, and for the same output the cable will have to deal with higher currents and lower voltages. As a consequence, the FR loss in the cable will increase and may eventually predominate. The effect is accentuated by the fact that the resistance of the inner conductor, owing to the high-frequency skin effect, is inversely proportional to its diameter and not to its cross-sectional area, and the drop in conductor resistance is of less effect than that of the lowered characteristic impedance.

There is thus a certain optimum relation between sheath and inner conductor diameter to give a minimum total loss. The relation between this diameter ratio and the cable loss, and also the characteristic impedance, is shown graphically in Fig. 3, from which it will be seen that a concentric cable with copper sheath and inner conductor will have a minimum high-frequency loss when the ratio of the inside diameter of the outer sheath to the diameter of the inner conductor is 3.59 to 1, and that its characteristic impedance will be 76.6 ohms.

Of next importance to obtaining suitable characteristics in a cable is their measurement; the two essential qualities are characteristic impedance and loss.

A simple and reliable method of measuring the first of these is by calculation from measurements of inductance and capacity made on an ordinary high-frequency bridge. A yard or so of the cable forms a convenient length for measurement, and will give values within the range of most bridges, and if the measurement is made at a relatively low frequency, say, at one megacycle, this length will be sufficiently remote from a quarter-wavelength to avoid unwanted resonance and consequent fictitious results. The characteristic impedance $Z$ is given in ohms by the formula:

$$Z = \frac{L}{\sqrt{C}}$$

where $L$ is the inductance per unit length of the cable in henrys and $C$ is the capacity of the cable per unit length in farads.

In connection with the characteristic impedance, an important point arises which bears on measurements of attenuation. These latter are usually made with apparatus of fixed input and output impedances, thus involving some means of matching when connected to cables of widely differing characteristic impedances.

### Error Through Reflections

An incorrect termination to the cable will result in reflections which can introduce large error into the measurement, especially in the case of a high quality cable where the normal attenuation will be a small quantity. To overcome these difficulties, matching networks of the type illustrated in Fig. 4 will provide a correct match between two impedances of any value, so long as the network resistances are chosen in accordance with the table given, and the two impedances are purely resistive, or at any rate negligibly reactive.

With correct termination obtained in this way, cable attenuation can be measured by the use of a signal generator and a sensitive indicator, such as a field strength measuring unit. Readings are taken of the strength of the signal to give a certain deflection on the indicator, and of that required to give the same deflection when the cable is inserted in the circuit. If the ratio of these two inputs is $(n)$, then the cable loss is $20 \log_{10} (n)$ decibels.

An example is shown in the photograph of this measurement being made at a frequency of 45 megacycles, in which is also illustrated the use of special concentric plugs and sockets for rapid connection and the maintenance of adequate screening. This has a further advantage than an extra short length of a yard or two of cable can be plugged into the circuit as a simple check on correct termination and absence of reflections, which, if present, would be indicated by sudden variations of loss with changes of total cable length instead of a gradual change.

The cables shown in Fig. 1 have been
measured in this way, and the results are given in the accompanying table.

<table>
<thead>
<tr>
<th>Cable</th>
<th>henrys</th>
<th>microfarads</th>
<th>impedance per</th>
<th>per yard</th>
<th>per yard</th>
<th>in ohms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.30</td>
<td>0.37</td>
<td>115</td>
<td>118</td>
<td>3.9</td>
<td>3.0</td>
</tr>
<tr>
<td>2</td>
<td>0.46</td>
<td>0.48</td>
<td>133</td>
<td>133</td>
<td>4.9</td>
<td>3.0</td>
</tr>
<tr>
<td>3</td>
<td>0.67</td>
<td>0.72</td>
<td>165</td>
<td>165</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>4</td>
<td>0.32</td>
<td>1.00</td>
<td>70</td>
<td>70</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.173</td>
<td>0.180</td>
<td>30</td>
<td>30</td>
<td>3.1</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>0.088</td>
<td>0.094</td>
<td>71</td>
<td>71</td>
<td>11.5</td>
<td></td>
</tr>
</tbody>
</table>

It will be seen that the general standard of these cables, which are typical of those in use to-day, is good, and in the case of the cable with the highest loss, reference to the graph of Fig. 3 will show that this is to be expected.

With a large number of different uses, there is a corresponding variety in these cables. A high-impedance cable such as No. 3 is useful where a cathode-coupled valve output circuit is employed, since the impedance of the valve circuit is in most cases above 150 ohms and a high-impedance cable is intended. Again, transformation from one impedance to another is often effected by means of a quarter wavelength of a cable of characteristic impedance which is the geometric mean of the two impedances to be coupled. In such cases it is useful to have a selection of cables of various impedances to provide the correct transformation.

These examples could be further multiplied, but sufficient has been outlined to indicate the many features in high-frequency cables of interest in the field of ultra-short-wave work, and that the future will see many fresh applications.

In conclusion, the author would like to express thanks to Messrs. Baird Television, Ltd., for permission to publish this article.

Random Radiations

By “DIALLIST”

With Care

“A grand piano has arrived for you to try,” announced my wife when I came in the other day. Grand pianos are not up my street, but wireless sets are, and I gathered that an out-sized specimen of these must have turned up. And, sure enough, it was so. Going out to the shed I beheld a gigantic packing case which looked almost big enough to contain a billiard table. Equipped with hammer and case-opener, I set about it. The Eddystone people don’t intend their receivers to suffer in transit, as you’ll realise when I tell you that my first task was to remove forty-two bent internals and one broken lead. However, when it came subsequently to be examined, the damage was found to be no more extensive than one valve with rather badly bent internals and one broken lead.

The Voice of France

The other day when Mrs. Diallist was giving a ban fight, one of her guests, knowing no doubt how basmen traditionally take their holidays, drew me into conversation on the subject of wireless. She was loud and enthusiastic in her praise of the programmes from the French stations and others joined her in maintaining that you were nearly always certain to find something good going, no matter which station you tuned in or what the time might be. As I was sceptical I was urged to prove the pudding by the eating by tuning in them and there any French station that I liked. Bordeaux-Sud-Ouest happened to be nearest to the pointer’s position on the dial; so I tuned up, and the necessary movement of the tuning knob and switched on. There was the usual waiting for the valves to warm up. Then spoke the announcer in a voice of thunder: “Meublées, meublées, meublées, maisonnes, souffrons-vous de la constipation sans le savoir?” I fled to answer a completely imaginary summons from the telephone bell.

In For It

That horrible word “video” will, I am afraid, soon become part and parcel of the English language to describe the vision side of wireless broadcasting. The Americans have adopted it whole-heartedly and they are pretty well bound to pass it on to us. Much as I like Americans I can never quite forgive them for the unkind things that they’ve done to written and spoken English. I wish that they could keep “video” on their side of the Atlantic, but that’s probably too much to hope for.

High-voltage Lighting

Amongst the diversions provided by my Sunday paper was a paragraph about what was described as “an insulated boy.” I can see no reason for any powers of resistance of liability to electricity equal to those of ten grown men.” Thrilled by this promising beginning I read on. The youngster, I learnt, had been unfortunate enough to play with a telephone wire which had somehow become draped over the cables of a power line. Thereupon 7,000 volts flashed through his body and burnt the ground on which he was standing.” But such was the lad’s insulation(!) that he was merely rendered unconscious, badly burnt about the back and deprived of all the fingers of his right hand. To drive home his point the writer added that 7,000 volts would be sufficient to light every house in the village. Much as I appreciate the importance of the matter, unless insulation of the village houses is also of some phenomenal kind! It’s astonishing, in this electrical age, that the lay reporter who expects to write an article on the subject can seldom dip his pen in the inkstand without putting his foot in it.

Movie Television

It is announced that the big fight to-night at the Lightwell between Eric Boon and Arthur Daahar, will be shown on the screen by means of television at two of London’s cinemas. It isn’t, of course, the first time that an important sporting event has been shown on the cinema screen in this way; but it is, nevertheless, a milestone in the history of television, for these two theatres are the first of a big “chain” that will shortly be equipped for giving regular items by television. If the results are satisfactory, as no doubt they will, it will stimulate the development of vision broadcasting; may be far-reaching. It has been stated that if the B.B.C. had not given permission for the pictures to be shown, the promoters would have refused the Corporation permission to televise it at all.

The Tables Turned

If the cinema theatres take up television on the grand scale, a rather curious position may result. In the past, proprietors of theatres and music-halls have been chary at times about allowing their programmes, or parts of them, to be broadcast from the sound stations. They felt that such broadcasting would result in people staying at home and hearing the performance for nothing with the aid of the loud speaker instead of going to the playhouse and paying their way. It was this that prevented the broadcast of the last Command Variety performance. Are we going to see the tables turned in television? Will the B.B.C. and the radio manufacturers be as appreciative of the reproduction of vision programmes in movie theatres as the local authorities have been with regard to the number of folk from buying vision receivers for their own? I don’t think that that is very likely that whole television programmes will be reproduced at the theatres. If their-
rowings from the vision programmes are confined, as probably they will be, to sports-

A Curious Parallel

all kinds of possibilities, some of them not

was, or could have been, forced in the

hardly like the idea that the B.B.C.'s hand

was the "suction" part, which is a long

wave-form, in fact, almost exactly similar to that of
certain typical atmospheres. Atmospheric

shock-excite our aerials, causing them to vibrate at their natural frequency; the

shock-wave of a high-explosive bomb has almost exactly the same effect on buildings.

The Mellow Tone

YOU don't, I think, come across nowadays

quite so many receivers as you used to

which achieve what is popularly known as

the "mellowing" of high frequencies by

resonances and suppressing the upper audio frequencies on mause. Listeners have come to

realise that, however majestic the carpet-

background or how rich the sound when an

orchestra is at work, severe cutting of the

upper audio frequencies can make speech

distinctly difficult to follow. I used to find

that whenever I tried one of the more popu-

larly priced receivers I invariably turned

the tone control (if there was one) as far as

I could go to get the pitched end of its

travel—and then wished that it would go a

good deal farther. Lately I've come across

several sets of this class which left me with-

out that wish; in fact, I have been able to

use them without turning the control hard

over against its clockwise stop.

Why the Late Hour?

Qn several evenings every week I'm an-

noyed by announcements in the nine

clock news bulletin to the effect that in-
teresting, eyewitness descriptions of events that matter will be given in the

fourth news bulletin, which starts at ten

clock. I believe that the statistics of the

B.B.C.'s Listening Research Department shows that the fourth news bulletin has the

smallest audience of any. I don't know the

figures, but I should be inclined to think

that, on the average, the number of people

who listen to it is not much over a quarter

of those who tune in the third news at nine.

Listeners who have to be up betimes in the

morning are either in bed or on their way

there; whilst those who, like myself, seldom

spring from their couches to greet the dawn,
have settled down to a quiet hour or so of

reading. And so all those thrilling things

offered in the fourth news go largely un-

heard because the time when they are

broadcast is convenient to so few. Wouldn't it

be a much better idea if some of them could be given imme-

diately after the third news? Those who

didn't want to listen, feeling that they'd

had enough of news, and soon, could always

switch over to the Regional programme. I

am sure that if the B.B.C. could hear the

groans and the cuss words that are uttered

when they tell us that something that we

very much want to hear is going to be given

over to our neighbours, they'd take this plea to

heart and do something about it.

News from the Clubs

Ashton-under-Lyne and District Amateur

Radio Society

Headquarters: Commercial Hotel, 86, Old Street, Ashton.

Meetings: Alternate Wednesdays at 3 p.m.

Hon. Sec.: Mr. A. King, 6, Broadway, Ashton-under-Lyne.

The number of members is now approaching the fifty

mark. GT 24Y has now obtained the call of GYW.

several stations have changed their airing to the

W3DP type, and reported improved results over the

popular end of the spectrum. The Society is not affiliated to the

R.S.G.S.

In the near future it is hoped to have a demonstration of

several Eddystone short-wave receivers. For the

benefit of those interested a programme of lectures

is being arranged. These will deal with the fundamentals

of short-wave radio.

Brentwood and District Radio Society

Headquarters: Old Palace, 2, Oxford Street, Brentwood.

Meetings: First and third Thursday of each month.

Hon. Sec.: Mr. E. T. Smith, "The Old Palace," Brentwood Road, Shenfield.

At the Annual General Meeting the officers for 1949 were elected.

The Society's transmitter, YG4W, is active on 110 metres and reports would be welcomed on transmissions of 1,800 kc. The Society produces its

d Annal Journal every month.

Exeter and District Wireless Society

Headquarters: Y.W.C.A., 3, Birn's Field, Sidmouth, Devon.

Meetings: Mondays at 7 p.m.

Hon. Sec.: Mr. W. J. Claxton, 5, Sidwell Place, Heavitree, Exeter.

On February 13th Mr. Cornish, of the General Electric Co., gave an interesting lecture on "Short-wave valves," and on February 23rd Mr. G. L. Sebald, of the Mallard Wireless Service Co., dealt with "Harmar's Valves," and on January 26th Mr. R. C. Steane, of the Telegraph Co., Ltd., lectured on the subject of "Short-wave reception and the

design and construction of cabinets for high-frequency work," and gave many interesting demonstrations to illustrate his points.

Northbourne and District Radio Society

Headquarters: The Science Room, Croydon Social Centre, South Norwood.

Meetings: Tuesday at 8 p.m.

Hon. Sec.: Mr. K. M. Tapp, 4, Capel Road, South Croydon.

In his radio reminiscences given at the last meeting Mr. H. Bewin Smith dealt with the whole history of the amateur movement and of the growth of the amateur movement in the last 40 years. At the next meeting, to be held on February 24th, a representative of the Wireless and Television Society, will give a lecture on "Radio Servicing Instruments and their use."

The Medway Amateur Transmitters Society

Headquarters: The Nervy Wire's Club, Dock Road, Chatham.

Meetings: Tuesdays at 9.15 p.m.

Hon. Sec.: N. A. C. Howard, "Veronique," Broadway, Gillingham.

The annual meeting was held on January 2nd. In January with a lantern lecture was given on "The Power of Short-wave Rays through the Earth," by Mr. E. J. Wrench, the lecturer, and he used slides taken by the Radio Wireless Co. Ota, January 16th Mr. M. B. Swaffield, of the Mallard Wireless Service Co., Ltd., dealt with "Rhamar's Valves," and on January 26th Mr. R. C. Stein, of the Telegraph Co., Ltd., lectured on the subject of "Short-wave reception and the

design and construction of cabinets for high-frequency work," and gave many interesting demonstrations to illustrate his points.

Susssex Short-wave and Television Club

Meetings: Mondays at 8.15 p.m.

Hon. Sec.: Mr. E. A. Bowler, "Veronique," Broadway, Gillingham.

Recent events have included lectures by representatives of Standard Telephones and Cables, Ltd., and Vozit Patents, Ltd. The Society have also paid a visit to the Portsea Technical College. The programme arranged for the next few months is as follows:

February 9th.—Lecture by Mr. C. Churms, entitled "The Cathode Ray Tube."—Morse Class.

March 9th and 23rd.—Morse Class.

March 16th—Lecture by R. F. Husband, entitled "The Cathode Ray Tube."—Morse Class.

May 4th and 18th.—Morse Class.

June 1st.—Morse Class.

HENRY FARRAD'S SOLUTION

(See page 177)

FROM the fact that the set was working when being carried about it can be
collapsed that it is battery-driven. If Mrs. Malag was so naive in her surmise concerning
the "special" set, I find her a little less naive than I still pose like her even at this date—it is
fairly safe to conclude that she knows nothing about the necessity for recharging
the sets. The symptoms are quite consistent with this explanation.

THE SOUND STAGE of the new B.T.H. film laboratory at Rugby, where the latest equipment
for processing and printing 16-mm. and 35-mm. sound film has recently been installed; facilities for the production of "silent" sound film is also provided. As the four walls of the studio
are differently treated variations in acoustic conditions can be obtained by changes in working
position on the floor.
Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section

**WIRELESS IN THE STRATOSPHERE**

The invention is concerned with a short-wave wireless outfit for use, say, on a stratosphere balloon, where the aerial normally projects outside an all-metal capsule or cage and so is not accessible from inside. In these circumstances, if the exposed aerial should freeze over when in the stratosphere, or if it should be deformed or damaged in the process of taking-off, the wireless transmitter is automatically put out of action.

To prevent this, means are provided for casting off the damaged aerial and replacing it by a new one, from inside the cage, without losing either heat or oxygen from the latter. The spore aerial, which for use with "centimetre" waves may be of the herring-bone type, is collapsed like an umbrella, and is passed through an airlock type, is collapsed like an umbrella, and is passed through an airlock and is passed through an airlock and is passed through an airlock and is passed through an airlock and is passed through an airlock and is passed through an airlock.

As soon as it emerges into the open the cage automatically opens out by spring action. The outer mounting may be made with a universal joint so that the aerial may be "pointed" in any desired direction.

O. Bornman and J. Pintsch Koun-Gez. Convention date (Germany), March 13th, 1936. No. 495019.

**VALVE COUPLINGS**

A valve amplifier is more coupled through a filter circuit consisting of a non-resonant combination of resistance and reactance in order that the feed-back may give "zero" phase-change for a selected frequency, and a phase-change which varies in opposite senses for frequencies on either side of the one selected. In addition, a negative feed-back is supplied from a fractional part of the output voltage. The arrangement is designed to generate, or selectively amplify, oscillations of sub-stantially pure sinusoidal waveform.

The object is to allow the primary stream of electrons to be strengthened by successive stages of secondary emission.

In the Figure, the parts shown inside the dotted-line square form a "filter" output circuit, from which voltage is fed back from the point P to the grid of the first valve V. A fraction of the output voltage is also fed back from the valve V1 through a variable resistance R and condenser C to a resistance R1 in the cathode circuit of the valve V. By varying the value of the resistance R, the amount of feed-back can be adjusted, so that the circuit acts either as an oscillation-generator or as a selective amplifier.

P. H. Williams and Munholland and Co., Ltd. Application date, April 12th, 1936. No. 497148.

**CATHODE-RAY TUBES**

A cathode-ray tube is formed with three or more glass stems which are arranged symmetrically around the central glass bulb. The object is to allow the primary stream of electrons to be strengthened by successive stages of secondary emission.

The picture to be televised is focused upon a photo-electric cathode mounted at the end of one of the stems. The resulting stream of primary electrons is then drawn forward by the voltage of the adjacent anode until it reaches the centre of the glass bulb. Here the magnetic field from an external winding deflects similarly drawn forward by the voltage of a near-by anode towards the centre of the bulb where the amplified stream that enters the magnetic control field, but, since its direction of travel is now different, it will be differently deflected towards a third stem containing a third target electrode. The process can be repeated indefinitely, or until the amplified stream reaches the required strength.

The British Thomson-Houston Co., Ltd. Convention date (Germany), July 30th, 1936. No. 497160.

**AUTOMATIC "QUALITY" CONTROL**

Automatic selectivity control operates to increase the width of the side-bands admitted to a set when the carrier-wave is strong enough, but is withdrawn on passing from a near-by station. Conversely, for distant signals the admittance band is narrowed down, so that although the quality may fall off, selectivity is improved.

Reproduction, in the latter case, is unfavourably affected by the increased attenuation of the outer side-bands frequencies relatively to those nearer the carrier-wave. This effect is most noticeable in the sharply tuned IF stages of a superhet set.

According to the invention, a negative feedback is established between the second detector and the preselector circuits of the set, through which voltages corresponding to the rectified signals are applied in phase-opposition to the received signals. The object is to increase the modulation depth of the outer side-band components relatively to those nearer the carrier-wave. This offsets the subsequent attenuation that must be expected in IF stages, and so gives a better frequency response and a corresponding overall improvement in the quality of reproduction.


**TELEVISION AMPLIFIERS**

The ordinary single-valve amplifier introduces a phase-difference of 180° between the input and output signals. This phase-reversal has little significance when the valve is handling sound signals, but in television it has the effect of converting a positive into a negative image. The proper phase can, of course, be restored by passing the signals through a second amplifier, but a more economical remedy may be desirable.

According to the invention, a single-valve amplifier is arranged to change the phase-reversal in question. As shown in the Figure, television signals over a wide band of frequencies are fed from a low-impedance transmission line through terminals T₁ to a resistance R in the cathode lead of the amplifier. The resistance should have a value which is large compared with the reciprocal of the mutual conductance of the amplifier valve. The connections are made with a battery B which neutralizes the effect of the current flowing through the valve, so that normally there is no potential drop across it. Under these conditions the output signal in the anode resistance R₁ will maintain the phase of the input signal. The grid of the amplifier is earthed through a biasing battery C.


**PROGRAMME INDICATORS**

A framed indicator is arranged to display the item being broadcast at any given hour, from any one of the selected lists of stations. On the front of the casing is a sheet on which a list of transmitting stations appears in a vertical column, with the programme containing a horizontal line against each. The horizontal spacing is divided into twenty-four divisions, one to each hour of the day, these being marked at the top of the casing. A pointer is moved by a clock-driven band along the horizontal "hour" slip, and serves to show the particular item being broadcast at any given hour, and also to indicate the time of day. The "hour" slip is preferably made as a continuous band, which is fitted with two pointers, so that one is visible at all times and the second on the next day. The clockwork drive may be fitted with an alarm, which can be set to give audible warning of any particularly desirable item.

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TEST REPORT, Jan. 5th, 1939
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